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<i>June 28, 1989</i>

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Disarmament Div.

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SECRET

April 4, 1962

The Deputy Minister,
Department of Transport,
O t t a w a.

(Attention: Mr. M.Fleming)

NOTAMS Concerning Nuclear Tests in the Pacific

The following information will supplement and confirm that given to Mr. Fleming by Mr. Reynolds of this Department this morning.

2. On instructions from London, Earncliffe has informed us that in order to ensure safety of aircraft and shipping in the event of nuclear tests taking place in the vicinity of Johnston Island and Christmas Island in the Pacific, it will be necessary as a routine step to issue an announcement now defining areas in which movement would involve some danger.
3. The announcement will be issued by both the United States and the British authorities. The danger area in relation to Christmas Island will take effect from April 15 and that in relation to Johnston Island from April 30.
4. The British Admiralty are arranging for naval authorities in the Pacific area to make a broadcast announcement to mariners in respect of the Christmas Island area at 2200 hours GMT on April 4. The British Air Ministry will issue a notice to airmen (code word: NOTAM) in respect of the Christmas Island area at the same time and date. This will be repeated on the Ministry of Aviation's Air Information Service for distribution to civil airlines. The U.S. authorities only will issue a warning to mariners and aviators in

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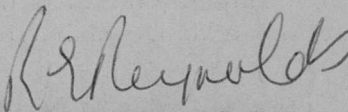
- 2 -

respect of the Johnston Island area.

5. Texts of the notices to airmen and mariners will be passed on receipt.

6. Although these NOTAMS will be brought to the attention of CPA in the routine manner, we understand that you will also take the double precaution of informing CPA, which will be the only Canadian Air Line affected.

7. If the NOTAM should be brought to the attention of Canadian ships as well we would appreciate your Department taking the necessary action.


1 Under-Secretary of State
for External Affairs

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TO EXTERNAL 622 PRIORITY
INFO PERMISNY NATOPARIS EMBPARIS LDN
TT BONN BRU ROME HAGUE FM OTT
BAG COPEN ATHENS OSLO LISBON ANKARA FM LDN
REFOURTEL 613 FEB28
ROLE OF NUCLEAR WEAPONS

YOU WILL PERHAPS HAVE SEEN THE ARTICLE ON THE FRONT PAGE OF TODAYS (MARI)NY TIMES INCORPORATING A STATEMENT ISSUED BY THE SEC OF STATE IN CONNECTION WITH THE WASHINGTON STAR REPORT ON THE ALLEGED VIEWS OF THE SEC ON THE ROLE OF NUCLEAR WEAPONS. THE TEXT OF THIS STATEMENT IS SET OUT BELOW. THE ARTICLE ALSO REPORTS STATE DEPT OFFICIALS AS SAYING, QUOTE THE STATE DEPT HAD NEVER RECOMMENDED RESTRICTING NUCLEAR WEAPONS IN THE FACE OF ANY KIND OF ATTACK ON ALLIES OF THE USA... THE DEPT HOPED TO STRENGTHEN THE CONVENTIONAL FORCES IN EUROPE WITH TWO OBJECTIVES: TO DETER ANY AGGRESSION FROM THE EAST AND TO REDUCE THE CHANCES OF A CRISIS IN WHICH NUCLEAR WEAPONS WOULD BE THE ONLY ADEQUATE DEFENSE... THERE SHOULD BE NO RPT NO DOUBT THAT IN CASE OF A MASSIVE ASSAULT BY THE COMMUNISTS, THE WEST WOULD USE THE FORCES AND WEAPONS IT FOUND NECESSARY TO HALT THE ATTACK. THESE FORCES WOULD INCLUDE NUCLEAR POWER IF THAT WAS THE ONLY ALTERNATIVE TO DEFEAT UNQUOTE.

2. THE FOLLOWING IS THE TEXT OF THE SEC OF STATES STATEMENT: TEXT BEGINS: I HAVE, OF COURSE, EXPRESSED MY VIEWS ON SUCH SUBJECTS IN DISCUSSIONS WITH THE ADMIN. I EXPECT TO DO SO IN THE FUTURE. WHEN CURRENT STUDIES ARE COMPLETED, THEY WILL BE CONSIDERED BY THE PRESIDENT, WHO WILL DETERMINE THE ATTITUDE OF THE EXECUTIVE BRANCH AND THE PROPOSALS TO BE MADE TO THE CONGRESS.

WE ARE ANXIOUS TO BRING ABOUT LEGITIMATE EASING OF TENSIONS THROUGHOUT THE WORLD. WE ARE HOPEFUL THAT SUBSTANTIAL PROGRESS ALONG THESE LINES CAN BE MADE IN THE COMING MONTHS. IN ADDITION,

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PAGE TWO 622

WE WILL CONTINUE TO STRIVE FOR SAFEGUARDED MEASURES OF ARMS CONTROL.

HOWEVER, UNDER PREVAILING CONDITIONS WE ARE DETERMINED, IN COOPERATION WITH OUR ALLIES, TO ENHANCE THE COMMON DEFENSE TO ASSURE THE SECURITY OF THE FREE WORLD. I HAVE LONG FELT THAT THIS WILL REQUIRE THE STRENGTHENING THE NON NUCLEAR ASPECTS OF THAT DEFENSE AS WELL AS THE MAINTENANCE OF ITS NUCLEAR ASPECTS. OUR COMMITMENTS TO THE COMMON DEFENSE ARE KNOWN, AS IS OUR DETERMINATION TO BACK THEM. TEXT ENDS.

50219-D-46
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orig 4901-7-46

FM WASHDC FEB28/61 CONFD

TO EXTERNAL 613 PRIORITY

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ROLE OF NUCLEAR WEAPONS

YOU WILL HAVE SEEN THE REPORT IN TODAYS(FEB28)NY TIMES CONCERN-
ING SEC RUSKS REPORTED VIEWS ON THE ROLE OF NUCLEAR WEAPONS.
THE STORY FIRST APPEARED IN YESTERDAYS(FEB27)WASHINGTON EVENING
STAR.THIS REPORT PURPORTED TO OUTLINE VIEWS EXPRESSED BY SEC RUSK
TO SEC OF DEFENSE MCNAMARA ON THE ROLE OF NUCLEAR WEAPONS IN
THE FOLLOWING TERMS:QUOTE

- 1.USE OF THE BIG MISSILES AND BOMBERS CARRYING ATOMIC WEAPONS
SHOULD BE CONFINED TO DETERRENCE OF ATTACKS ON THIS COUNTRY AND
DETERRENCE OF SINGLEQUOTE NUCLEAR BLACKMAIL.SPNGLEUNQUOTE
- 2.ATTACKS ON EUROPE SHOULD BE MET WITH SINGLEQUOTE CONVENTIONAL
SINGLEUNQUOTE, NON-NUCLEAR WEAPONS UNLESS THE ENEMY STARTED TO
USE NUCLEAR WEAPONS.
- 3.LIMITED AGGRESSIONS OUTSIDE EUROPE SHOULD BE HANDLED BY OUR
TROOPS,RATHER THAN THOSE OF OUR ALLIES,AND WE SHOULD USE NON-
NUCLEAR WEAPONS IN MEETING SUCH AGRESSION.UNQUOTE THE EVENING
STAR ART CONCEDED THAT THE VIEWS EXPRESSED WERE NOT RPT NOT
QUOTE FIXED UNQUOTE AND THAT EVEN WITHIN STATE DEPT ITSELF THEY
WOULD HAVE TO BE QUOTE REVIEWED AND PERHAPS REVISED IN THE LIGHT
OF CURRENT POLICY STUDIES UNQUOTE.THE REPORT ATTRIBUTED THE INFO
TO QUOTE STATE DEPT SOURCES UNQUOTE.
- 2.THE REPORT IN THE TIMES CARRIES THE TEXT OF STATE DEPT PRESS
OFFICERS COMMENT:
QUOTE SEC OF STATE OF COURSE EXPRESSES HIS VIEWS TO THE SEC
OF DEFENSE ON A CONTINUOUS BASIS.HOWEVER,THE STORY TODAY IS A
GROSSLY DISTORTED VERSION OF VIEWS EXPRESSED BY THE SEC OF STATE
TO SEC OF DEFENSE.

...2


PAGE TWO 613

QUOTE THE VIEWS IN THIS ART DO NOT RPT NOT REFLECT THE VIEWS OF DEPT OF STATE.THESE ARE MATTERS INVOLVING LIFE OR DEATH CONSIDERATIONS,NOT RPT NOT ONLY TO AMERICANS BUT TO THE PEOPLES OF THOSE NATIONS WITH WHICH WE ARE ALLIED IN SOLEMN TREATY COMMITMENTS AND TO THOSE WITH WHOM WE HAVE THE CLOSEST ASSOCIATION.

QUOTE I DO NOT RPT NOT PRETEND TO KNOW THE SOURCE OF THIS REPORT BUT THE PERSON OR PERSONS RESPONSIBLE REFLECT THE MOST IRRESPONSIBLE AND RECKLESS ATTITUDE I CAN CONCEIVE.I REPEAT THE VIEWS EXPRESSED IN THIS ART ARE THE GROSSEST DISTORTIONS OF THE VIEWS HELD BY DEPT OF STATE.UNQUOTE

3.LAST EVENING WE SPOKE TO FESSENDEN(DIRECTOR EUROPEAN REGIONAL AFFAIRS)ABOUT THE ART.HE WAS RATHER GUARDED IN HIS REPLY TO OUR QUESTION WHETHER THE ART WAS ACCURATE INsofar AS IT PURPORTED TO DISCLOSE VIEWS SUBMITTED BY SEC TO SEC OF DEFENSE.HOWEVER HE DID EMPHASIZE THAT THE MEMORANDUM FORMED ONLY PART OF AN EXCHANGE OF VIEWS DURING THE CURRENT REASSESSMENT OF STRATEGY AND THAT IT WAS NOT RPT NOT A FINAL POSITION.THE BURDEN OF THE MEMO HAD BEEN TO EMPHASIZE THE NEED TO STRENGTHEN CONVENTIONAL FORCES.THIS WAS NOT RPT NOT A NEW IDEA,INDEED MR HERTER,IN HIS PROPOSALS TO NATO MINISTERIAL MEETING IN DEC,HAD EMPHASIZED SUCH A NEED.GENERAL NORSTAD HAD ALSO POINTED UP THE DANGER OF TOO MUCH EMPHASIS ON NUCLEAR ARMS.FESSENDEN THOUGHT THE ONLY QUESTION WAS ONE OF DEGREE.THERE WAS NO RPT NO QUESTION,HE THOUGHT,OF TIPPING THE WESTS HAND AS TO PRECISELY WHEN NUCLEAR WEAPONS MIGHT BE EMPLOYED.

TRANSMITTAL SLIP

TO:  Under-Secretary of State for
External Affairs, Canada
ATTENTION: DEFENCE LIAISON (1)
FROM: Canadian Embassy,
Washington, D.C.

Security...Unclassified.....
Date.....March 15, 1960.....
Air or Surface....Courier Bag.....
No. of enclosures.....2.....

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Despatching Authority		Also referred to:																						
Copies	Description																							
2	<p><u>86th Congress (2nd Session)</u></p> <p>H. CON. RES. 611 of March 7, 1960 -- Concurrent Resolution expressing the sense of the Congress with respect to the distribution of nuclear weapons and nuclear weapons secrets to other nations.</p> <p><i>g 10</i></p> <p><i>Mr. [unclear] JHT</i></p> <p><i>Mr. [unclear] (Mr. Jay)</i></p> <p><i>45 me and [unclear]</i></p> <p><i>Harlowe</i></p> <p><i>DL(1)</i></p>	<table><tr><td colspan="2"><u>D-1</u></td></tr><tr><td>1</td><td></td></tr><tr><td>2</td><td>✓</td></tr><tr><td>3</td><td></td></tr><tr><td>4</td><td></td></tr><tr><td>5</td><td></td></tr><tr><td>6</td><td></td></tr><tr><td>7</td><td></td></tr><tr><td>8</td><td></td></tr><tr><td>9</td><td></td></tr><tr><td>10</td><td></td></tr></table> <p>17 MAR 1960</p>	<u>D-1</u>		1		2	✓	3		4		5		6		7		8		9		10	
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86TH CONGRESS
2D SESSION

H. CON. RES. 611

IN THE HOUSE OF REPRESENTATIVES

MARCH 7, 1960

Mr. LANE submitted the following concurrent resolution; which was referred to the Joint Committee on Atomic Energy

CONCURRENT RESOLUTION

Whereas the dispersion and transfer of nuclear weapons to other nations will decrease the chance for negotiating effective international agreements for control of nuclear weapons; and

Whereas the dispersion and transfer to other nations of nuclear weapons will render it more difficult to reach agreement on disarmament; and

Whereas the dispersion of nuclear weapons will increase the chance of nuclear accidents, and of nuclear irresponsibility and nuclear blackmail; and

Whereas the dispersion and transfer to other nations of nuclear weapons will result in the heightening of international tensions; and

Whereas the dispersion and transfer to other nations of nuclear

weapons threaten the survival of our civilization, and of the human race: Now, therefore, be it

1 *Resolved by the House of Representatives (the Senate*
2 *concurring)*, That it is the sense of the Congress (1) that
3 the United States should not transfer nuclear weapons or
4 nuclear weapons secrets to other nations, and (2) that the
5 President should undertake negotiations immediately with
6 the Soviet Union, the United Kingdom, and France to seek
7 agreements prohibiting the transfer of nuclear weapons and
8 nuclear weapons secrets from one nation to another.

86TH CONGRESS
2D SESSION

H. CON. RES. 611

CONCURRENT RESOLUTION

Expressing the sense of the Congress with respect to the distribution of nuclear weapons and nuclear weapons secrets to other nations.

By Mr. LANE

MARCH 7, 1960

Referred to the Joint Committee on Atomic Energy

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50219-D40
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TRANSMITTAL SLIP

TO:..... The Under-Secretary of State for
..... External Affairs, Ottawa.
.....
FROM:..... The Canadian Embassy,
..... Washington, D.C.
.....

Security UNCLASSIFIED
Date..... September 25, 1959.
Air or Surface..... Courier
No. of enclosures..... 2 -

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your information.

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DESCRIPTION

ALSO REFERRED TO:

Aircraft Nuclear Propulsion Program

Report of the Joint Committee on
Atomic Energy, Congress of the USA,
September, 1959.

29 SEP 1959

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1959 SEP 29 AM 10:12

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Congress }
Session }

JOINT COMMITTEE PRINT

AIRCRAFT NUCLEAR PROPULSION PROGRAM

R E P O R T

OF THE

JOINT COMMITTEE ON ATOMIC ENERGY
CONGRESS OF THE UNITED STATES



SEPTEMBER 1959

Printed for the use of the Joint Committee on Atomic Energy

UNITED STATES
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WASHINGTON : 1959

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III

AIRCRAFT NUCLEAR PROPULSION PROGRAM

Report of the Joint Committee on Atomic Energy

I. INTRODUCTION

Public hearings on the aircraft nuclear propulsion program (ANP) were held by the Research and Development Subcommittee of the Joint Committee on Atomic Energy July 23, 1959. This was the first time in the 13-year history of the program that hearings had been held in public session.

The 36 previous meetings of the committee on this subject were held in closed session at the request of the executive branch on the basis of national security considerations. However, in view of the continuing lack of a definitive plan for achieving nuclear flight and a prospective reorientation of the program which would remove existing target dates for technical objectives, some members of the committee considered that the time has come for public discussion of the ANP program so as to provide for a better public understanding of the problems and issues involved.

It was believed that such public hearings could now be held without endangering the national security. On the contrary, it was felt that public hearings at this time would, in fact, enhance the national security through an informed public opinion.

The hearings culminated 11 years of consideration and discussion of the ANP program by the Joint Committee. During these years the committee has lent its active support to this project on recognition of the vital potential of nuclear energy for aircraft propulsion.

Especially in the military sphere, some committee members felt that a need exists—and will continue to exist for some time—for a means of propulsion which will give military aircraft the range and endurance which are not possible with conventional, chemically fueled aircraft. With the availability of nuclear propulsion, whole new dimensions would be added to the spectrum of manned flight, opening up entire new areas for strategic and reconnaissance applications.

Over the years the ANP program has been marked by a series of ups and downs in terms of objectives, financing, and program guidance. The program has been characterized by changes in policy direction and lack of firm objectives. For example, there is apparently no firm requirements by the Joint Chiefs of Staff at present, although the Joint Chiefs have expressed the view that flight testing is desirable when such flight becomes technically feasible. (See p. 8.) Despite these difficulties, steady technical progress has been made by the working scientists and engineers in the field and technical objectives have, in general, been met on schedule. It may well be that future technical progress in the program will require a shifting of primary responsibility for achievement of first flight from the Defense Department to the Atomic Energy Commission, at least through the flight feasibility and demonstration stage.

Appearing at the full day of public hearings were representatives of the Atomic Energy Commission and the Department of Defense, who share responsibility for the conduct of the program. Witnesses included Maj. Gen. Donald Keirn, Director of the ANP project; Philip B. Taylor, Assistant Secretary of the Air Force for Materiel; Gen. Thomas White, Air Force Chief of Staff; Fred A. Bantz, Under Secretary of the Navy; Adm. John T. Hayward, Deputy Chief of Naval Operations for Development; John A. McCone, Chairman of the Atomic Energy Commission; Hon. Thomas Gates, Deputy Secretary of Defense; and Dr. Herbert York, Director of Defense Research and Engineering. Brief statements were also received from representatives of the major contractors contributing to the program, including the General Electric Co., Pratt & Whitney Co., and Convair Division of the Dynamics Corp.

The printed record of the hearings, which contains the oral testimony of the above witnesses and supplementary statements and materials for the record, will provide the public for the first time with a comprehensive description of the ANP program, including its history, present status, and discussion of plans for the future.

II. HISTORY OF PROGRAM

As indicated in the detailed chronology attached to this report, the first study project on the ANP program was initiated under contract to the Air Force in May of 1946 by the Fairchild Engineer & Airframe Co. to explore the feasibility of nuclear-powered aircraft. This was the so-called NEPA project (nuclear energy for the propulsion of aircraft) which was located at Oak Ridge shortly after its inception. Over the next several years, the project was reviewed by various groups inside and outside the Government, including the Massachusetts Institute of Technology, which issued the so-called "Lexington Report" in September 1958, predicting the feasibility of nuclear flight in about 15 years.

In early 1951 the NEPA project at Oak Ridge was phased out after general feasibility was indicated and a decision was taken to shift the program to an industrial contractor, the General Electric Co., for development on a propulsion plant.

In mid-1951 the Defense Department informed the Joint Committee that the Joint Chiefs of Staff had established a military requirement for construction of a nuclear powerplant suitable for aircraft propulsion. By 1952 plans were underway to flight test a nuclear propulsion system in the 1956-58 period, utilizing a converted B-36 as a flying test bed. Later in the year the Office for Aircraft Nuclear Propulsion (ANPO) was established to coordinate AEC and Defense Department participation in the program, in line with suggestions by the Joint Committee.

In the spring of 1953 the first of the major cutbacks occurred. The Defense Department initially "canceled" the ANP program, but reconsideration of this decision was made following active intervention by the Joint Committee. As part of the reoriented program which followed, plans for a flying test bed were canceled and a series of "high temperature reactors experiments" (HTRES) were initiated to develop reactor systems for a direct cycle nuclear propulsion plant. Work was also begun by the Pratt & Whitney Co. and Oak Ridge National Laboratory on development of an indirect cycle system as an alternative technical approach for aircraft propulsion.

In 1954 the Joint Committee transmitted a report to the President, Secretary of Defense, and Chairman of the Atomic Energy Commission calling for a sharply stepped-up effort to achieve nuclear flight. A high performance aircraft program was initiated a year later, aimed at testing a prototype propulsion plant about 1959.

In the years that followed steady technical progress was made on the "heater" reactor experiments, but the high performance aircraft program was canceled, following a technical reappraisal of the status of the art and a review by the Budget Bureau.

In the fall of 1957 proposals were made in the Defense Department to the Deputy Secretary of Defense for an "early flight" program utilizing a modified conventional military aircraft as a flying "test

bed." The Joint Committee gave strong support to this proposal and, in a letter to the President, Chairman Price urged a vigorous program looking toward early nuclear flight, both as a military requirement and also to bolster U.S. scientific prestige following the launching of the Soviet sputnik.

After some indications of a favorable reception to these proposals, the President's Adviser on Science and Technology appointed a special panel early in 1958 to review the program. This was the eighth in a series of committees in the executive branch which has been asked to review the program since its inception in 1946. This panel, which was later reconstituted as an advisory group to the Defense Department, recommended proceeding with a flight program.

In early 1959, the chairman and vice chairman of the Joint Committee, together with the chairman of the Research and Development Subcommittee, issued a joint statement again urging adoption of an early flight program. In April, at the suggestion of the committee, Deputy Defense Secretary Quarles and Chairman McCone of the AEC accompanied members of the committee on a personal inspection tour of the General Electric project in Evendale, Ohio, for a briefing on progress in development of the direct cycle propulsion system. The next month, following a top-level meeting of Defense Department and AEC officials, instructions were given to prepare a draft recommendation to the President with regard to an early flight program.

Following the untimely death of Secretary Quarles, this procedure was set aside and the Joint Committee learned that a major reorganization was in prospect, including the abolishment of existing target dates for a ground test prototype propulsion system and abandonment of the present technical program aimed at development of such a system. The committee thereupon announced that public hearings would be held in mid-July.

III. MAJOR POINTS COVERED

A. PROGRAM PURPOSE AND MILITARY REQUIREMENTS

It was generally agreed by all witnesses that a basic need exists for the development of a reactor-engine propulsion system capable of providing nuclear flight for military aircraft. There were differences of opinion as to how firm a requirement there is for such a nuclear-powered aircraft and what time scale is appropriate.

With regard to the propulsion systems, research and development is currently being carried out on two basic concepts: (1) The direct cycle system whereby air, which is used to remove the heat from the reactor core, is employed directly to provide the necessary thrust, and (2) the indirect cycle system whereby heat is transferred indirectly to the air from the reactors liquid metal coolant system and the heated air then used to provide thrust. The majority of funds and effort to date have been spent on the direct cycle development program but plans are now underway to increase the indirect cycle effort looking toward development of advanced reactor materials.

There has been considerable confusion as to terminology applying to the programs, particularly with regard to the word "useful" when applied to first nuclear flight. Several witnesses including the project director, pointed out, in this connection, that specific requirements are not necessarily needed in a development program aimed at demonstrating feasibility of new propulsion systems. They emphasized that in all such programs intermediate steps, including limited first flight are necessary as basic stages in the development of militarily useful aircraft of full operating capability.

It was clear from the testimony that while no general operational requirement has been approved by the Defense Department, the Air Force has a requirement for a continuously airborne missile launching and low-level penetration aircraft flying at high subsonic speeds. This is the so-called CAMEL system whose operational requirement (GOR 172) was issued in October 1958. The Navy has an interest in a subsonic turboprop system installed in a large flying boat for reconnaissance and antisubmarine warfare purposes.

It was noted that "General Operational Requirements" are in the process of being replaced in the Air Force by (a) "Specific Operational Requirements," describing in specific terms the characteristics of a weapons system required for near term needs which is technically ready for production; and (b) "Systems Development Requirements," covering new systems presently beyond the technical state of the art but for which an operational requirement is foreseen.

General Keirn, director of the ANP project, expressed the view that a recent Joint Chiefs of Staff report on the ANP program supports a system development requirement but Under Secretary Gates stated that the Joint Chiefs had established no requirement for a nuclear aircraft. (See p. 8.)

AIRCRAFT NUCLEAR PROPULSION PROGRAM

In commenting on the future need for manned military aircraft, General White, the Air Force Chief of Staff, had this to say:

Results of numerous studies have convinced me that for the foreseeable future a requirement will continue to exist for an advanced, operationally-flexible, manned, intercontinental, recoverable, recallable strategic aerospace weapon system which can penetrate and attack the enemy's military forces. Surface-to-surface missiles are expected to increase in reliability, accuracy and flexibility of employment to a point where they will represent a significant contribution to the overall strategic effort. However, there are certain fundamental capabilities which I consider mandatory as a part of our strategic posture and which are not characteristic of missiles. These dictate the retention of the manned weapon system as an integral part of our strategic force structure.

With regard to nuclear propulsion for manned aircraft, he said:

Although the Air Force does not now forecast each specific configuration which future military weapons will eventually assume, we are certain that vital military applications will derive from the development of nuclear propulsion * * *. While it is too early to define the exact weapon system which may evolve, applications now foreseen emphasize the military development requirement for nuclear-powered aircraft.

B. PROGRAM OBJECTIVES

A broad objective of the ANP program has, from the beginning of the program in 1946, been to develop a strategic weapons system which would eliminate the range and endurance limitations of chemical aircraft systems. Within this broad objective there have been wide fluctuations in flight test philosophy, resulting from frequent changes in emphasis and direction of the program by the Department of Defense. But during this time, technical objectives have been generally met by the contractors in the field and their efforts have been directed toward ultimate development of a propulsion system suitable for a useful military aircraft.

It is to be noted that the period since 1946 has been one of major transition in the Nation's military requirements. The period also has been one of swift technological change, characterized by the emergence of ballistic missile systems capable of both strategic and tactical employment. These considerations have imposed upon military planners the difficult and fluctuating burden of allocating available funds between costly commitments for wide range military power in being able to meet the crises of the day and research and development programs to meet the crises of the future. Accordingly, the ANP program has, from time to time, shifted position in the competition for priority.

Major difficulties have arisen, particularly among the contractors in the field, from a lack of clearly defined guidance as to what the objectives of the program are and what time scale, if any, is being used to serve as a measure of progress toward successful completion. Chairman McCone of the AEC noted in this regard:

A clearly stated first milestone toward which the program could be directed would, in my opinion, provide best assurance of its early attainment and would be a real stimulant to all personnel involved in the program.

Later in the testimony, Dr. York described the general outlines of the present program, as it has been reoriented and stated that objectives for the immediate future should be—

(a) Continue the development of only such reactors and powerplants as would be suitable for militarily useful nuclear flight.

From the Office of the Joint
Committee on Atomic Energy

Release No. 246
For Release A.M. Papers
Wednesday, September 23, 1959

The Joint Committee on Atomic Energy today issued a report on public hearings held last July by the Research and Development Subcommittee on the Aircraft Nuclear Propulsion Program (ANP), it was announced today by Senator Clinton P. Anderson, Committee Chairman, and Representative Melvin Price, Chairman of the Subcommittee.

The report, summarizing results of the first comprehensive public hearing on the ANP program since its inception 13 years ago, emphasizes the need for establishment of firm program objectives, including target dates for a ground test propulsion system and for first nuclear flight. It points to the frequent changes in policies governing the program in the past and stresses the importance of providing firm guidelines to the working scientists and engineers in the field.

The report commends the ANP project office for its efforts but notes that the office has often been given responsibilities without commensurate authority to carry them out effectively. The report suggests that in view of Defense Department testimony that the program is basically a research and development effort, Congress may wish to consider placing primary authority and responsibility for the conduct of the program on the AEC, through the flight feasibility and demonstration stage, rather than the Defense Department.

The report stresses the desirability of early flight testing of a nuclear propulsion system, with varying opinions as to the exact timing of such early flight.

The report notes that there has been continuing technical progress in the program to date and that there is virtual agreement that nuclear flight is feasible with materials which are now available. Testimony indicated, in this connection, that budgetary considerations had played a substantial role in the Defense Department's decision not to proceed with a flight prototype program at this time, together with a desire for development of more advanced reactor materials for first flight.

The report emphasizes the importance of continuing a strong program of research and development on more advanced materials to insure better performance in the future, including a vigorous program on the indirect cycle system.

The report includes separate views by some members of the Committee regarding time scheduling for early nuclear flight.

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Increase the effort on the indirect cycle program so as to determine its possibilities at an earlier date than previously contemplated.

(c) Defer initiation of a specific flight program until (1) one of the advanced powerplants is established as feasible and potentially useful, and (2) a flight program can be instituted without seriously interfering with the development of militarily useful powerplants.

In response to questioning, Dr. York observed that detailed aspects of the reoriented program have yet to be worked out and that for the time being no schedules for completion are contemplated.

C. TARGET DATES

It was apparent from the testimony of Defense Department officials that no target dates are established for the program at the present time, either for a ground test prototype propulsion system or for first flight. A reorientation of the program, referred to above, has resulted in virtual abandonment of the "available materials" program for a direct cycle ground test prototype reactor and consequent elimination of the previous ground test target date of mid-1961. It was indicated that this reorientation would entail a delay of about 2 years in construction of such a prototype.

Similarly, the Navy confirmed that no target dates for the Navy program had been set. Witnesses testified that the Navy did not desire to spend additional funds of its own on an accelerated program, but stated that if the Defense Department had agreed to provide the necessary funds for the program proposed by the Navy, a flying boat could have been flown in 1962 or 1963 as a test bed.

Considerable comment was made on the importance of establishing firm target dates, both for ground test and actual flight, as a guide and incentive to the working scientists and engineers in the field. For example, Chairman McCone of the AEC stated:

I would think that the determination of the nuclear-powered aircraft in the air desired at a particular date would be the greatest stimulus to the research and development effort.

The position of the project director, General Keirn, was expressed in this way:

When you reach the stage where you can technically move into a flight test program, it is time to do it because if you postpone it, your basic costs are continuing to run but the costs of moving into the flight test program essentially are unchanged.

General Keirn pointed out further that the test-flight program will be delayed by whatever length of time it takes for a decision to be made to move into it, and that from that point on it would take some 4½ to 5 years to reach nuclear flight. Chairman McCone agreed that the 5-year flight program could only be initiated after a decision is actually taken to fly, whether it is this year or 5 years from now.

The prime contractor for the direct cycle propulsion system development program made this comment regarding the importance of target dates:

The need stands today for such a flight objective—as concrete and definite as possible. The ANP program, up to now, has never had this type of definite long-term objective which has stayed in existence long enough for it to be reached, and the program thus put in a position where a real evaluation of its potential could be made.

Dr. York summed up the Defense Department attitude on the question of target dates by stating:

I would rather be told what the performance wanted was rather than the date. You cannot specify both * * * I myself would choose performance and that is the way I intend to try to do this.

D. EARLY FLIGHT

There was extensive discussion during the course of the hearings on the question of so-called "early flight" of a nuclear plane as a step toward development of a militarily useful aircraft. Proponents of the early flight concept pointed out that historically, aviation development has occurred on a step-by-step basis and that prototype aircraft are always limited-performance vehicles to begin with. The utility of early models is to learn what problems need to be overcome as a necessary prelude to achievement of full operating capability.

Strongly advocating this approach, General Keirn had this to say:

It is my personal conviction that we have reached a point where it is now appropriate to commence the design and construction of an experimental aircraft suitable for flight testing the propulsion systems presently under development and of evaluating the operational characteristics of such an aircraft as a first step in determining the manner in which the unique capabilities of nuclear power in the air can best be utilized.

Commencing such flight testing with a propulsion system, even though it does not meet the military performance as specified in General Operational Requirement No. 172 (CAMAL system), still serves the purpose of developing the powerplant external to the reactor core, the powerplant-airplane combination as a complete machine, and permits us to tackle the many problems of flight, maintenance, servicing, and problems associated with operational techniques irrespective of whether or not the aircraft would be flown at maximum performance. I believe that these problems can be solved concomitantly with the development of improved reactor cores and that these improved cores can subsequently be installed to provide full performance of the aircraft.

The Chief of Staff of the Air Force, General White, concurred in this view, pointing out that only through a flight-development phase will pertinent information and data be obtained in these areas of operational uncertainty so that logical decisions concerning possible follow-in weapon systems can be made. In response to a question, General White stated his personal opinion that the Joint Chiefs of Staff, on the basis of recent discussions of the early flight question, believe it to be militarily desirable to undertake a flight-test program as an extension of the present ANP program, as soon as such a flight program is considered to be technically feasible.

Later in the testimony, Secretary Gates noted that the Joint Chiefs of Staff have—

expressed their conviction that there is considerable military potential in the nuclear-powered aircraft and that early achievement of the capability for nuclear flight would be in the national interest.

Secretary Gates went on to state, however, that the Joint Chiefs were—

unable at this time to establish a military requirement for nuclear-powered aircraft or to define the specific weapons systems for which it would be used. With respect to the future course of the development program, the Joint Chiefs advised that the present program should be extended to include flight test as soon as technically feasible.

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As noted, in this connection, that Secretary Douglas of the Air Force had made this comment in a letter to the Joint Committee in June 1957:

We are convinced that early nuclear-powered flight testing is an important part of the program. It is believed that accomplishment of actual nuclear flight will crystalize and clarify many of the problems concerning radiation hazards, nuclear powerplant operation and maintenance, and the actual capabilities of nuclear-powered aircraft.

Chairman McCone of the AEC expressed the view that—

flight testing of a nuclear-propulsion system would provide useful test data for later systems of improved performance.

He then went on to say, in response to a question:

I think all things considered, Sir, that to proceed with (a ground and flight testing) program would stimulate this whole developmental program. I realize, however, that the decision in this respect is a decision to be made by the Department of Defense which is the using agency.

Reference was also made during the course of the testimony to a report by the AEC General Advisory Committee on June 1959, which said in part:

The work by General Electric (prime contractor for the direct cycle propulsion system) has now reached the point where it appears likely that fuel elements can be developed which will be capable of making the performance of the direct cycle reactor high enough to be useful for propulsion of military aircraft. * * * If the Department of Defense is in favor of proceeding with this system, then the Reactor Subcommittee recommends that the necessary steps be taken to develop the XMA * * * powerplants by General Electric and that these steps include provision for flight testing and demonstration of these propulsion systems as proposed by General Electric and Convair.

Opposition to the early flight concept, voiced principally by Secretary Gates and Dr. York, was based primarily on what they considered to be the inadequacy of available materials in the direct cycle propulsion system and what they believed were serious limitations in their growth potential for higher performance, as well as funding considerations. The nature of this opposition is described in the following sections, namely, E, F, and G.

E. TECHNICAL FEASIBILITY AND ADEQUACY OF PRESENT MATERIALS

There was general agreement among witnesses that materials which are now available for the reactor in the direct cycle propulsion system are adequate to sustain early nuclear flight. There were, however, differences of opinion as to whether the performance to be gained from these materials and their growth potential were adequate to warrant proceeding with an early flight program at this time.

General Keirn expressed the belief that a nuclear-powered aircraft—can be achieved within the state of the art and on a predictable time basis.

Chairman McCone made this observation about the feasibility of a nuclear flight:

Our fundamental technology has now been brought to the point that the question is no longer "can we fly on nuclear power?" but rather, "In what manner do we wish to fly on nuclear power, when and with what kind of performance?"

A somewhat different view was offered by the Assistant Secretary of the Air Force, Mr. Taylor, who stated:

We all agree that it is technically feasible to fly with an atomic powerplant. I think what we are talking about is how good a powerplant and how good an airplane are we likely to develop within the time limit.

Secretary Gates, in referring to conclusions of a study by the Defense Department's Weapons Systems Evaluation Group, stated that nuclear propelled aircraft do not offer a substantial margin of improvement over chemically fueled aircraft. He added that propulsion systems constructed of materials that are essentially in hand at the present time will fall far short of chemically fueled competitors.

Dr. York, testifying in the same vein, expressed the view that an aircraft with a propulsion system utilizing available materials cannot be considered as a militarily useful vehicle and the particular powerplant involved would have little or no growth potential. Together with other witnesses, Dr. York agreed that such a powerplant could probably sustain nuclear flight, but he personally felt that such flight would only be marginal in nature.

A representative of the General Electric Co., chief contractor for the direct cycle propulsion system, had this to say about the present status of development on the direct cycle system:

We now have in hand the technology and capability to provide an aircraft nuclear powerplant of the direct cycle turbojet type which can perform in the air and on the delivery schedule which matches that for the design, fabrication and test of an experimental airplane. This powerplant is currently in final design and initial stages of manufacture.

F. GROWTH POTENTIAL AND PERFORMANCE

As indicated in the sections above, a major argument advanced against early flight was the contention that performance and growth potential of available materials in the direct cycle propulsion system was so marginal that it would be desirable to wait for the development of better reactor materials.

In contrast to this line of argument, General Keirn and contractor representatives contended that operational, servicing, and maintenance problems can be solved at the same time as improved reactor cores are developed. It was emphasized that successively improved reactor cores can be installed subsequently in the same prototype airframe without undue technical difficulty. Thus, General Keirn stated in this connection:

Waiting for the full performance cores before initiating such a flight test program needlessly delays the program, and in the long run is a more costly procedure. We can tackle many problems with the reduced temperature reactor core which we now know how to build and have many of those problems associated with the flight test phase solved by the time we are ready to install a core which will operate at a temperature necessary to provide military power.

A representative of the prime contractor for the direct cycle propulsion system put it this way:

It has been our plan and philosophy of development to try to generate the mechanical systems and control systems, etc., so that they could be readily used with improved materials in the reactor itself * * *. The basic hardware, it is our intention, must be made sufficiently universal so that improvements in reactor technology can be incorporated with a minimum of change.

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Consing this view, Dr. York commented that changing the reactor core could present technical difficulties and that it is "not a minor thing" to substitute a core with advanced materials for one with available materials in the same propulsion system. He then went on:

* * * Many of the results and much of the experience which would be obtained from a premature flight using interim results and possibly dead end design are very likely to be erroneous and misleading * * *. The powerplant using the available materials has little or no growth potential.

Supporting this viewpoint, Secretary Gates stated:

While it is technically feasible to fly an airplane, the airplane we fly under this program is a very limited airplane in performance and flight both. It leads to nowhere as far as further development of the reactor that is flying is concerned * * * it does not produce an airplane reactor that has growth potential for reasonable performance * * *. Everyone agrees that at the proper time we should try out an airframe. (The proper time would be) when we have a reactor that is possible of greater growth than the reactor we would have to use and concentrate on to fly this first airplane.

G. FUNDING AND BUDGET CONSIDERATIONS

It was pointed out at the hearings that during the 13 years which the aircraft nuclear propulsion program has been underway, over \$800 million has been spent to date directly on the program.¹

Of this total expenditure the Air Force portion has been about \$460 million and the AEC portion, about \$380 million. In addition, the Navy has spent about \$12.5 million, mostly in studies of applications and systems. Included in these totals are \$166 million for facilities, the Air Force having spent \$114.5 million and the AEC \$51.5 million. Current rate of expenditure is about \$150 million per year.

TABLE I.—ANP manned aircraft program summary, fiscal years 1946-60

USAF-NAVY-AEC

[In millions]

Fiscal year	Operations	Facilities	Annual total	Cumulative total
1946	\$1.3		\$1.3	\$1.3
1947	2.0		2.0	3.3
1948	6.2		6.2	9.5
1949	6.9		6.9	16.4
1950	6.7		6.7	23.1
1951	8.3	\$0.5	8.8	31.9
1952	20.7	6.2	26.9	58.8
1953	40.6	18.6	59.2	118.0
1954	21.5	3.3	24.8	142.8
1955	46.8	7.1	53.9	196.7
1956	96.8	60.4	157.2	353.9
1957	141.0	45.0	186.0	539.9
1958	130.0	11.4	141.4	681.3
Subtotal	528.8	152.5	681.3	
1959 (estimated)	139.7	19.2	158.9	840.2
1960 (estimated)	143.4	7.0	150.4	990.6
Total	811.9	178.7	990.6	

¹ In addition to this amount, about \$10 million has been spent for collateral projects, such as the reactor facilities at Wright-Patterson Air Force Base.

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TABLE 2.—ANP manned aircraft program by agency, fiscal years 1946

[In millions]

Fiscal year	USAF		Navy, operations	AEC	
	Operations	Facilities		Operations	Facilities
1946.....	\$1.3				
1947.....	2.0				
1948.....	6.2		(\$1.0)		
1949.....	6.9		(.5)		
1950.....	5.3			\$1.4	\$0.5
1951.....	2.8			5.5	.5
1952.....	10.0	\$6.0	(.5)	10.7	.2
1953.....	22.6	6.3	.2	17.8	12.3
1954.....	6.2	.2	.1	15.2	3.1
1955.....	22.4	6.4	.5	23.9	.7
1956.....	46.4	57.4	3.7	46.7	3.0
1957.....	66.1	35.6	1.5	73.4	9.4
1958.....	60.5	2.4	2.9	66.6	9.0
Subtotal.....	258.7	114.3	8.9	261.2	38.2
1959 (estimated).....	63.4	5.8	3.5	72.8	13.4
1960 (estimated).....	68.0	7.0	2.0	73.4	
Total.....	390.1	127.1	14.4	407.4	51.6

¹ Based on current program planning, the total amount may not be placed under contract during fiscal year 1959.

² Excludes \$0.3 of prefinancing.

Figures in parenthesis above are Navy funds transferred to Air Force which are included in the Air Force amounts. These amounts are not included in the Navy total.

Between 85 and 90 percent of the total expenditure so far has been in the general area of propulsion work, with 10 to 15 percent spent directly on airframes, systems studies, and components, radiation effects, basic shielding measurements and so on.

With regard to funding in fiscal 1959, about \$103 million was earmarked for work on the direct cycle program and about \$17 million for the indirect cycle program.

It was estimated by the project director, General Keirn, that in addition to the current \$150 million annual level of expenditure, an accelerated program looking toward early flight of two experimental aircraft would cost about \$340 million spread over 4 to 5 years. It was brought out, that as the first increment in such an accelerated program, it was proposed to increase the Air Force and AEC's budget for fiscal 1960 by about \$25 million apiece, bringing the Air Force total to about \$101 million and the AEC total to about \$98 million. It was proposed that the Defense Department provide an additional \$45 million to cover initial work on airframe development.

In his testimony, General Keirn expressed the opinion that such additional outlays in the next 4 to 5 years for an accelerated program would not only save several years in the achievement of first flight but would also cost less in the long run.

In response to questioning, Assistant Secretary Taylor confirmed that budgetary considerations had played a substantial role in deciding not to proceed with a flight program at this time. He noted that a review of available powerplants would be made at the end of the present fiscal year which may lead to a flight test oriented program, adding that—

consideration of the availability of funds from the 1961 budget will also influence this decision.

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In response to a question as to whether Dr. York would have gone ahead with a flight program if additional funds had been provided, Dr. York stated:

Not on the basis of what I know about all the other things that other responsible groups, equally responsible with ANPO would like to see going further. I think there are plenty of other good places for money besides this one.

It was also brought out at the hearings that about \$200 million has been spent to date on development of available materials for the direct cycle propulsion system which it was proposed to install in an early flight aircraft. Considerable knowledge and experience has been gained in this development effort which will have a useful application in other areas of the atomic energy program. In response to questioning, Dr. York indicated that while not all of the effort on available materials would be suspended, most of the emphasis from now on would be placed on the development of advanced materials, both for the direct and indirect cycle propulsion system. He added that on the basis of "theoretical convictions" concerning the advanced materials now under consideration," he believed there was a real possibility that a "useful" nuclear powerplant could be built.

H. NEW PROTOTYPE VERSUS MODIFIED TEST BED

During the course of the discussions, there was general agreement on the desirability of constructing a new aircraft for initial flight tests. There was some feeling, however, as reflected by Chairman McCone, that a modification of a conventional military plane might be preferable as the first test flight vehicle or "test bed."

In supporting the new prototype plane concept, General Keirn pointed out that even if there were no plan to build an aircraft which might serve as a prototype of an aircraft meeting some military requirement, it would be necessary, in the propulsion system development process, to put an experimental nuclear powerplant in some sort of airframe for flight testing purposes.

Proposals to this effect were made to the Defense Department by both the Air Force and the Navy. Latest of these were in the fall of 1957 when the Air Force proposed a modified conventional tanker plane and the Navy a modified version of the British *Princess* flying boat.

General Keirn made reference in the course of his testimony to the decision in September 1951 to develop a direct cycle system for installation in two modified B-36 airplanes which were to be used as a flying test bed. It was recognized at that time that the reactor did not provide a suitable tactical powerplant but that the flight testing of this powerplant would permit attack on many of the problems of nuclear-powered flight, and provide the understanding through which advanced tactical powerplants could be produced. This flight test element of the program was rejected by the Department of Defense on the basis it would not provide directly for a militarily useful powerplant, and consequently did not warrant the dollar expenditure.

After weighing the various factors involved, General Keirn has concluded that a new airplane designed specifically for nuclear propulsion is the preferable airplane for test flight purposes. He noted, in this connection, that the same new airplane employed for test

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purposes would also be useful in evaluating the military utility of the airplane.

Mr. McCone said he had expressed the hope that a shortcut could be found to flight testing by using an existing aircraft, but that others with competence in this area did not seem to believe that this is as useful or desirable as proceeding with a new airplane designed specifically for nuclear power. He maintained that a reasonably performing test bed plane could be useful for demonstration purposes, although it would obviously have little or no military utility to begin with.

I. PROGRAM ORGANIZATION AND ADMINISTRATION

During the course of his testimony, Secretary Gates noted that there had been some criticism in the past on the management of the aircraft nuclear propulsion program and that the matter was being jointly reviewed by the Defense Department and AEC with the view to determining whether the present management system should be altered. He stated that several alternatives were being discussed, including the possibility of setting up a board-of-directors-type management. Several members of the committee commended General Keirn and the staff for their conduct of the program and the question was raised as to whether the criticism referred to might more appropriately be directed to what the management had to work with in this program. It was agreed by all that unified technical direction of the program, which the Joint Committee had strongly recommended in previous years, is desirable to coordinate the activities of both AEC and the Defense Department, together with the major contractors.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. NEED FOR CONCRETE OBJECTIVES AND FIRM TARGET DATES

Committee hearings and historical review of the program indicate that concrete objectives and firm target dates are essential to provide working scientists and engineers in the field with clear guidelines for a research and development program and to give them the necessary incentives to press forward toward achievement of specified objectives, including target dates for a ground test prototype propulsion system and for first flight. It is recognized that such target dates may not, in fact, be met in every instance, but the impetus they provide constitutes an important factor in the eventual success of a program effort.

It is clear from the hearings and the history of the ANP project since its inception in 1946 that there has been a lack of concrete objectives and target dates either for a ground test prototype propulsion system or for early flight.

B. TECHNICAL PROGRESS

Technical progress in the program to date has been both positive and continuous. In general, technical objectives have been met on schedule.

C. DESIRABILITY OF EARLY FLIGHT

It is evident that early flight with materials now on hand would provide a powerful stimulus toward early development of a fully operational military aircraft propelled by nuclear energy. Many problems associated with nuclear flight could be met and solved through such early flight, with concurrent development of more advanced reactor cores to produce improved performance. The first test aircraft would not be designed to meet the requirements of a fully operational aircraft. It would, however, provide valuable information and possibly save time in the development of a useful military aircraft.

It is in the national interest to achieve nuclear flight as early as possible, not only to meet stated military requirements, but also to provide a boost to world confidence in America's scientific capabilities.

D. IMPORTANCE OF ADVANCED MATERIALS

In any programing effort to achieve early nuclear flight utilizing available materials, there should be continued emphasis on the development of advanced materials so as to insure a better performance and capability in the future. The recent technical advances made in the indirect cycle system appear most promising and it is the feeling of the committee that every effort should be made to push ahead with the proposed experimental reactor program.

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E. NEED TO STRENGTHEN PROGRAM DIRECTION

General Keirn and his staff in the Aircraft Nuclear Propulsion Office have through the years performed valuable services in co-ordinating the efforts of the Atomic Energy Commission and the Defense Department, but the ANP Office has more often than not been given responsibilities without delegation of the actual authority needed to carry out these responsibilities effectively. The concept of coordinated direction of the technical program between the Defense Department and AEC has, in general, worked well since the establishment of the joint office and should be reinforced by firmer top-level support from both agencies.

F. POSSIBLE ALTERNATIVES

In view of statements by Department of Defense representatives that there is at present no general operating requirement by the Defense Establishment for a nuclear-propelled aircraft, and that the program, as it is presently constituted, is basically a research and development effort, the Congress may wish to consider the desirability of placing primary authority and responsibility for the conduct of the ANP program in the Atomic Energy Commission, which is well equipped to carry the program forward as a development effort through the flight feasibility and demonstration stage. Present cooperation with the Defense Department would be continued, under such an arrangement, but the primary emphasis of the program would be upon the development of a ground test prototype propulsion system and the flight testing of such a propulsion system in an experimental aircraft. Such an approach in the committee's opinion should prove out the feasibility of nuclear flight and would provide the basis for a judgment by the Defense Department on firm military requirements for a nuclear-propelled aircraft.

CLINTON P. ANDERSON,
CARL T. DURHAM,
RICHARD B. RUSSELL,
JOHN O. PASTORE,
ALBERT GORE,
HENRY M. JACKSON,
BOURKE B. HICKENLOOPER,
HENRY DWORSHAK,
GEORGE D. AIKEN,
WALLACE F. BENNETT,
CHET HOLIFIELD,
MELVIN PRICE,
WAYNE N. ASPINALL,
ALBERT THOMAS,
JAMES E. VAN ZANDT,
CRAIG HOSMER,
WILLIAM H. BATES,
JACK WESTLAND.

SEPARATE VIEWS REGARDING TIME SCHEDULING FOR EARLY NUCLEAR FLIGHT

Although we concur in the report's conclusion that early nuclear flight is in the national interest, we caution that the report's recommendation that it be accomplished "as early as possible" does not, to us, necessarily connote either a "crash" program or a major step-up in present programming to overcome remaining technical problems.

In declaring that there is no question as to the feasibility of nuclear flight, Chairman McCone pointed out that the questions are, rather:

* * * in what manner do we wish to fly on nuclear power, when, and with what kind of performance?

It is to be noted that the answers to each of the questions raised by Mr. McCone involve judgments based not alone on technical considerations, but on nontechnical ones as well.

The question of the manner in which we wish to fly on nuclear power involves a yet to be made decision as to where, in a spectrum ranging from a flying test bed to a completed weapons system, should early nuclear flight be aimed.

The question of when do we wish to fly on nuclear power involves considered judgment as to the relative priority call on the Nation's not unlimited financial and scientific manpower resources between the ANP program and many other military programs which may be of greater or lesser importance to the national interest.

The question of what kind of performance do we wish from early nuclear flight involves a considered determination of whether the Nation's highest interest lies in low performance flight with existing materials or better performance flight after development of better materials.

Some of the technical witnesses expressed opinions on these non-technical questions which appeared to favor nuclear flight at the earliest possible moment. However, the principal witnesses actually responsible for decisions on nontechnical aspects, Deputy Defense Secretary Thomas S. Gates, Jr., and the Defense Department's Director of Research and Engineering, Dr. Herbert F. York, testified to the effect that the probable answers to them seem not at this time to place the ANP program in a time-scale "first priority" position for available funds and scientific manpower.

In this regard the report points out that the program has, from time to time, shifted position in the competition for priority amongst various military programs as changing international conditions since 1946 have dictated changes in the Nation's military requirements.

Thus, in concurring with the report's conclusion that early nuclear flight is in the national interest, we wish to make it clear that its recommendation to achieve it "as early as possible" should be taken to mean getting something in the air flying on nuclear power at the earliest moment technically possible only when technical and non-technical considerations both clearly point to that interpretation.

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In summary, we believe that amongst various military programs in the national interest, the ANP program should continue to take its place in an order of importance determined by best considered judgment of the Nation's highest interest, based on all factors involved.

BOURKE B. HICKENLOOPER.

HENRY DWORSHAK.

GEORGE D. AIKEN.

WALLACE F. BENNETT.

JAMES E. VAN ZANDT.

CRAIG HOSMER.

WILLIAM H. BATES.

JACK WESTLAND.

APPENDIX

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CHRONOLOGY

1946

- May----- First study project is initiated to explore feasibility of nuclear powered aircraft. This was the so-called NEPA project (Nuclear Energy for the Propulsion of Aircraft) undertaken for Air Force by Fairchild Engine & Airframe Co. Project located in Oak Ridge shortly after its inception.

1947

- December----- Research and Development Board of the Defense Department recommended that the NEPA program proceed on a priority basis as a single unified and coordinated project with AEC.

1948

- January----- President's Air Policy Commission recommends in its report (Finletter report) that steps to intensify research efforts on nuclear plane be taken immediately.
- February----- Joint Committee holds first of 36 meetings on ANP program and receives briefing from Gen. Leslie Groves, Chief of Manhattan Engineering District.
- March----- In a report to Congress, the Congressional Aviation Policy Board urges that program be accorded "the highest priority in atomic energy research and development * * *"
- September----- Report prepared by Massachusetts Institute of Technology at request of AEC (Lexington report) predicted that a nuclear powered aircraft was feasible and could be achieved in about 15 years.

1949

- Spring----- Ad Hoc Steering Committee for NEPA project established to provide program guidance, with representation from Air Force, Navy, AEC, and National Advisory Committee for Aeronautics.
- November----- AEC begins ANP research project at Oak Ridge National Laboratory.

1950

- March----- Aircraft Reactors Branch established in AEC and assumed responsibility for AEC part of NEPA project.

1950

- August----- Technical Advisory Board of Ad Hoc Steering Committee reviews NEPA program and generally endorses it.
- December----- Research and Development Board of Defense Department recommends program for development of subsonic aircraft for flight in 1956-57 period.

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1951

- February----- Air Force and AEC agree to close out NEPA project at Oak Ridge as general feasibility is indicated and research and development phase begins. It is decided to shift the program, under joint auspices, to the General Electric Co. for development of a propulsion plant.
- Do----- Air Force contracts with Convair Division of General Dynamics Corp. for application studies and initiates "flying testbed" program aimed at first flight in 1957.
- Do----- Joint Committee insists that Air Force support the ANP program on a scale sufficient to insure success or cancel it.
- March----- Defense Department informs Joint Committee that Joint Chiefs of Staff have established official military requirement for construction of a nuclear powerplant suitable for aircraft propulsion. Air Force Chief of Staff (General Vandenburg) urges AEC to give project high priority.
- May----- NEPA project officially terminated and General Electric Co. initiates project aimed at development of a powerplant for eventual flight test. Direct cycle system is decided upon later in the year (October).

1952

- April----- Air Force recommends to AEC development of nuclear propulsion system for flight test in subsonic aircraft in 1956-57 period.

1952

- May----- AEC approves use of part of National Reactor Testing Station at Arco, Idaho, as flight test base.
- July----- AEC and Defense Department inform Joint Committee that plans are being made for flight test of a nuclear propulsion system in the 1956-58 period, utilizing a modified conventional plane as a "testbed" (B-36).
- December----- Office for Aircraft Nuclear Propulsion is established to coordinate AEC and Air Force participation in the program, following suggestions by Joint Committee. Maj. Gen. Donald Keirn is named Director of the joint project, as Ad Hoc Steering Committee is phased out.

1953

- March----- Ad Hoc Committee of Air Force Scientific Advisory Board recommends cutting ANP program back by 50 percent on grounds that activities are unwarranted by state of the art and rate of progress.
- April----- National Security Council orders AEC and Defense Department cancellation of ANP program on grounds of budget savings and contention that program is not in the national interest. Secretary of Defense Wilson subsequently orders program canceled, terming nuclear plane a "shitepoke."
- May----- Joint Committee calls urgent meeting to discuss the situation with Under Secretary of Defense Keyes and Secretary of Air Force Talbot. Cancellation of project is termed a misinterpretation of order and it is reported that reorganization of project is underway.
- Do----- The flying "testbed" program is terminated, together with most development on direct cycle propulsion system. Schedules for ground and flight test of propulsion system are indefinitely postponed. Program redirected toward applied research and development on a limited fund basis. Under this revised program a series of high temperature reactor experiments (HTRE's) were scheduled to develop and prove out the reactor powerplant.
- December----- Air Force informs AEC of its renewed interest in manned nuclear aircraft and asks AEC to expedite experimental work.

AIRCRAFT NUCLEAR PROPULSION PROGRAM

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1954

- April----- General Keirn, Director of ANP project, tells Joint Committee that nuclear propelled aircraft could be in operation in as little as 50 percent of scheduled time, given a high priority.
- May----- Joint Committee approves report by its Research and Development Subcommittee calling for a crash effort on the ANP project. Report is transmitted to the President, Secretary of Defense, and Chairman of Atomic Energy Commission.
- July----- Joint Pratt & Whitney and Oak Ridge National Laboratory program established to develop indirect cycle propulsion system.

1955

- February----- AEC reports that progress on direct cycle reactor has exceeded expectations and authorizes additional funds to be spent during the remainder of fiscal year 1955 in support of direct cycle program.
- March----- Air Force issues requirement for high performance nuclear powered aircraft weapons system. Testifies before Joint Committee, indicating that ground test of a prototype of the direct cycle system can be tested in about 1959.
- April----- High performance aircraft program initiated, with project office established at Wright Field. Competition for airframe studies is begun.
- June----- AEC and Defense Department agree to accelerate ANP program with objective of testing prototype propulsion plant about 1959.
- July----- Navy and AEC programs to develop nuclear plane integrated in AEC Aircraft Reactors Branch. Navy expresses interest in subsonic nuclear powered seaplane.
- September----- Test aircraft with small irradiation reactor aboard to test radiation effects and shielding was flown.
- Do----- Pratt & Whitney is authorized to perform work on indirect cycle reactor. Construction of CANEL (Connecticut Aircraft Nuclear Engine Laboratory) facility is started to accommodate anticipated expansion of ANP program.
- November----- Navy requirement for nuclear seaplane is established and AEC assistance in developing propulsion system is requested.
- Do----- Air Force directs teamup of General Electric-Convair and Pratt & Whitney-Lockheed to proceed with propulsion systems for high performance aircraft.

1956

- January----- First "heater" experiment utilizing a direct cycle reactor with a turbojet engine is carried out successfully at Arco, Idaho.
- April----- Navy proposal for third-approach program is disapproved by Defense Department following recommendation by AEC that Navy should utilize efforts of two existing programs.
- June----- Air Force Chief of Staff, General Lemay, tells Joint Committee he believes there is strong requirement for nuclear powered aircraft. He expresses interest in achieving nuclear flight at earliest practicable date.
- July----- General Keirn tells Joint Committee that ground test of a propulsion system is possible about 1959 and first flight about 1960.
- August----- Revised fiscal 1957 program results in 18 months' slippage in program schedule.
- November----- Joint Committee informed of Defense Department policy decision to cut back ANP program.
- December----- New reactor experiment operates successfully at Arco, Idaho, and logs many hours of turbojet operation from nuclear heat.
- Do----- Accelerated program for high performance aircraft canceled following meeting of Defense Department and Budget Bureau officials with the President in Augusta. Direct cycle development continues on reduced basis; indirect cycle effort virtually eliminated. No specific objectives or target dates are retained.

AIRCRAFT NUCLEAR PROPULSION PROGRAM

1957

- January----- Air Force Scientific Advisory Board reviews ANP program. Board recommends less emphasis on engine and airframe development, more on reactor research and development.
- February----- Ad Hoc Committee of Defense Department (Littlewood Committee) begins review of ANP program.
- Do----- Joint Committee calls Defense Department and AEC officials to testify on status of program. Committee members urge that measures be taken to achieve early flight for nuclear aircraft prototype. Deputy Defense Secretary Quarles states that no flight date has been set, says none will be until propulsion system developed which is adequate for useful military plane.
- Do----- Air Force proposes expansion of existing program to include low level subsonic plane.
- Do----- Ad Hoc Panel of General Officers (Mills Panel) appointed in Defense Department to review ANP program and missions contemplated.
- Do----- Joint Committee sends letter to Secretary Quarles expressing concern about lack of firm program objectives and lack of centralized direction of program.
- April----- Joint Committee urges Defense Department to proceed with vigorous ANP program and meets again with Secretary Quarles to emphasize its concern. Secretary Quarles testifies that program objectives have been established for ground and flight test propulsion systems, looking toward first flight in the early 1960's.
- April----- Littlewood Committee report is issued recommending, inter alia, that ANP development program should be carried through flight test stage.
- May----- Ad Hoc Evaluation Board of Air Research and Development Command issues report recommending development of low-level nuclear plane (Canterbury Panel).
- Do----- Budget Bureau sends directives to executive agencies, requiring that fiscal 1959 budget be held at same or lower level than fiscal 1958.
- June----- Air Force Secretary Douglas sends letter to Joint Committee stating: "We are convinced that early nuclear powered flight testing is an important part of the program. It is believed that accomplishment of actual nuclear flight will crystalize and clarify many of the problems concerning radiation hazards, nuclear powerplant operation and maintenance and the actual capabilities of nuclear powered aircraft."
- Do----- Mills report recommends that program objective should be early fabrication and flight testing of prototype propulsion system in the early 1960's. Report noted that problems of propulsion system could only be solved through actual test flight; favored test aircraft as immediate objective.
- Do----- Joint Committee is informed that procedures are being developed for unified project direction under General Keirn for better coordination of AEC and Defense Department activities.
- Do----- Navy proposes to Defense Department that nuclear turboprop plane concept be adopted.
- Do----- Joint Committee again meets with Secretary Quarles to discuss ANP and urge vigorous action on early flight.
- July----- Secretary Quarles approves Air Force program looking toward first flight of experimental aircraft in mid-1960's.
- September----- Budgetary ceilings cause slippage in time schedule for ground test and flight test of direct cycle system. It is recognized that under budget limitation, Pratt & Whitney effort on indirect cycle cannot be carried on as secondary effort at desired levels.

AIRCRAFT NUCLEAR PROPULSION PROGRAM

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1957—Continued

- October----- Defense Department and AEC decide that high level group should be established to review hazards aspects of nuclear plane and make recommendations for national policy. Group is established (Hunsaker Committee) and begins review of program.
- Do----- Representative Price, chairman of Research and Development Subcommittee, after trip to Russia, sends letter to the President urging early flight program, both for military requirements and for psychological reasons in light of Russia's success with sputnik. Letter expresses concern over lack of well-defined objectives and target dates.
- November----- Proposals are made within Defense Department that a program looking toward early flight of a nuclear propelled aircraft be instituted, utilizing a direct cycle propulsion system and a modified test aircraft as a flying testbed. No action is taken.
- December----- Air Force advises Department of Defense of Air Force capability to demonstrate early flight in early 1960's.
- Do----- Navy advises Defense Department of Navy's intent to proceed with early flight program, utilizing modified seaplane with turboprop engines and direct cycle system. Navy says it is prepared to reprogram its own funds to carry out this objective.
- Do----- Hunsaker Committee report expresses concern over potential hazards of nuclear flight over land in development period and recommends first flights be made from island or coastal base. Joint Chiefs and service Secretaries, after review of report, express opinion that such action is premature.

1958

- January----- AEC recommends to executive branch that early flight of nuclear plane should be pursued as means of increasing American scientific prestige in post-sputnik era.
- Do----- President requests his science adviser, Dr. Killian, to review ANP program and Dr. Bacher is appointed chairman of study committee. Bacher group later is reconstituted as Ad Hoc Advisory Committee to the Deputy Secretary of Defense on the ANP Program.
- February----- Air Force makes strong recommendation to Defense Department on acceleration of early flight program aimed at achieving early flight in the early 1960's with direct cycle system.
- Do----- Bacher Committee recommends against accelerating early flight program with available materials and that greater emphasis be placed on more advanced materials capable of producing higher reactor performance.
- Do----- Following meeting with representatives of AEC, Defense Department, Dr. Killian and Dr. Bacher, President decides that accelerated flight program would detract from goal to achieve militarily useful aircraft and disapproves early flight proposals.
- March----- President responds to Representative Price's letter of previous October, stating conviction that needs for development of a high performance military aircraft override early nuclear flight objective.
- Do----- Joint Committee meets with Secretary Quarles to discuss Bacher report on ANP program, including recommendations that plans for early flight be subordinated to increased emphasis of fundamental problems of research and development. Joint Committee is informed that the President has approved Bacher report.
- April----- Joint Committee is given Air Force and Navy briefing which was presented to Bacher Committee. General Keirn reiterates his confidence in direct air cycle system; expresses view new plane should be built for first flight rather than converted conventional plane.

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AIRCRAFT NUCLEAR PROPULSION PROGRAM

1958—Continued

- April----- Joint Committee calls members of Bacher Committee to testify on their report. Bacher Committee reiterates its belief that more fundamental research and development work needs to be done before decision is taken for first flight. Representative Price and some committee members indicate that Bacher Committee report is inadequate and not adequately based on firsthand review of work or reports.
- June----- Strategic Air Command submits formal operating requirement for CAMAL aircraft (Continuous Airborne Missile Launching and Low-level Penetration System).
- July----- Air Research and Development Command is authorized to initiate design-management competition for selection of airframe contractor by Jan. 1, 1959.
- October----- Air Force and Navy present proposals to Defense Department for flight program, and are asked to attempt to reach some common ground to satisfy both requirements. Both services conclude that requirements are not compatible and therefore a common program is not possible.
- November----- Defense Department agrees with AEC that ground test of propulsion system in about 1960 is desirable. Defense Department states that decision on plan for first flight has been deferred.
- Do----- Air Force and AEC present proposals to Secretary of Defense for accelerated early flight program, calling for reprogramming of about \$25 million in fiscal 1960 for each agency as added funds.
- Do----- Third experimental reactor in "Heater" series at Arco begins power tests. Operating incident causes temporary shutdown.
- December----- Following meeting with the President and Budget Bureau officials, decision is taken to cut back proposed AEC and Defense Department budgets to about \$75 million each for fiscal year 1960.

1959

- January----- Joint Committee receives testimony from Secretary of the Air Force, Secretary of the Navy, and Under Secretary of Defense Quarles on status of ANP program. Committee is informed that both Air Force and Navy have established requirements for nuclear propelled aircraft. Air Force and AEC representatives state that both agencies have recommended reprogramming an increase in their own 1960 funds for a flight program but proposals are not approved.
- Do----- General Keirn estimates that budget cutbacks will result in delay of about 1-year in achievement of a ground test prototype and confirms that no decision has yet been taken on flying program.
- February----- Secretary Quarles briefs Joint Committee on program, reiterating position that, until materials problems are solved, program would remain oriented toward development of nuclear propulsion system. Decision on nuclear flight would come later.

1959

- February----- Joint Committee announces scheduling of first public hearings on ANP program for mid-May.
- March----- Convair selected in competition for airframe contractor.
- April----- At Joint Committee suggestion, Secretary Quarles and Chairman McCone of AEC accompany members of the committee on personal inspection tour of General Electric project in Evendale, Ohio, for briefing on direct cycle propulsion system development.

AIRCRAFT NUCLEAR PROPULSION PROGRAM

25

1959—Continued

- May----- Consensus of meeting between representatives of Defense Department and AEC, including Secretary Quarles and Chairman McCone, is that draft recommendation should be prepared for submission to the President calling for an early flight program. Respective staffs are instructed to prepare such a draft recommendation.
- Do----- Following death of Secretary Quarles, Joint Committee postpones public hearings on ANP program.
- Do----- Joint Committee meets with Chairman McCone of AEC and Dr. Herbert York, Director of Defense Research and Engineering of the Department of Defense, to receive clarification on intentions with regard to an early flight program. Committee members are promised a report the following month.
- June----- Deputy Defense Secretary Gates, Dr. York, and Chairman McCone informed Joint Committee of decision to reorient ANP program toward development of more advanced materials and greater emphasis on indirect cycle approach. Committee is informed that decision will result in less work on materials for early flight program and that target dates for ground test prototype and nuclear flight have been eliminated. A delay of at least 2 years in achieving flight test prototype is admitted.
- July----- Joint Committee announces rescheduling of public hearings on ANP program.



TRANSMITTAL SLIP

Attention: Defence Liaison I Div.

TO: The Under-Secretary of State Security UNCLASSIFIED.
..... for External Affairs, Ottawa. Date..... September 2, 1959
FROM: The Canadian Embassy, Air or Surface.....
..... Washington, D.C. No. of enclosures... 1.....

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REVIEW OF NAVAL REACTOR PROGRAM AND ADMIRAL RICKOVER AWARD

HEARINGS

BEFORE THE

JOINT COMMITTEE ON ATOMIC ENERGY CONGRESS OF THE UNITED STATES

EIGHTY-SIXTH CONGRESS

FIRST SESSION

ON

REVIEW OF NAVAL REACTOR PROGRAM
AND ADMIRAL RICKOVER AWARD

APRIL 11 AND 15, 1959

Printed for the use of the Joint Committee on Atomic Energy



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NOTE

The Joint Committee hearing of April 11, 1959, was held aboard the U.S.S. *Skipjack* at sea while the nuclear submarine was establishing new records for speed and depth of operation. The record of that hearing except for deletions of classified information is hereby made a part of the printed record.

The hearing of April 15, 1959, was in open public session for the purpose of presenting to Vice Adm. Hyman G. Rickover a special congressional gold medal in recognition of his achievements in successfully directing the development and construction of the world's first nuclear-powered ships and the first large-scale nuclear power reactor devoted exclusively to production of electricity. The hearing also included a review by Admiral Rickover of the naval reactor program which is hereby made a part of the printed record.

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REVIEW OF NAVAL REACTOR PROGRAM

SATURDAY, APRIL 11, 1959

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY.

The Joint Committee on Atomic Energy met pursuant to call at 8 p.m., in the ward room of the U.S.S. *Skipjack*, at sea, Hon. Clinton P. Anderson (chairman of the Joint Committee) presiding.

Present: Senators Clinton P. Anderson, John O. Pastore, Henry M. Jackson, and George D. Aiken; and Representatives Chet Holifield, James E. Van Zandt, and Jack Westland.

Also present: James T. Ramey, executive director; John T. Conway, assistant director, David R. Toll, staff counsel; and Edward Bauser, technical adviser, Joint Committee on Atomic Energy.

Vice Adm. Hyman G. Rickover, Assistant Director for Naval Reactors, Division of Reactor Development, Atomic Energy Commission; Comdr. William W. Behrens, U.S. Navy, commanding officer, SSN-585 *Skipjack*; and Carlton Shugg, general manager, electric boat division, General Dynamics Corp.

Senator ANDERSON. This is an official meeting of the Joint Committee on Atomic Energy. We meet this evening in executive session aboard the U.S. nuclear submarine *Skipjack*, more than 400 feet below the surface of the Atlantic Ocean and approximately 135 nautical miles out of New London, Conn.

We are present here today to receive a report from Vice Adm. H. G. Rickover, Assistant Chief for Nuclear Propulsion, Bureau of Ships, and Comdr. William W. Behrens, commanding officer of the U.S.S. *Skipjack* on the operation of this new nuclear submarine which completed its first sea trials on March 10, 1959, just 32 days ago. We are present here today also to observe for ourselves the operation of this outstanding submarine and thus obtain firsthand knowledge of what has been accomplished.

It was 4 years ago last month, on March 20, 1955, that the Joint Committee held a hearing aboard the U.S.S. *Nautilus*, the world's first nuclear submarine. We met as a committee below the surface of the Atlantic in approximately the same location we are now.

Congressmen Chet Holifield and James Van Zandt and Senator John Pastore who are present here today were among those who were with me that memorable day 4 years ago aboard what was then the only nuclear submarine at sea. Since then five additional nuclear submarines have gone to sea: the *Seawolf*, the *Skate*, the *Swordfish*, the *Sargo*, and the *Skipjack*. This is a marvelous record of the accomplishments of Admiral Rickover and his splendid team.

On behalf of the committee, I wish to say how pleased we are to be aboard this, the newest addition to our nuclear undersea Navy, and to have the opportunity to meet the fine officers and crew of this submarine and to observe them in their important work.

STATEMENT OF VICE ADM. HYMAN G. RICKOVER, USN

Admiral RICKOVER. Thank you very much, sir. I want to say one thing right at the beginning, and that is that each one of these nuclear submarines constitutes a complete task force in itself. Each of these ships is able, on its own, to perform functions which outstrip the requirements placed on it. Sometimes people ask why these submarines are so big and complex; why don't we make them tiny? Some people would like to see nuclear submarines operate like airplanes—small craft with only a few people aboard, dashing out on a quick mission and then having to return to some protecting ship or base. I believe strongly that such a concept is a degradation of the tremendous potentiality of these ships. In a large surface-ship task force the Navy makes a tremendous investment to get a self-sufficient offensive capability where and when it wants it, with a capability for staying there and doing a job. Now in the nuclear submarine, we have such a capability at low cost. The ocean acts as its protecting screen and as its armor. As a result, the submarine can be made all weapon, rather than part weapon and part shield. Therefore we should look at each new improved feature which is added to the submarine as an increase in the effectiveness of this one-ship task force, rather than concern ourselves unduly over the fact that the submarine may be getting bigger than other submarines or bigger than somebody's idea of an underwater "pursuit ship".

Perhaps I have belabored this point but I think it is an important one.

With this concept in mind we lay out the machinery in these ships so that the ship's force can maintain it. We also provide installed spares of all important equipment wherever practicable. This permits the ships to stay at sea for several months and even to stay submerged for 2 months or more. It means we can operate throughout the whole Arctic region any time of the year and surface at will through the many openings or thin spots in the ice. It means that the ship does not have to return to a base for servicing after a few hours of operation as an airplane does, or as a "small" submarine with "aircraft-type engines" would.

The real significance of these polar voyages is that another large area of the world—larger than the whole United States—which was heretofore secure from war has now been exposed by these exploits. The entire northern coastline of Russia, formerly protected by the Arctic icepack, is now exposed. And of course the same applies to Alaska and to Canada.

So far as the ship is concerned, it is the fastest submarine in the world. It has made a speed of over (classified) knots. The highest previous speed for a nuclear ship was (classified) knots, by the *Nautilus*. These figures are classified. The *Skate* makes about (classified) knots. In this ship we made improvements to get it over (classified) knots. (Classified.) A surface ship often can't make her maximum speed because of the variable surface conditions of the sea or because of heavy weather; a nuclear submarine isn't affected by these weather conditions. Even diesel submarines are dependent on surface weather conditions to use their snorkel.

Our hard-worked diesel submarines now steam about (classified) miles a year at an average speed of less than (classified) knots. A

small fraction of this, less than 15 percent, is totally submerged. On the other hand, our nuclear submarines are now averaging about 40,000 miles a year of which as much as 90 percent is completely submerged.

Senator PASTORE. Does the performance of the *Skipjack* make the *Nautilus* obsolete?

Admiral RICKOVER. No, sir; the *Skipjack* does not make the *Nautilus* obsolete because even the *Nautilus* is so far superior to all others constructed before it. The performances of the *Skate*, *Nautilus*, and *Skipjack* are making all conventional submarines obsolete. They are making perhaps 800 to 900 submarines in the world obsolete.

Senator PASTORE. How do you account for the difference between the *Skipjack* and the *Nautilus*?

Admiral RICKOVER. The *Nautilus* is a two-propeller ship. Her hull shape is not designed for optimum performance submerged. The *Skipjack*, on the other hand, is designed to make maximum speed submerged. She has essentially no superstructure. You may remember when you came aboard there was very little room for people to walk around up there. Also, the fact that she has a single propeller gives her better propulsive efficiency.

Representative VAN ZANDT. What percent of your steampower are you using?

Commander BEHRENS. 85 percent.

Admiral RICKOVER. We are not putting out as much power from the reactor as it is capable of. The limitation comes in the machinery plant. Most of our problems on these ships, incidentally, have been with the conventional machinery and not with the reactor.

Representative VAN ZANDT. We are now turning over the machinery to its full extent?

Admiral RICKOVER. There are various limitations. At this particular moment our condenser vacuum is too good. If we were operating in warmer water we would get higher speed.

I would like to announce at this time, 8:26 p.m., e.s.t. on April 11, 1959, that the captain of the *Skipjack* has just reported to me that we are at a depth of (classified) feet, the greatest depth a submarine has ever been, and that we have attained a speed of (classified) knots, the highest speed any submarine has ever attained. This is the first congressional committee that has ever deliberated so deeply and so fast.

Senator ANDERSON. I am happy to participate in this second record-breaking action. The members of the Joint Committee are very confident that you and your team will continue to lead the world in this area. There is no argument about it. There may be arguments about other programs, but in this one there isn't.

Admiral RICKOVER. I would like to thank the gentleman of the Joint Committee. Without your constant help we would not have this submarine or any other of our nuclear-powered ships.

Senator ANDERSON. More money has already been spent on the nuclear airplane than all the research and development money spent on nuclear submarines, including the cost of your land prototypes and your laboratories, and all of your research and development, and the complete cost of the reactor plants for the first two nuclear submarines; isn't that correct, Admiral?

Admiral RICKOVER. Yes, sir.

Senator JACKSON. I know the entire committee congratulated the captain of the ship and the entire crew for the very competent job they are doing in getting the *Skipjack* ready for acceptance during these trial runs and for the new records they have just established.

Senator PASTORE. Would it violate any rules for us to say publicly we have done this?

Admiral RICKOVER. No, sir, not that you have traveled at a depth in excess of 400 feet, and that you traveled faster than any submarine has ever traveled. (See p. 24.)

Senator ANDERSON. That doesn't mean anything in itself. Has there been any published speed of any of the nuclear submarines?

Admiral RICKOVER. The only figure released publicly is that they can make over 20 knots and go deeper than 400 feet. The British say one of their submarines made 27 knots.

Senator ANDERSON. There are reasons why a nominal speed and depth are given?

Senator PASTORE. Are the figures 400 feet and 20 knots used because they are the figures for a conventional submarine?

Admiral RICKOVER. No; that speed was laid down by President Truman in a speech he made at the *Nautilus* keel laying. The President decided to say "in excess of 20 knots" and that is the figure that has been used since that time.

Senator ANDERSON. Will you tell us about reactor safety? The danger to the people on it? The danger to people who come near it? Is there any danger? Can you tell us that?

Admiral RICKOVER. Yes, sir. I would like to spend a little time on that, if I may. I think it's very important. First, before getting to the details of the safety of any one ship, I must tell you that there is a question in some people's minds as to whether the AEC has any responsibility at all for the safety of these ships once they have been turned over to the Navy.

Representative HOLIFIELD. I think the law is very clear on that. It was certainly intended to be. We have a copy of the act here. Let me read you the pertinent section from the law. The Atomic Energy Act of 1954 states:

CHAPTER 14, GENERAL AUTHORITY

SEC. 161. GENERAL PROVISIONS.—In the performance of its functions the Commission is authorized to—

- b. establish by rule, regulation, or order such standards and instructions to govern the possession and use of special nuclear material, source material, and byproduct material as the Commission may deem necessary or desirable to promote the common defense and security or to protect health or to minimize danger to life or property;

And if that isn't enough, the Commission is authorized in the next paragraph (161c) to—

make such studies and investigations, obtain such information, and hold such meetings or hearings as the Commission may deem necessary or proper to assist it in exercising any authority provided in this act, or in the administration or enforcement of this act, or any regulations or orders issued thereunder.

This authority carries with it the responsibility to exercise that authority "to protect and to minimize danger to life or property."

The responsibility of the Navy for running its ships in no way relieves the AEC of the responsibility for protecting the public. After all, the AEC and its agents made the uranium, they designed

REVIEW OF NAVAL REACTOR PROGRAM

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and the reactor, and they designed and built the reactor plant and safety system. They reviewed its safety and then they turned it over to the Navy. Do you think they can now walk away and forget it?

Admiral RICKOVER. I don't, sir. I was just pointing out that some people in the Commission apparently think so. They seem to think the law isn't explicit on this point. They have lawyers researching it right now. They think that the AEC must either run the ships themselves or else forget about them.

Representative HOLIFIELD. But a reactor in a ship, when it's in a port, is just like any big reactor on land. In fact it may be closer to a lot of people than many central station reactors which are located out in the country. The AEC can certainly not look the other way whenever a nuclear ship comes into port and still claim responsibility for protecting the public from civilian reactors.

Senator ANDERSON. Admiral, how do you handle the safety when you turn one of these reactors over to the Navy?

Admiral RICKOVER. It's quite straightforward. Before the *Nautilus* reactor was started we drew up an agreement between the AEC and the Department of Defense which recognized that each agency had a responsibility where the safeguards aspect of naval reactors was concerned. Nobody questioned it then; it is only recently that the AEC responsibility in this area has been questioned. This agreement, and the memorandums of understanding between the AEC and the Navy which followed it, provided that the AEC would present the design of the reactor plant to the Advisory Committee on Reactor Safeguards for a safety review and that the results of this review would be forwarded by the AEC to the Navy for their guidance. The reactor plant would then become the responsibility of the Navy, except that the Navy was obligated to make available to the AEC all pertinent information and data concerning operation, including safety standards and operational experiences.

This arrangement has worked well. The Navy, after considerable study, has set up a procedure whereby nuclear ships do not go into ports without authorization from the Chief of Naval Operations. He makes the decision, but he seeks out the advice of the AEC. In accordance with the terms of the memorandums of understanding between the Navy and the AEC, this is done informally with me and my people on a day-to-day basis, and the Chairman of the AEC is officially informed whenever basic policy matters are involved. For example, the Chief of Naval Operations has sent letters to the Chairman of the AEC forwarding naval instructions for nuclear ships regarding operation, selection, and training of personnel, and maintenance and repair of the nuclear plants.

Representative HOLIFIELD. Admiral, since these naval instructions form the basic policy by which the Navy operates its nuclear ships, I would like to see them put into the record, along with Admiral Burke's letter to the AEC. (Admiral Burke's letter is classified and is on file with the Joint Committee.)

(The instructions referred to follow:)

REVIEW OF NAVAL REACTOR PROGRAM

DEPARTMENT OF THE NAVY,
BUREAU OF SHIP.
Washington, D.C., February, 25, 1958.

BuSHIPS INSTRUCTION 9890.4

From: Chief, Bureau of Ships.

To: Commander in Chief, U.S. Atlantic Fleet.
Commander in Chief, U.S. Pacific Fleet.
Commander Submarine Force, U.S. Atlantic Fleet.
Commander Submarine Force, U.S. Pacific Fleet.
Commanders, Submarine Squadrons.
Commanding Officers, All Submarine Tenders.
Commanding Officers, All Nuclear Powered Ships.
Commanders, All Naval Shipyards.
All Industrial Managers, USN.
All Assistant Industrial Managers, USN.
All Supervisors of Shipbuilding, USN, and Naval Inspectors of Ordnance.
Commanding Officers, U.S. Naval Ship Repair Facilities.
Commanding Officers, All U.S. Naval Submarine Bases.
Commanding Officers, All U.S. Naval Stations (BuShips).
Commandants, All Naval Districts and River Commands.

Subject: Repair and Maintenance of nuclear propulsion plants for naval ships.

Reference: (a) OPNAV Instruction 03000.5 of February 6, 1958; (b) BuPers instruction 1540.38 of December 31, 1957.

1. *Purpose.*—This instruction is to emphasize for nuclear-powered ships that:
(a) Any repair and maintenance to the propulsion plant must be accomplished in accordance with procedures specifically approved for that class of ship.

(b) Any changes to the propulsion plant must receive prior approval of the Bureau of Ships.

2. *General requirements.*—

It should not be assumed that repair and maintenance procedures prescribed for nonnuclear propulsion plants will be applicable to nuclear plants. Failure to follow procedures specifically approved for repair and maintenance of a nuclear plant could adversely affect reactor safety. Therefore, the instructions contained in the ship's powerplant manual must be strictly adhered to and any deviations which appear to be necessary must receive approval from the Bureau of Ships.

It may not always be apparent to personnel in working on propulsion components and systems of nuclear-powered ships that reactor safety may be involved. It is, therefore, of the utmost importance to insure that no inadvertent changes are made, through nominally routine maintenance, which could adversely affect reactor safety.

The longstanding requirement that any changes in a propulsion plant must receive prior approval from the Bureau of Ships is especially important for nuclear plants. This is necessary because of the possible consequences of a casualty in a nuclear plant and the obligation of the Navy to keep the Atomic Energy Commission informed of any changes which could affect reactor safety. The importance of providing the highest degree of safety in operation of nuclear-powered ships is established by the Chief of Naval Operations in reference (a). Reference (b) states the program of the Bureau of Naval Personnel for insuring that a high standard of selection, training, and qualification is maintained for operators of nuclear-powered ships.

3. *Effective date.*—This instruction is effective upon receipt.

H. G. RICKOVER,
Assistant Chief of Bureau for Nuclear Propulsion.

Distribution list:

SNDL, part II, F2, L1, L2, L3, L19, L30, L35

SNDL, part I 29W, 24G, 32DD, 21 (less GINCNELM) 28K (RONS Only)

Copy to: CNO.

1500 distribution: Rickover (p), Rockwell, Dunford, Shaw, Mandil, Panoff, Leighton, Marks, Grigg, Resnick, Swenson—1500 (25).

Representative HOLIFIELD. This operating instruction makes it clear that the Navy is responsible for operating their ships but that

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the AEC has statutory responsibilities to protect the public. Is anyone objecting to that?

Admiral RICKOVER. There seems to be one school of thought that if the Navy is responsible for the ships then the AEC should stay out of it.

Representative HOLIFIELD. Even where the safety of the public is concerned?

Admiral RICKOVER. Apparently. I would assume myself that the Public Health Service and the Civil Aeronautics Authority in their respective fields would provide adequate legal precedent for an agency being held responsible for protecting public safety without being given policing authority; but this view is not universally accepted.

Representative HOLIFIELD. I certainly agree with your viewpoint on that. And I'm sure the public thinks so—which is also important. Why, if the AEC has no responsibility to protect the public, maybe we'd better look at their appropriations more closely. I've always thought that we were paying for this public protection. If not, we should eliminate some jobs. Have you been acting as if you had responsibility in this matter, or not, Admiral?

Admiral RICKOVER. I have always taken the stand that *res ipsa loquitur*, the action speaks for itself, and that the Atomic Energy Commission is responsible. Acting on this basis, I have worked with the Reactor Safeguards Committee since it was founded, and with its Chairman and other members of that Committee for many years before that. It was first an advisory committee without statutory authority. In 1957, I believe, that was changed and the Committee was established by statute. However, it still does not have independent status. It reports to the Chairman of the Atomic Energy Commission. At any rate, at the time we were developing the *Nautilus* we held frequent meetings with them and they passed on every phase of our design. Finally they approved our design and they approved our operating the reactor alongside the dock. Later they approved operating out of New London, and finally more general operation. The *Seawolf* wasn't approved by them for general operation because it was sodium cooled and the Reactor Safety Committee never did give us the same kind of approval to operate; for this reason we always restricted her operation.

The point is that we have always taken the attitude that it was our personal responsibility to the people in surrounding areas. As I interpret the Atomic Energy Act, the onus for protecting the public rests on the Atomic Energy Commission. The Safeguards Committee also looks to me and my people to give them personal assurance that we are watching the safeguards aspects of these ships closely.

I would like to illustrate this by reading you some excerpts from their letters to the AEC regarding naval reactors.

I understand that the AEC is furnishing your committee with copies of letters they have received from the Safeguards Committee. In the present context you might be interested in some excerpts. They fall into two categories: first, expressions of concern over the hazards of operating naval reactors in port; and second, expressions of their confidence in the close safeguards review which I and my people are giving these ships and their belief that such review should be continued.

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Representative HOLIFIELD. Admiral, may we have those the record?

(The excerpts referred to follow:)

1. EXCERPTS FROM LETTERS FROM THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS) AND FROM THE ATOMIC ENERGY COMMISSION EXPRESSING CONFIDENCE IN, AND NECESSITY TO CONTINUE, CLOSE SAFEGUARDS REVIEW BY THE NAVAL REACTORS BRANCH

1. Excerpt from minutes of Advisory Committee on Reactor Safeguards, transmitted by a letter from the Director of Reactor Development, U.S. Atomic Energy Commission, to the Chief, Bureau of Ships, on April 21, 1955:

"(d) These conclusions and recommendations are based in part on consideration of the high degree of training which has been given the present operators and the extent of technical review of design and operation presently being conducted. The committee feels that maintenance of high standards in both of these regards is essential to continued safe operation."

2. In transmitting these recommendations the Director of Reactor Development, AEC, stated:

"This program has borne the responsibility of establishing policy for the routine operation of a power reactor in a populated area, as well as for special problems associated with mobile reactors, and the satisfactory solution to the hazards problems achieved in the case of the *Nautilus* has been the result of continuing effort by the staff in the Naval Reactors Branch and the Bureau of Ships responsible for this program. Many of the problems involved have been unprecedented. It is important that future problems of this type receive the same careful and thorough attention."

3. Excerpt from letter from Chairman, ACRS, to General Manager, AEC, dated July 12, 1957, subject, "Fleet Operations, *Seawolf*."

"The committee considers that an important factor in achieving this safety record was the high quality and degree of review afforded by the Naval Reactors Branch of the Division of Reactor Development during design and initial operation of these ships."

"In order to insure continued safe operation of nuclear powered naval vessels the committee urges that such review be continued throughout the operation of all nuclear powered naval vessels. This review should include all aspects of design, operating procedures and operational plans which could affect reactor safety; it should also include training and qualification of personnel who operate or maintain naval nuclear propulsion plants."

4. Excerpt from letter from Chairman, ACRS, to Chairman, AEC, dated September 19, 1957, Subject: "U.S.S. *Skate*, SSN578":

"This conclusion is based, as was the case for the *Nautilus* and *Seawolf*, on the Committee's understanding that the same careful surveillance as was exercised by the Naval Reactor Branch in the design of the prior nuclear propulsion plants also will be applied to those aspects of design, training, operating procedures, and plans which could affect the reactor safety of the *Skate*."

5. Excerpt from letter from Chairman, ACRS, to Chairman, AEC, dated August 5, 1958, subject "S5W powerplant":

"The Naval Reactors Branch has demonstrated its ability to monitor the design and construction of nuclear powered vessels and to develop well-trained operating crews."

"The Advisory Committee on Reactor Safeguards, however, wishes to point out that nuclear power ships are not completely free from presenting a possible hazard to the public. There exists an ever-present low-level risk of release of radioactivity * * *

"The Committee reiterates that the prime assurance of safety during building, operating, and repairing nuclear ships at various locations depends upon the proper prior evaluation of potential hazards. This must be done for each new situation and at present, on a case-to-case basis, by persons having a detailed knowledge of the factors influencing reactor safety. This requires that the training of officers and crews of nuclear ships must continue to emphasize knowledge of reactors and reactor safety. It also means that the experience and technical judgement of the Naval Reactors Branch must be utilized to the maximum extent in evaluating such operations. The problem assumes increasing importance as the number of nuclear powered ships increases."

6. Excerpt from letter from Chairman, ACRS, to Chairman, AEC, dated November 12, 1958:

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"he request of the Chairman of the Commission, Admiral Rickover described to the Committee the pertinent experience and lessons learned in the naval reactors program. The Navy's desire to bring nuclear submarines into various populous ports has resulted in considerably more of such operations than the Committee had envisioned when it first commented on nuclear submarine operation. The Committee wishes to repeat the point it has emphasized on previous occasions that entry of nuclear ships into populous ports cannot yet be considered routine or entirely without risk. In this situation, the Committee depends heavily on the technical judgment of the Naval Reactors Branch to evaluate the risk as compared with the necessity for each case. Such judgment by persons responsible for and experienced in the problems of reactor design and hazards evaluation should not be replaced by rules or by routine decisions by persons not knowledgeable in the technical factors involved.

7. Excerpt from letter from Chairman, ACRS, to Chairman, AEC, dated March 16, 1959:

"During the review of the S1C, Admiral Rickover commented on the recent sea trials of the *Skipjack*. It was stated that the nuclear powerplant of the *Skipjack* demonstrated completely its stability and reliability during radical maneuvering, thus proving the basic emphasis placed on safety by the naval reactors group during the design, construction, testing, and operation of naval reactor plants is worthwhile. The ACRS continues to consider it essential that such basic emphasis on safety be continued."

II. EXCERPTS FROM LETTERS FROM THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS), AND FROM THE ATOMIC ENERGY COMMISSION EXPRESSING CONCERN OVER HAZARDS OF OPERATING NAVAL REACTORS IN PORT

1. Minutes of the February 17, 1954, meeting of the ACRS:

"The committee again recommended for long-range planning that serious consideration be given to providing a truly safe base for nuclear powered ships where testing, unloading operations, etc., can be conducted without public hazards even under wartime conditions."

2. Letter of July 12, 1957, from the Chairman, ACRS, to General Manager, USAEC:

"The committee believes that the operation of the *Seawolf* should not be unrestricted and would like to see the Navy develop principles upon which suitable ports may be selected and designate certain specific ports for operation based upon an evaluation of the hazard problem."

3. Letter of September 19, 1957, from Chairman, ACRS, to Chairman, AEC:

"The committee is concerned that with increasing numbers of nuclear powered ships the risks associated with operations in populous ports is intrinsically larger. It is suggested that any plans for operations of nuclear ships take this fact into consideration. Since the continued safe operation of the Navy's nuclear powered ships has an important bearing on the development of the entire reactor program in this country, the committee would be interested in learning of any general plans and criteria which the Navy may be developing for the operation of nuclear vessels in port."

4. Letter of March 8, 1958, from Chairman, ACRS, to Chairman, AEC:

"The ACRS has received OPNAV 03000.5, BuShips 9890.4 and BuPers 1540.38. It is sympathetic to the position taken in which nuclear safety is to be insured primarily by the action and decisions of personnel trained specifically to deal with nuclear systems and their hazards.

"The committee endorses the present Navy practice to consult with and to be guided by the Naval Reactors Branch regarding reactor safety and operational procedures for nuclear powered ships. It considers this practice to be important and urges its continuance.

"To maintain the present admirable safety record of nuclear powered ships, the committee emphasizes the importance of keeping to a minimum consistent with military necessity the number of ports which nuclear powered naval ships may enter, pointing out that as the number of nuclear powered ships increase, consideration should be given to the designation of ports or bases where multiple berthing may be permitted."

5. In transmitting the above comments by memorandum dated April 8, 1958, the Director of the Division of Licensing and Regulation, AEC, stated:

"The three operational documents (OPNAV Instruction 03000.5, BuPers Instruction 9890.4, and BuPers Instruction 1540.38) seem to us to represent a good approach to the problems of operating criteria for nuclear vessels in coastal areas. We believe, however, that eventually the Navy may need to make more

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definitive the boundaries and limitations of the guiding principles (a)) of 3.d(1) of OPNAV Instruction 03000.5 within which vessel commanders c. make decisions in particular situations."

6. Memo from Director, Licensing and Regulation, AEC, to Director, Reactor Development, AEC, dated May 28, 1958, Subject: Proposed operation of the U.S.S. *Skate* (SSN-578) and *Skate* follow ships (SSN-579, 583, 584 and SSG(N) 587):

"In summary, it is our believe that there is reasonable assurance that the proposed operations of these submarines can be conducted without undue hazard to the health and safety of the public. However, as suggested in our previous memorandum of April 8 concerning the criteria and procedures developed by the Navy to assure safe operation of nuclear ships in populous areas, we believe that it may not be completely adequate to rely on the decisions and judgments of the commanding officers in all situations that might develop in the operations of nuclear powered vessels. Rather, it is our belief that eventually the Navy may wish to make more definitive the boundaries and limitations within which vessel commanders can make decisions concerning the operation of their ships in particular situations."

7. Memo from Director, Licensing and Regulation, AEC, to Director, Reactor Development, AEC, dated August 29, 1958, Subject: Hazards review of S5W core 2:

"In view of the increasing number of nuclear ships now in prospect, we recommend development of operational policies and procedures under which the present degree of safety will not decrease with increasing numbers of vessels. As we suggested in our comments with regard to the *Skate* follow ships, more definite guidelines should be available to ship commanders so that their decisions concerning operation near populated areas may rest on more deliberately prepared bases; and, as suggested by the ACRS, there is need for beginning the systematic development of environmental information on coastal areas in which nuclear ship operation is contemplated."

Representative WESTLAND. You say an order was sent out by CNO and it said a ship could go into a port only if absolutely necessary. That order becomes public. How would that affect the operations of a ship like the *Savannah*?

Admiral RICKOVER. I would imagine the people on the *Savannah* will take the same precautions.

Representative WESTLAND. The fact that CNO has come out with an instruction accepting the responsibility will be known. Won't that scare people?

Admiral RICKOVER. A number of people have asked me about it and I have always said—and the words are contained in the CNO instruction—that the operation of nuclear submarines is not entirely without reactor hazards but should be considered an acceptable risk. Our attitude is that we will not unnecessarily take a risk, even a remote one. We design the utmost safety into them. We review the design and fabrication in detail. Everything involving safety or radiation I get into personally. I am only talking about naval ships now, you understand. The merchant ship program is not mine. I'm sure you are aware that there is concern in some parts of the world about a nuclear ship going into a port. The Danes not letting the *Skate* in, and the attitude of the British about the *Skate* entering one of their ports are examples. As time goes on this may become more of an issue. I say that we have the responsibility to assure the public we are not taking any unnecessary or unreasonable risks.

Representative HOLIFIELD. The section of the law I quoted earlier makes it obligatory for the Commission to retain control of standards and criteria by which any of these reactors are built. That responsibility is centered in the Atomic Energy Commission.

Senator ANDERSON. Is that applicable both when in our waters or out?

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Representative HOLIFIELD. I think that any ship that goes into international waters is subject to international law.

Admiral RICKOVER. Once it gets into international waters, the AEC has no control, but wherever it goes the AEC cannot completely escape blame if anything goes wrong with the reactor, because the national law applies.

In any case, the port authorities have the right to decide whether or not they will permit nuclear-powered ships, or any other type ship for that matter, into their ports. What we are doing is that we are trying to establish criteria and experience that will indicate to the public, and that they will gradually accept, that nuclear submarines are safe.

Senator PASTORE. Are we talking about American ports?

Admiral RICKOVER. You can't enter a foreign port either unless prior permission is obtained. The Chief of Naval Operations has ruled that no nuclear powered naval ship can go into any port unless authorized by him.

Now I will tell you just how safe these plants are and to what degree we control the radioactivity.

I have always insisted that reactor plant designs under my cognizance use all reasonable conservatism wherever radiation or radioactivity are involved. I am under continual pressure from many quarters to relax this conservatism by reducing the weight of radiation shielding. I have resisted these pressures and, as a result, our ships have been able to meet even the recently decreased permissible civilian radiation doses without changes in designs or operating procedures. In all matters where shielding, radiation, or safety are concerned, I personally go over the designs. I lay it all out and go over it in detail and approve it myself. No one else in my organization has that authority. I will not delegate that authority to anyone. I consider it that important.

We have gone about as far as we can in reducing radiation and increasing shielding. Further restrictions with regard to radiation or radioactivity could impair the military effectiveness of our nuclear-powered naval ships. This even applies to civilian reactors. Further radiation restrictions would also impose an intolerable expense and administrative burden on the civilian reactor program.

Because of the current interest by Congress and the public in these matters of radiation I have recently reexamined this subject in considerable detail and in particular the question of what it would mean to reduce the permissible radiation levels still further on our ships or at the Shippingport Atomic Power Station. I have reached the following conclusions:

First. Using present radiation standards, nuclear-powered naval ships and the Shippingport station provide adequate protection for the reactor plant operators and for the public.

Second. Radioactivity discharged to the environment by naval reactors and by the Shippingport station is insignificant; it has been shown to be so small as to have no detectable effect on the environment. The amounts of radioactivity discharged are trivial compared with that discharged by some other reactors now considered acceptable.

Third. Further lowering of the permissible levels of radiation and radioactivity would pose serious problems by requiring heavier shielding on ships, by restricting the performance of maintenance on

all reactor plants, by increasing the difficulty of controlling large quantities of radioactivity in air and waste water, and by complicating the problem of measuring and monitoring radiation and radioactivity.

I will explain the basis for these conclusions in more detail.

First I will discuss radiation and shielding.

Present naval reactor shielding meets all existing civilian radiation standards and recommendations, and in addition has the following built-in factors of conservatism:

Present AEC radiation standards, based on recommendations by the National Committee on Radiation Protection and Measurement, permit up to 15 rem in any one year, so long as a person's accumulated dose does not exceed 5 times his age beyond 18 years. To insure always meeting this latter requirement we design our shielding for 5 rem per year.

In our designs we make certain conservative assumptions as to how long a man might stay, on the average, at various locations, and what the average power level of the reactor will be.

We also design the shielding so that the highest radiation level in any compartment will not exceed specifications, and this means that the average radiation levels in each compartment are considerably lower than this.

There are many other factors which we cannot predict precisely but which help reduce radiation. We do not count on any of these in our shielding design. This includes such things as the shielding effect of various equipment, contents of tanks, etc. which may not always be present.

These factors give us considerable conservatism for the average crew member under average conditions. Our records show that the average person in the engineering department of a naval nuclear-powered ship has been receiving about one-half rem per year.

However, the shielding must be designed for the worst case, not the average case. The highest doses received by any person aboard each nuclear ship thus far have been about 1 or 2 rem per year. In addition, there are other factors which will tend to increase the radiation received by personnel in the future. For example, the *Nautilus* and the *Seawolf* first operated about 1,000 full power hours per year, but current operations of nuclear ships are about double that figure, and may increase still further.

In addition to the normal operating doses, allowance must be made for radiation received during maintenance. We must assume that as the ships get older the number of hours spent on maintenance will increase.

We must also assume that the radiation levels encountered in reactor plant maintenance will increase as more reactor operating hours are accumulated.

These factors indicate that although radiation doses received by naval personnel to date have been low, they may increase, and a further reduction in permissible radiation levels would require added shielding. Any additional shielding sufficient to effect a significant decrease in radiation levels throughout the ship would result in serious weight increases. In many cases shield weights could not be so increased without direct impairment of military characteristics.

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In addition to the question of weight, the problem of monitoring radiation levels even lower than those now maintained would be difficult. Present permissible levels for neutrons are already below practical detection limits and dependence must be placed on gamma monitoring, supplemented by occasional laborious counting of microscopic neutron tracks in special nuclear emulsions. Even the present permissible gamma levels are so low that they present a difficult monitoring problem.

Next I will discuss radioactivity in the ship's atmosphere.

Present permissible levels for radioactivity in air are also so low that they are near the limit of detectability of available radiation monitoring equipment. If these permissible levels were to be reduced any further, detection and monitoring could become a serious burden, since every fluctuation in normal background radiation would have to be assumed to be significant. We are already at the point where wristwatches must be sealed up in soldered cans during any submergence of more than a few days because radon from the watch dials would otherwise build up in the ship's atmosphere to greater than present permissible levels. This has actually been observed experimentally, and because of this we have prohibited use of radium on nuclear submarines for the usual purposes of luminous dials and switches. In the few cases where stock items containing radium were inadvertently brought aboard, their presence was easily detected by the ship's monitoring equipment. This is indicative of how low the radiation levels are that we are currently maintaining.

Another aspect of the permissible air activity problem involves leakage of water from the reactor system. The water normally contains radioactive impurities at or below current permissible drinking water levels. Leakage of this water into the air normally creates no hazard. However, if permissible airborne radioactivity levels were decreased, this situation could then be defined as "intolerable" or "not permissible." Not only minor leaks, but routine operations such as sampling, venting, draining, and minor maintenance could lead to fluctuations in background radioactivity. Decreasing permissible airborne radioactivity levels might require that during such fluctuations, if detectors could be built to detect reliably such low levels, all personnel would have to wear respirators. This is not a safe, desirable, or effective way to work. This point is particularly important in a military craft where survival may depend on the crew operating at maximum effectiveness.

Now let me cover disposal of radioactive wastes.

Present Navy instructions, worked out in cooperation with the AEC and with the U.S. Public Health Service and cognizant local public health authorities, permit water from nuclear-powered naval ships to be discharged into harbors when it contains radioactivity less than 100 times the drinking water tolerances defined in National Bureau of Standards handbooks. Reactor cooling water in our ships normally runs, at full power, at or near drinking water tolerance for iron 59, somewhat less for tungsten 187, and considerably less for all other isotopes. Operating instructions to the ships state that radioactivity levels 10 times higher than normal indicate undesirable plant chemistry which should be investigated and corrected. This level has never been reached in any of our ships.

During 1958 the *Nautilus* and the *Skate* together discharged radioactive water into New London Harbor a total of 84 times. Each time, the quantity of water discharged and its radioactivity were measured and recorded; at no time was the permissible radioactivity limit exceeded. The records show that a total volume of 7,500 gallons containing a total radioactivity of only 0.4 curies was discharged. Stringent monitoring of the water and air in the immediate vicinity of these discharges has never disclosed an increase in environmental radioactivity attributable to these discharges or to any other aspects of the operation of nuclear-powered ships. These surveys are maintained by the Public Health Department of the State of Connecticut in cooperation with the U.S. Public Health Service, the Navy, and the Electric Boat Division. Similar surveys are being carried out at all other shipyards building nuclear-powered naval ships and at Shippingport.

Reduction of the limits on waste disposal might require the ships to have waste disposal systems for handling and treating wastes. These would increase space and weight requirements. As with shielding, such weight and space increases could impair military characteristics of the ships.

The radiochemistry of the pressurized water reactor, or PWR, at Shippingport is similar to that of the naval reactors. The Duquesne Light Co. and the AEC voluntarily applied for a waste disposal permit from the State of Pennsylvania for the PWR. This permit allows the disposal of 0.5 curies per year of mixed radioisotopes into the Ohio River, plus 3,600 curies of tritium. Because of its low energy, the tritium is difficult to detect and presents little biological hazard. By actual measurement, the PWR in 1958 dumped only 0.035 curies of mixed radioisotopes into the river, plus 50 curies of tritium. As with the naval reactors, no effect on the radioactivity of the environment has been detected.

Finally I will draw some comparisons.

It should be borne in mind that under present regulations and operating procedures naval reactors and PWR discharge quantities of radioactivity which are small compared to natural environmental variations and trivial compared with other existing sources of man-made radioactivity. A few examples may be useful:

First let's take wristwatches: As I have stated, the radon from ordinary wristwatches produces more airborne activity than is currently permissible aboard ship.

Next let's take cosmic radiation: The ships' monitoring equipment in engineering spaces and living quarters shows no detectable increase when the reactor is started up and brought to power. Yet these same detectors show a twofold or threefold decrease in the background level when the cosmic radiation aboard is decreased by the ship submerging.

Then consider fallout and natural background variations: The environmental monitoring programs at shipyards and at Shippingport cannot detect the radioactivity discharged to the environment by our reactor plants, yet they show seasonable variations in natural radioactivity and easily pinpoint each major nuclear weapons test by the United States, United Kingdom, or the U.S.S.R.

Now look at waste discharge from other reactors: The 0.4 curies per year discharged from *Nautilus* and *Skate* together and the 0.035 curies per year of mixed activity plus 50 curies per year of tritium at

the Shippingport Station present a striking contrast with the millions of curies per year of metallic radioisotopes discharged by Hanford into the Columbia River, or even with the approximately 1 million curies of argon 41 discharged into the atmosphere annually by the Brookhaven reactor. These figures include only radioactivity produced by activation of the reactor coolant; fuel-processing wastes are not included.

Finally, I should like to mention for comparison, weapons fallout: The number of curies of fission products produced by 1 kiloton of fission weapon detonation is about equal to the number of curies of radioactivity discharged by Hanford each year. Since fission products are more harmful than the same number of curies of the activation products discharged at Hanford, it actually takes less than a kiloton of fission weapon detonation to equal the total contribution of radioactive hazard from Hanford. Of course the radioactivity from weapons testing is widely dispersed compared with that discharged from Hanford or any other stationary reactor. I am comparing only total contribution of radioactivity to the earth's atmosphere and oceans.

To further illustrate these comparisons I have a little table here that shows the equivalent quantities of water which would be contaminated up to the maximum permissible concentrations (MPC's) listed in Bureau of Standards handbooks by waste disposal operations and fallout:

Reactor:	<i>Equivalent amount of water contaminated to MPC per day (average for 1958)</i>
(a) <i>Skate and Nautilus</i> (total radioactivity dumped into New London Harbor).	About 10 gallons each.
(b) Shippingport Station (including tritium).	About 3,000 gallons.
(c) Hanford reactor coolant (into river; excludes fuel-processing wastes).	About 1 billion gallons.
(d) A 1 kiloton fission weapon detonation.	Over 1 trillion gallons per detonation.

I recognize the pitfalls of quantitative comparisons between dissimilar situations, but I believe the contrast is valid.

The conclusions then are these:

Current standards and procedures regarding radiation and radioactivity on naval nuclear-powered ships and at the Shippingport Station provide adequate and reasonable protection for operating personnel and for the public.

The total amount of radioactivity released to the environment by naval reactors and by the Shippingport Station is trivial, based on environmental measurements and on comparisons with other accepted sources of radioactivity.

Any further reduction in permissible levels of radiation or radioactivity would create a difficult monitoring and control requirement, complicate operating procedures, increase costs of equipment and records, and increase weight and size of naval ships.

If further reductions in permissible levels of radiation or radioactivity are enacted, the Navy would have to consider taking exception to them for naval application, based on military necessity and on demonstrated adequacy of present criteria on naval reactor plants.

For these reason, the Navy would probably be unwilling to accept more restrictive radiation standards, and would have to consider con-

tinuing with present practice on the grounds of military necessity and experience to date.

If more stringent radiation standards were to be applied to civilian reactors, the resulting expense and regulatory complexity could well be a decisive factor in stifling the timely development of atomic energy.

I believe the public should be aware of these facts I have given you. We have kept the local and U.S. Public Health agencies fully informed of what we are doing. We work closely with these agencies. I feel that we have a definite responsibility to do so.

Representative VAN ZANDT. Have you had any criticism from these agencies?

Admiral RICKOVER. No, sir. We have explained to them what we are doing, and these public health agencies have always been interested and cooperated well with us.

Representative VAN ZANDT. The water that has been dumped into the harbor—what will happen to it?

Admiral RICKOVER. The water has such a low radioactivity that when it is discharged into the harbor it cannot be detected even right next to the ship. The discharged water merely becomes mixed with the harbor water and flows out to sea.

Senator JACKSON. Would it be possible to dump it only at sea, there would be no question? Is it more convenient to discharge it in the harbor than at sea?

Admiral RICKOVER. In many cases it is not just a matter of convenience; it is necessary to discharge into the harbor. The reactor plant must discharge some water when it is being warmed during startup; this takes place while the ship is in the harbor. To hold this water until the ship is far at sea would require extra tanks and considerable equipment that would all add significantly to space and weight requirements. The radioactivity of the water is so low that we are permitted to discharge it directly into the harbor and it is so low that it cannot even be detected there.

Senator JACKSON. You mentioned 10 gallons of waste water from the ships, Admiral; why can't this be taken out to sea?

Admiral RICKOVER. The 10 gallons is an equivalent quantity of water at drinking water tolerance, Senator. By this I mean that if you put all the curies of radioactivity discharged by the *Nautilus* and the *Skate* on an average day into a 10-gallon pail of pure water, the pail of water would still meet lifetime drinking water tolerances. The volume of the water discharged by the ships actually averaged about 15 or 20 gallons per day, but its radioactivity was lower than drinking tolerance. Of course, a ship will usually go for weeks or even months without dumping any water into a harbor; but when it does some maintenance or has a startup in a harbor, it has to dump as much as several hundred gallons at one time. On a large surface ship this could amount to several thousand gallons at one time. To hold up thousands of gallons for discharge at sea would take more space and weight in the ships than we can afford.

Senator AIKEN. How would the danger of radioactivity from the aircraft carrier compare with the danger of the radioactivity from a submarine?

Admiral RICKOVER. The problem is basically the same. The radiation and shielding criteria are the same. As I said before, I personally go over the shielding design and other aspects of the design

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involving radiation or safety. I review it and approve it myself. I consider it my responsibility. I can assure you that the carrier will not present any different or any worse radioactivity problems than the submarine. I also look at the personnel records and the training. We check up and see that the crews are adequately trained.

Senator AIKEN. These facts that you have given us are not classified, are they Admiral? I definitely would like to see them in the record if they are not.

Admiral RICKOVER. No, sir. In the Shippingport and naval reactors programs such information has always been handled on an unclassified basis and has been widely disseminated to appropriate Public Health authorities, to Congress and to the general public. I can give you some examples to illustrate this.

First, all information on the PWR reactor at Shippingport is categorically unclassified, including information on the discharge of radioactivity.

The Duquesne Light Co. of Pittsburgh, Pa. which operates the Shippingport Station, and Westinghouse, who designed the reactor plant, publish periodic unclassified reports, available to the public, which include the latest data on radioactivity in the PWR coolant and on release of radioactivity to the environment. In addition, Duquesne and Westinghouse report quarterly to the State of Pennsylvania in accordance with the provisions of a Pennsylvania waste disposal permit which Duquesne voluntarily applied for. These reports include data on waste disposal and also results of a continuing survey of radioactivity in the environment near Shippingport and also at the AEC's Battis Plant which is operated for the AEC by Westinghouse.

The AEC voluntarily initiated an environmental radioactivity survey at Shippingport in cooperation with the U.S. Public Health Service more than a year prior to PWR operation. I also arranged with the U.S. Public Health Service to station a Public Health officer at the Pittsburgh Naval Reactors Operations Office of the AEC at the Battis Plant to follow developments at Shippingport.

Then, as you may know, entire reactor safeguards report on PWR-15 separate reports—is unclassified and has been given wide distribution.

In addition, detailed reports on radioactive waste handling at PWR, at Bettis and at the Knolls Atomic Power Laboratory (KAPL) which designs naval reactors and is operated for the AEC by the General Electric Co. were prepared especially for the Joint Committee's hearings on waste disposal this February. These were detailed technical reports; no data or information were withheld.

Senator AIKEN. What has been your policy on this sort of information regarding the naval reactors?

Admiral RICKOVER. In September 1957, I arranged with the U.S. Public Health Service to have a meeting of all interested Public Health officials and scientists at National, regional, State, and local levels. We gave them all of the information available at that time on radioactivity associated with operation of nuclear powered naval ships and their land prototypes. An all day discussion of these data took place and copies of our technical report summarizing the information were then given to Public Health officials by the U.S. Public Health Service.

I have also arranged with the appropriate local public health authorities, through the U.S. Public Health Service, to conduct continuing cooperative radioactive surveys at each location where nuclear powered naval vessels are being built.

A detailed technical report was prepared by my people and submitted to your committee in connection with this year's waste disposal hearings.

Representative HOLIFIELD. I wish that you would supply a copy of that report for the record of this meeting; I remember it provides a detailed explanation of your current Navy waste disposal instructions and criteria, and the technical data which they are based on.

(The report referred to is attached as an appendix to this record, p. 47.)

Admiral RICKOVER. In addition, every effort has been made to acquaint all pertinent responsible public health and medical authorities with our data and program in this area and to solicit their comments. Representatives from the AEC's Division of Biology and Medicine, the Advisory Committee on Reactor Safeguards, the National Committee on Radiation Protection and Measurement, the Navy's Bureau of Medicine and Surgery, the AEC's Division of Reactor Development and the AEC's Division of Licensing and Regulation, as well as individual scientists and engineers, have been kept fully informed. We have also held detailed discussions on our data and plans with prominent and responsible scientists and officials in the fields of meteorology and oceanography. For example, we have supplied all of our information on waste disposal to the National Academy of Sciences Committee on Oceanography which is currently publishing a report on waste disposal from ships.

Senator ANDERSON. I am pleased that you have not withheld any of this information, Admiral. I just got a study of fallout that Los Alamos finished in 1956 and cleared 2 days afterward and it was just cleared by the AEC recently.

Admiral RICKOVER. We do feel our responsibility for the public. If the public, or your committee, thinks we are not carrying out our responsibility, I hope you will say so. I have always tried to put myself in your place in determining what we should do. I never want your committee to think that I do not feel this responsibility. We have to be able to certify that there is no danger.

Senator ANDERSON. What you have said is that the public need not worry about submarines?

Admiral RICKOVER. They need not worry about nuclear submarines as long as we keep on watching them as we have. It is very dangerous to be negligent where radiation is involved. Everyone must be aware of it and act accordingly. There are a considerable number of people who are incapable of making a distinction between ordinary death or injury and injury by radioactivity. You have to think many years in the future. Radioactivity may inflict greater injury on our posterity than on ourselves. We are responsible for future generations too.

Senator ANDERSON. Admiral, on behalf of the committee, I wish to say that this trip and this meeting have given us an excellent picture of the important work you are doing. We have a strong feeling of

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price for this nuclear navy, and a great deal of confidence in your work. We are highly pleased to have this opportunity to meet with Captain Behrens and the fine officers and crew of this submarine.

Representative HOLIFIELD. I would like to say on my behalf and on behalf of my colleagues in the House, that we join Senators Anderson, Jackson, and Aiken in a feeling of pride and confidence in the operations and development of these nuclear submarines and we extend on behalf of the Members of the House on the Joint Committee to the Admiral and Captain Behrens our sincerest thanks and congratulations.

Mr. RAMEY. What is the status of the natural circulation reactor? Are you any closer to getting any money? What is your situation in getting money or authorization for it?

Admiral RICKOVER. We are in exactly the same status we have been for a long time—on dead center. I told your committee on March 23 if we didn't get funds for it this fiscal year we would lose a lot of time. As far as I know, nothing has been done. So, unless the Joint Congressional Committee acts, nothing will be done.

Senator JACKSON. How much is needed to initiate it?

Admiral RICKOVER. The total cost for the land prototypes will be \$18½ million. We need authorization for it in fiscal year 1960. We need authority to obligate \$6 million and to spend \$2 million.

Senator JACKSON. Which year?

Admiral RICKOVER. This current fiscal year—the one you are working on now, fiscal year 1960.

Senator ANDERSON. Why do you think the natural circulation system should be developed? What are its advantages?

Admiral RICKOVER. The basic consideration is simply that it is simpler. It is more reliable. There are fewer parts. The more parts and machinery you have, the more difficulties you have. With such a reactor we will be able to eliminate all the primary coolant pumps and check valves, and all the electrical supplies and controls that go with them. This also makes the plant more efficient and quieter. This added reliability is particularly necessary because we expect to use these submarines under the ice. We want to make them as reliable as possible.

Representative VAN ZANDT. What does the Director of Reactor Development think about this?

Admiral RICKOVER. Dr. Libby asked him to appoint a board to look into the natural circulation reactor. He convened this Board and then recommended to Dr. Libby that we go ahead. But the Commission still took it out of the budget. Year after year the General Advisory Committee to the AEC meets and accuses me of not being venturesome enough. Recently another committee set up by one of the offices in the Department of Defense said I wasn't venturesome enough. Yet whenever I want to do something I can't get support. What does one do in a situation such as this? It is completely illogical and contradictory.

(Discussion off the record.)

Representative VAN ZANDT. Has the Department of Defense set a military requirement for the natural circulation reactor?

Admiral RICKOVER. Yes, sir.

Representative VAN ZANDT. Will you put the letter into the record?
Admiral RICKOVER. Yes, sir.
(The letter referred to follows:)

ASSISTANT SECRETARY OF DEFENSE,
Washington, D.C., September 3, 1958.

Mr. JOHN A. McCONE,
Chairman, U.S. Atomic Energy Commission,
Washington, D.C.

DEAR MR. McCONE: Recent studies indicate that it is feasible to develop a pressurized water reactor plant for submarine application in which the reactor coolant would be circulated by natural convection, eliminating the need for the large coolant pumps, coolant check valves and associated electrical power equipment required in current designs. Successful development of a natural circulation reactor could result in substantial improvement in simplicity, reliability and inherent safety of naval pressurized water reactor plants. These potential improvements are highly desirable, particularly for nuclear submarines which may operate in Arctic regions.

It is therefore requested that the Atomic Energy Commission undertake the early development and test of a natural circulation pressurized water reactor plant of (classified) shaft horsepower for submarine application.

Your cooperation with the Department of the Navy in the development of this plant will be greatly appreciated. Detailed guidance in connection with the development will be furnished through the Naval Reactor Branch of the Bureau of Ships.

Sincerely,

HERBERT B. LOPER,
Assistant to the Secretary of Defense (Atomic Energy).

Senator ANDERSON. What about the Shippingport reactor?

Admiral RICKOVER. We designed that reactor for 60,000 kilowatts of electricity. When we started working on it we hoped that we might get more power. Accordingly, there was installed at Shippingport a generating capacity of 100,000 kilowatts. About a year ago we started to design the second core for the reactor. As the development of the core and its fuel elements progressed, it became apparent that we might be able to get as much as 150,000 kilowatts out of the core. Your committee and the AEC authorized us to develop the Shippingport plant, and the cost to the Government and to the Duquesne Light Co. has been about \$120 million.

Now by spending another \$20 million we can increase the plant generating capacity to $2\frac{1}{2}$ times the original rating of 60,000 kilowatts. It is also possible that when we get to the third core for PWR we may get still more power. I therefore would like to put in an additional turbogenerator of 75,000 kilowatts capacity, to bring the total capacity to 175,000 kilowatts and permit us to take full advantage of the potential of the Shippingport plant. However, before we can proceed with this, the necessary funds have to be appropriated. Of the \$20 million needed approximately \$15 million is for the increase in generating capacity and \$5 million for modifications to the reactor plant.

Incidentally, the difference in cost between a 50,000-kilowatt and a 75,000-kilowatt generator is small, so that it is worthwhile to put in the larger size generator to be sure that we can test the plant to its maximum power capability. I have discussed with the chairman of the Duquesne Light Co. the possibility of Duquesne furnishing the \$15 million for the generator expansion, and he is currently studying this. It will take about $3\frac{1}{2}$ years to install this generating equipment, and so if I do not get the money and authority to proceed with this modification this fiscal year, the plant will not be ready

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to the full capacity of the new reactor core, and the project will be delayed considerably. Actually all I need to spend in fiscal year 1960 is about \$2 million.

I have been asked: Instead of increasing the generating capacity at Shippingport, why not install a condenser to get rid of the excess steam generated by a 150,000 kilowatt core? While this is technically feasible, I believe that the waste of such large amounts of energy would be unwise and unjustifiable. It would be a waste of our most valuable material resource just to burn up uranium and dump the steam into a condenser. The Nation can make good use of all the electric power it can get.

Another suggestion we have had is to not increase the Shippingport generating capacity but to install a second core of only 100,000 kilowatt capacity instead of 150,000 kilowatts. If we did this, we would never really find out if the Shippingport reactor plant is capable of putting out any more than 100,000 kilowatts. The whole reason for designing and building the Shippingport plant in the first place, and the intent of Congress in approving it, was to advance our reactor technology so that people both here and abroad can benefit. Also, the design of a 100,000-kilowatt core is technologically easier than a 150,000-kilowatt core, so we would not be faced with solving difficult problems which we must face and solve if we are to make real advances in this reactor business, advances which are necessary if we are ever to make competitive atomic power.

As I have said before, if I don't get some money and authority this fiscal year the project will be delayed considerably.

Representative HOLIFIELD. Are you requesting \$5 million to do the alterations or are you asking for the full \$20 million?

Admiral RICKOVER. You could provide in the legislation for the entire amount if industry doesn't furnish any.

Senator ANDERSON. They have to come up with the money, or forget it.

Admiral RICKOVER. Would you want to spend more later and have a delay, too?

Senator ANDERSON. We will be going into partnership with a public utility. You will get into a whole lot of objections on that. It is a good deal for us, but it is also a good deal for Duquesne.

Representative HOLIFIELD. We could make it "providing Duquesne puts up \$15 million."

Senator ANDERSON. If it is put that way, you might get some support for it. You know the Comptroller has written a letter about that plant up there.

Senator JACKSON. How long before Duquesne will let you know?

Admiral RICKOVER. Probably a couple of months. They have to figure what power they are going to need in that area in the future. It is a large expenditure for them. They are now paying us 8 mills per kilowatt-hour, which is about what their oldest plants cost them.

Senator AIKEN. What are we getting out of it?

Admiral RICKOVER. Two and one-half times the power from the same basic reactor plant. If we don't do it now, it will cost much more later. The whole industry both here and abroad is depending on the PWR information and what we are doing to advance the reactor art.

Representative HOLIFIELD. The \$20 million you speak of would consist of \$5 million for the change in reactor plant to adapt it to new generator equipment, and the generator machinery would be around \$15 million. That would not take into consideration the cost of the reactor core?

Admiral RICKOVER. We have separate money for the development of the core. We are going ahead with the research and development. But I can assure you you will make more progress for less money by going ahead now with the 175,000-kilowatt modification.

Representative HOLIFIELD. I think it might be well to call a representative of the company before the committee and ask him.

Admiral RICKOVER. I am meeting with Mr. Philip Fleger, chairman of the board of the Duquesne Light Co., Monday, to discuss this matter with him.

Representative HOLIFIELD. It might be proper to ask AEC Chairman McCone to take it up with Mr. Fleger.

Admiral RICKOVER. Last Tuesday Mr. McCone spoke to the Edison Electric Institute in New Orleans and told them that the second PWR core is estimated to produce 150,000 kilowatts of electricity and that the third core might even exceed that. The point of issue is that we definitely want to have sufficient generating capacity in time to exploit this potential. I hope you will authorize it in this year's bill.

Senator JACKSON. In other words, you are suggesting that we write into the bill \$5 million, contingent upon Duquesne coming up with \$15 million. I would be in favor of that.

Admiral RICKOVER. Yes, sir; but, in order not to delay the project, you could provide in the legislation for the total amount, in the event industry does not furnish it.

Senator ANDERSON. Captain Wilkinson, we are happy you are here with us. Would you care to comment on the operations of our nuclear-powered ships?

STATEMENT OF CAPT. E. P. WILKINSON, UNITED STATES NAVY

Captain WILKINSON. Having had the honor of taking you and other members of your committee on your first nuclear submarine ride 4 years ago, it is a great pleasure to be with you again on this trip. The *Nautilus* was the culmination of a major scientific effort under the inspired leadership of the admiral and was made possible by your support. Most of my Navy career has been spent at sea. How a ship performs at sea means a lot to me. It has to be reliable; it has to run far and fast. The *Nautilus* ran and ran. I could count on her. In the 4 years since she was commissioned, a lot has happened. We have in the *Skipjack* a submarine that is entirely different. It is easier to get at her machinery for maintenance, so that people working at sea in case of necessity can fix it and keep it going for a long period of time. I know that this can't be done cheaply. The things that count—such as reliability, speed, maneuverability—they mean much to me.

It is fabulous that so much has been done in these 4 years.

Captain Behrens and his crew are to be congratulated on their handling of this new model that is so important to the security of our country.

Senator PASTORE. As you build new ones you make improvements and you have to build and try them out.

Admiral RICKOVER. It is more than that, sir. A lot of programs that are presented to your committee are just paper studies, and you never can tell what will come of a paper study, if anything.

A few weeks ago there was an article in one of the Sunday newspaper supplements stating that a man had invented the *Nautilus* in 1946. Well, Jules Verne did it long before that, and Buck Rogers was using an atomic bomb in the comics in 1930. A mere idea and a little paperwork is not enough. There is hardly a single idea that is new. What really counts is to take an idea, fight for the authority to do it, establish the organization, find and train the necessary scientists and engineers, justify to Congress the large sums of money involved, worry over and solve the thousands of technical difficulties. Well, about \$200 million and 8 years after the 1946 "idea," and with the devoted efforts of many, many hundreds of scientists and engineers, and the active participation of many hundreds of companies, we finally had the *Nautilus*.

Ideas and paper studies alone do not solve anything. You run into no trouble until the instant you start the designing and development and the manufacture of the new items. Actually, it would have made no differences if Jules Vernes had never written about the *Nautilus*. No matter what new thing comes out, there will always be thousands of people to say that they were the first ones to have the idea.

Senator PASTORE. I asked you earlier whether or not the *Skipjack* made the *Nautilus* obsolete. Let's assume that the Russians had a *Nautilus* and we had one. Then they get a *Skipjack*. Would our *Nautilus* then be obsolete? In other words, it is not obsolete if you compare it with a conventional submarine.

Admiral RICKOVER. Right, sir; the *Skipjack* can make it pretty tough for the *Nautilus*.

Representative VAN ZANDT. In your new submarines, will you get any more speed out of them?

Admiral RICKOVER. I can't answer that right now. If we redesign it, we may. Higher speed usually means more displacement, more machinery. You always hope for higher speed. Speed is important, because it may make the difference between catching up with a ship and sinking him or just watching him pull away. You can't sink him if you can't catch him.

Representative VAN ZANDT. On the high seas in rough weather, surface ships have to slow down. The *Skipjack* does not.

Admiral RICKOVER. You have been on surface ships and you know that in a rough sea you can't maintain a high speed. I was on a battleship once that could only make 8 knots in a heavy sea, even though we were using close to full power.

Representative HOLIFIELD. How much could she make in a calm sea?

Admiral RICKOVER. Twenty-one knots. I think the *Skipjack* might set a record in a winter crossing of the Atlantic.

During the war we learned from hard experience that surface ships have to slow down in heavy seas. We had cases of the flight decks of aircraft carriers being damaged by the seas when too high a speed was attempted.

Before I close my testimony, Mr. Chairman, I would like to thank the Westinghouse people at the Bettis plant for the outstanding job they did in the design of the *Skipjack* powerplant. And I want to thank Electric Boat and Mr. Shugg for the very fine job they have done. They have designed and turned out these fine ships. The Navy's Board of Inspection and Survey has just completed its inspection of the *Skipjack* and I understand they found it in as fine a state of readiness for war as any new ship they have inspected.

Senator ANDERSON. Mr. Shugg, any comments?

STATEMENT OF CARLTON SHUGG, GENERAL MANAGER, ELECTRIC BOAT DIVISION, GENERAL DYNAMICS CORP.

Mr. SHUGG. I would like to say for the several thousand Electric Boat employees that this is more than just a job for them. They are interested in these ships personally—they are devoted to this new nuclear submarine program and its development and many of them work overtime to get the job done correctly.

Senator JACKSON. It is a real privilege to have Mr. Shugg aboard. I have known him for many years. He was operating Hanford for the AEC at the time the Soviets exploded their first atomic bomb. I think it is fortunate that he is in this field. He is a distinguished graduate of the Naval Academy—graduated third in his class, or was it first?

Mr. SHUGG. Second.

Representative VAN ZANDT. How many subcontractors were there for these submarines?

Admiral RICKOVER. About 500 or 600 I believe. A sizable portion of these are small business firms. Some of our statistics on this are reported in a July 1955 report of the Senate Small Business Committee. The Small Business Committee stated in this report that we had approached 90 percent of the small-business potential. Our record since then has been just as good.

Senator ANDERSON. Thank you Admiral Rickover. And thank you, Captain Behrens, for having us aboard to see the *Skipjack* and to be present when the records were broken. I hope you will tell your men how much the members of this committee appreciate it.

Representative HOLIFIELD. I would like to suggest that we prepare an appropriate news release for the subcommittee that is assembled here and also a message of congratulations to the people that build these fine submarines.

Senator ANDERSON. I will have one prepared.

(The news release referred to follows:)

JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES

[Apr. 12, 1959, for immediate release]

Two new performance records of the USS submarine *Skipjack* were announced today by Senator Clinton P. Anderson, chairman of the Joint Committee on Atomic Energy upon his return from an overnight trip on the submarine with six other committee members and Vice Adm. H. G. Rickover, USN.

Senator Anderson stated:

"While underway and submerged, the Joint Committee held an official committee meeting, during which time the *Skipjack* was going faster and deeper than any known submarine in history. For security reasons, I can only say that we were deeper than 400 feet and moving faster than 20 knots. In 1955 some of us

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also called on the *Nautilus* and we were impressed today by the many technical advances and substantial increases in performance that have been achieved in *Skipjack*, including speed, maneuverability, and endurance."

In addition to Chairman Anderson, the following committee members were aboard: Senator John O. Pastore (R.I.), Henry M. Jackson (Wash.), George D. Aiken (Vt.), and Congressmen Chet Holifield (Calif.), James E. Van Zandt (Pa.), and Jack Westland (Wash.).

During the recordbreaking trip, the committee members and staff were given a thorough tour of the new submarine, and participated in high speed maneuvers.

At the underwater hearing held in *Skipjack's* wardroom, Admiral Rickover gave a presentation on the accomplishments of the *Skipjack* and new developments in the naval reactors program. In response to questions, the Admiral explained the safety features of the reactor design and operation of the *Skipjack*.

The committee members stated that the Electric Boat Co. and other participating industrial companies deserved congratulations for a job well done.

Senator Anderson, on behalf of the congressional committee, thanked Commander William W. Behrens, Jr., USN, the Commanding Officer of the *Skipjack*, for the hospitality extended by him, his officers and crew, and for the expert way they put *Skipjack* through its paces.

In closing, Senator Anderson said:

"We are impressed with the tremendous advancements that have been made in the 4 short years that have transpired since the first atomic submarine went to sea.

"The country and all our citizens can be proud of Admiral Rickover and his fine team for achieving for the United States technological leadership in the field of nuclear ship propulsion. The committee, on behalf of the Congress, will recognize these accomplishments at its forthcoming public ceremony, Wednesday, April 15, 1959, when we will present to Admiral Rickover the special Congressional Medal authorized by Congress last year."

The committee and Admiral Rickover were accompanied by Capt. E. P. Wilkinson, USN, Commander Submarine Division 102; Carleton Shugg, vice president, General Dynamics Corp., Electric Boat Division; and James T. Ramey, Executive Director of the Joint Committee Staff.

(The hearing adjourned at 9:43 p.m.)

NAVAL REACTOR PROGRAM AND ADMIRAL RICKOVER AWARD

WEDNESDAY, APRIL 15, 1959

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D.C.

The Joint Committee on Atomic Energy met, pursuant to call, at 2:30 p.m., in room G-308, New Senate Office Building, Washington, D.C., Hon. Clinton P. Anderson (chairman) presiding.

Committee members present: Senators Clinton P. Anderson (presiding), John O. Pastore, Albert Gore, Henry M. Jackson, Bourke B. Hickenlooper, George D. Aiken, and Wallace F. Bennett; Representatives Carl T. Durham, Chet Holifield, Melvin Price, Wayne N. Aspinall, James E. Van Zandt, William H. Bates, and Jack Westland.

Other Members of Congress present: Hon. Lyndon B. Johnson, majority leader, U.S. Senate; Hon. Everett M. Dirksen, minority leader, U.S. Senate; Hon. Herbert C. Bonner, chairman, Merchant Marine and Fisheries Committee, House of Representatives; Hon. Carl Vinson, chairman, Armed Services Committee, House of Representatives; and Hon. Clarence Cannon, chairman, Appropriations Committee, House of Representatives.

Representatives of the Atomic Energy Commission present: Hon. John A. McCone, Chairman; and Vice Adm. Hyman G. Rickover, Chief, Naval Reactors Branch.

Committee staff members present: James T. Ramey, executive director; John T. Conway, assistant director; David R. Toll, staff counsel; Thomas J. Foley and George E. Murphy, Jr., professional staff members; Edward J. Bauser, technical adviser, Joint Committee on Atomic Energy.

STATEMENT OF HON. CLINTON P. ANDERSON (NEW MEXICO), CHAIRMAN, JOINT COMMITTEE ON ATOMIC ENERGY

Chairman ANDERSON. Because of the pressures on the Members of the House and Senate I think we will proceed, although some of our distinguished guests will be arriving a little later.

I do want to explain, ladies and gentlemen, that this is a beautiful room and I regret very much that we had to upset its beauty by arrangement with the Architect of the Capitol to permit these television stands to be erected. There are galleries with equipment for taking pictures which could be utilized. However, since this is the first time this room has been tested this way it was felt these stands would serve much better. Also, a special lens is in reality required from the far booth and they were not available. They will be available in 3 or 4 days. Therefore we paid the price that all people pay

who are trying something for the first time—some little flaw develops. I am as sorry about it as I can be. The fault is that we didn't have a chance previously to become familiar with all of the circumstances surrounding its use.

I appreciate very much the many friends of our distinguished guest of honor who are here today, particularly those who wear the proud uniform of the U.S. Navy. We are extremely proud of our distinguished guest and extremely proud of the people who have come here today to pay him honor. May I say also that it is a matter of great personal joy to me to have on the platform the very able and distinguished Chairman of the Atomic Energy Commission, Hon. John McCone. Would you rise and take a bow, please? [Applause.]

This illustrates the working of pure democracy. We fixed another place for him, put the card in it, and then wouldn't let him sit there. That is as much choice as people have in this world.

I am happy that the officials of the Westinghouse Co., where a great deal of Admiral Rickover's work has been done, are here, and I express my appreciation to Mr. Mark Cresap and the others who have come here also to honor our distinguished guest.

The Joint Committee on Atomic Energy is honored to have with us today those distinguished Americans to whom Congress has entrusted its leadership. We meet on behalf of the Congress to present a special gold medal to Vice Adm. Hyman G. Rickover.

Last year, in the 85th Congress, a joint resolution was enacted unanimously authorizing the Chairman of the Joint Committee on Atomic Energy to confer this medal on Admiral Rickover.

The text of the resolution is in your program and I shall read only a few words from it.

*Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That in recognition of the achievements of Rear Admiral Hyman George Rickover, United States Navy, in successfully directing the development and construction of the world's first nuclear-powered ships and the first large-scale nuclear power reactor devoted exclusively to production of electricity, the Chairman of the Joint Committee on Atomic Energy, on behalf of the Congress, is authorized to present to Admiral Hyman George Rickover, United States Navy, an appropriate gold medal. * * **

Since 1947 Admiral Rickover has been primarily responsible for the application of atomic energy and nuclear power to the propulsion of naval vessels, and in the annals of modern science and technology there have been few efforts more successful than his.

He has contributed immeasurably to the defense of our Nation and concurrently demonstrated the peaceful intentions of the United States in atomic energy. He directed the development and construction of the Shippingport Atomic Power Station—the first full-scale peaceful atomic plant in the United States.

Within the Navy Admiral Rickover made possible a new strategic weapons system of paramount importance in the missile age—the first ballistic missile submarine.

His attack submarines promise the control of the seas in event of war.

The voyage of the *Nautilus* and the *Skate* under the North Pole—and this bottle which Admiral Rickover brought along with him is not a special elixir for throats of individuals who may be speaking here but is water from the North Pole. It ought to be parceled out drop by drop I am sure, but I want you to see that it is very similar to the

when you get at the South Pole if you have been there. (Laughter.) This trip of these ships under the North Pole contributed immeasurably to the prestige of the United States following events like the Soviet sputnik. Members of the Joint Committee on Atomic Energy have just returned from a voyage on the *Skipjack* during which we set two records: we went to a record depth and then traveled at a speed greater than any submarine ever attained.

May I just say to you that the task of trying to preside at a meeting of the Joint Committee at that depth is no small task because these sly individuals keep commenting on that fact that we are giving the deepest thought to our problems and so forth that anybody could ever give.

Anyhow, because of Admiral Rickover our science is richer—our Nation is stronger.

Over the years it has been the custom of the Joint Committee to have Admiral Rickover meet with us for an annual report on the naval reactors program. It occurred to us that it would be fitting and in keeping with the workaday atmosphere of his naval reactors program if we heard today from the admiral on his work with submarines and at Shippingport.

I am, therefore, going to let him go part way through his report and then we are going to break in because some of the Members of Congress have some additional responsibilities for which they must leave. Then we will return to his report. This is also in the best tradition of the Joint Committee on Atomic Energy which has to sometimes jump from subject to subject.

Admiral Rickover, it is a tremendous honor and pleasure to present you to this fine audience and to give you an opportunity to comment on the reactor program.

In the tradition that we have developed we bring Admiral Rickover in and he doesn't prepare an address. We ask him a question and let him freewheel. This will be no different from the ordinary.

Admiral Rickover, how many submarines, ships, and powerplants have been built or are under construction or authorized? This would be commonly known as the James Van Zandt question. Jimmy Van Zandt, who is a good captain of the Naval Reserve—and whom I found to be an excellent navigator of the *Skipjack*—generally starts with this question, so we will start with it today.

STATEMENT OF VICE ADMIRAL HYMAN G. RICKOVER, CHIEF, NAVAL REACTORS BRANCH, ATOMIC ENERGY COMMISSION

Admiral Rickover. Thank you, Senator Anderson. Congress has authorized a total of 33 nuclear-powered submarines. Of the 33, 5 are presently in operation and the others are either under construction or shortly will be under construction. Twenty-two of the submarines are attack submarines. Nine will be capable of carrying the Polaris-type missile. One, the largest submarine in the world, the *Triton*, will be a radar picket submarine which will be fast enough to operate with a task force; the last one is a submarine which will carry Regulus guided missiles.

In addition to the submarine program, Congress has also authorized a nuclear-powered aircraft carrier which is being built by the Newport News Shipbuilding & Dry Dock Co. at Newport News, Va. Congress

has also authorized a nuclear-powered guided missile cruiser and a nuclear-powered fleet destroyer; both are being built by the Bethlehem Shipbuilding Co. at Quincy, Mass.

The naval reactors program is carried out by a group of 120 engineers and scientists at my Washington headquarters who supervise the work of the scientists and engineers of our three nuclear laboratories. These are the Bettis Laboratory at Pittsburgh, Pa., which is operated for the Atomic Energy Commission by the Westinghouse Electric Corp.; the Knolls Atomic Power Laboratory at Schenectady, N.Y., operated for the Atomic Energy Commission by the General Electric Co.; and the Windsor Laboratory at Windsor, Conn., which is owned and operated by Combustion Engineering. At these laboratories there are about 2,000 scientists and engineers together with the supporting people, who work in the naval program. There are, of course, many other additional scientists and engineers who work for the subcontractors who are designing equipment for our program.

We have designed and built five land prototypes for the various types of nuclear-powered ships we are building. These land prototypes are located at the Atomic Energy Commission's Nuclear Reactor Testing Station at Idaho Falls, Idaho; at West Milton, N.Y.; and at Windsor, Conn. At these places the first model of each nuclear plant is tested to determine whether it is suitable. We also conduct many nuclear and engineering experiments in these plants. The total cost of the naval nuclear program to date is about \$800 million. This figure includes the cost of building all of the laboratories, of building the five land prototypes, the cost of all the research and development from the beginning of our program, and even the cost of the propulsion plants of the first two nuclear submarines, the *Nautilus* and the *Seawolf*. We are currently spending on research and development about \$100 million a year, of which 85 percent is supplied by the Atomic Energy Commission, and 15 percent by the Navy.

I believe that the members of the Joint Committee and many in the audience are aware of the tremendous benefits that can be derived from having nuclear power in a submarine. World War II submarines, which operated in the Pacific and did such a valiant job for our Navy and our country were only able to make about 10 miles an hour for only 1 hour, after which they were no longer able to operate submerged because the storage batteries were exhausted. In fact, hardly any submarines ever used more than half their storage battery capacity because they had to reserve battery capacity to permit escape in the event they were attacked by the Japanese.

Nuclear-powered submarines, on the contrary, can travel almost indefinitely at far higher speeds than the conventional submarines. The conventional submarines simply are not capable of making any such high speed. In fact, even today the most modern nonnuclear submarines can only make about 18 knots for half an hour. The *Nautilus* and all our other nuclear submarines can make 20 knots and more. The 20-knot figure was stated by President Truman when he laid the keel for the *Nautilus* in 1952, and we have not been authorized to disclose a higher figure since that time. I hope that the Republican administration will permit us to give a new figure. A conventional aircraft carrier can go about 5,000 miles continuously at full power; the nuclear-powered carrier will be able to steam at full power for about 90,000 miles. The conventionally powered fleet

destroyer can go about 2,000 miles at full power; the nuclear-powered fleet destroyer will be able to go about 150,000 miles.

Representative DURHAM. Admiral, I suppose that since we have had a Van Zandt question we should also ask what we call the Mel Price question because Mel has done such an outstanding job in the Research and Development Subcommittee. What new developments, such as the *Skate* going under the North Pole, have occurred in the past year?

Admiral RICKOVER. The most important development from a technical standpoint is the considerable increase in the life of the nuclear cores which has greatly extended the cruising range of our nuclear-powered ships. This is due to the fact that we have learned how to design and build the nuclear cores in such a way that they will last for much longer periods of time. The increased life is obtained with practically no increase in cost because the major part of the core cost is the fabrication. We can now get cores that last two or three times as long as the first one. We thereby cut the cost proportionately. The tremendous advantage of being able to operate a naval vessel in wartime for indefinite periods of time without having to return for refueling is obvious.

Another advancement has been our ability to use computing machines to help us design nuclear cores. We spend several million dollars a year developing and using new computing machine methods. For example, a calculation which used to require 3 months and many physicists can now be done in less than a day. We just would not be able to develop our advanced reactor cores without these machines and the techniques we have developed for using them.

Another event that has happened is that two new submarine building yards have demonstrated their ability to construct nuclear-powered submarines. These are the Mare Island (California) Naval Shipyard and the Portsmouth (New Hampshire) Naval Shipyard. We have also arranged for additional commercial shipyards to engage in building nuclear-powered submarines. The Ingalls Shipbuilding Co. at Pascagoula, Miss.; the Newport News Shipbuilding & Dry Dock Co. at Newport News, Va.; and the New York Shipbuilding Co. at Camden, N.J. So you see we have considerably expanded our facilities from the early days when the Electric Boat Division at Groton, Conn., the builder of the *Nautilus*, the *Seawolf*, the *Skate*, the *Skipjack*, and the *Triton*, was the only commercial yard building nuclear-powered submarines.

Another item that may be of interest is the industrial strength we have developed to build the many items of equipment needed for our nuclear-powered ships. As you may know, the facilities for building airplanes and missiles are somewhere about 98 percent owned by the U.S. Government. I decided, in establishing the manufacturing capacity to supply us with our nuclear components, that it should be 100 percent industry owned, and that not one dollar of Government money would be used to build these facilities.

Thus, we have now established at least three sources of supply for every item we use, and so we are able to buy the components for our nuclear plants on a competitive lump-sum basis. And these components are being made in facilities that are wholly owned by the companies themselves. In fact, we do not even give these companies

the benefit of a certificate of necessity, which permits a fast amortization of the facilities. This lump-sum competitive purchase of parts applies to all the nuclear and machinery parts, including even the reactor cores.

There have been operational developments in the past year too, Mr. Durham. To illustrate this, I would like to give you some of the records that have been established.

The *Nautilus*, on her first nuclear core, steamed more than 62,000 miles. A conventional submarine would have used about 2 million gallons of oil in going this distance. And this oil would have required a line of tank cars more than 1.5 miles long. On her present second core, the *Nautilus* has already steamed more than 80,000 miles, and still has energy left in the core. We are now designing nuclear cores that should enable ships to operate for an entire war without refueling.

The *Nautilus* last year steamed nonstop from Honolulu to England, a distance of more than 8,000 miles, during which time she traveled 1,830 miles under the polar ice cap. The *Skate* a few days later went under the North Pole from the other direction, east to west, and then made the shortest circuit around the earth that has ever been made. She went around the earth in 1 hour. She was only 1 mile from the pole, but it is still the record. I suppose some day an airplane will just spin around the pole and so make it in even shorter time; nevertheless, today the *Skate* holds the record for circumnavigation of the globe.

To give you an idea of what a nuclear powerplant can do, in 1956 I had the plant of the *Nautilus* land-based prototype at Idaho Falls, Idaho, operated for 66 days and nights continuously at full power. The distance a submarine would have gone during that period at that power is twice around the world. For conventional ships, the requirement for acceptance by the Navy is that the plant be able to operate for only 4 hours at full power; but we ran that propulsion plant for 66 days and nights continuously at full power. Last year the *Seawolf* stayed completely submerged, on a military exercise for 60 days. She traveled 13,000 miles during that time; she was completely independent of the earth's atmosphere.

Just a few days ago, the *Skate* again steamed under the North Pole. This time she was under the polar ice for 3,000 miles continuously; she demonstrated that we can operate our submarines at will in the Arctic. This also means that when we have developed submarines that can carry Polaris ballistic missiles, these submarines can remain undetected in the dark polar seas, hidden from an enemy. If an enemy dared to attack the United States; even if he were successful in destroying the United States, he will know that he himself would inevitably be destroyed.

Representative DURHAM. How thick was the ice?

Admiral RICKOVER. The ice in the polar region varies with the time of the year. It varies from about 30 feet to 40 feet to nothing in some places. The *Skate* carries equipment on board by which she can tell roughly where the ice is not too thick to break through. She was able to "punch" her way through the ice 10 times on this recent polar voyage.

Another most significant record was set by the *Sargo*. She left the Mare Island Navy Yard in January of this year and steamed nonstop for 19,000 miles in the Pacific. She returned to port about 2½ months

lat Of this 19,000 miles, 18,880 were fully submerged, and only 120 miles were on the surface.

This brings out another important fact about our nuclear submarines. They travel nearly all of their time fully submerged—at the present time about 85 percent. They can go much faster submerged than on the surface because their hulls are designed for submerged operations, and they do not have to worry about weather or rough seas. For example, the *Skipjack*, which is our fastest submarine, can travel about 10 knots faster submerged than on the surface.

Some of the very fine officers who have piloted these ships are in the audience. I am more proud of what these young men have done than I am of what we have done with atomic power. With officers such as these and their highly devoted crews, there is nothing our country cannot do. They are the finest men in the finest military organization in the world. When people of their caliber are exposed to the challenge and opportunity of our nuclear power program, the results go beyond all expectations. Not only do we get these outstanding operating crews, but individual officers and sailors go on to do an outstanding job in other parts of the Navy as well.

For example, about 20 times as many sailors are selected, proportionately, as officer candidates from our nuclear power program than from the entire Navy. One out of every six sailors who has been in the nuclear power program has already been selected for officer programs. Of course, these men represent a loss to the nuclear power program, and an additional training burden to us, but the Navy as a whole benefits immeasurably.

Chairman ANDERSON. Admiral, if you will let us break in, we will introduce a couple of other people and come right back to you.

I am very happy that some of my old associates from the House of Representatives are here today. I appreciate it tremendously. When I went into the House in 1941 next to me was a young Congressman from North Carolina. I want to ask Herbert Bonner to stand up. Congressman Bonner. [Applause.]

At that time everyone conceded the greatest expert on naval affairs in the Congress of the United States was Carl Vinson of Georgia. Carl. [Applause.]

He is just a few months behind Sam Rayburn in his record for longevity as a Member of the House and he is certainly one of its finest Members.

Everyone who tries to get an appropriation from the House Appropriations Committee knows what an easy time he has with Clarence Cannon. [Applause.]

I want to say to him that it was my great honor to serve under him when I was in the House of Representatives and he is truly one of our great public officials.

I see a great many Senators in the audience. I hope I will see a good proportion of them. There is Senator Javits of New York. Would you rise please? [Applause.]

I saw Senator Prescott Bush a minute ago. Is he still in the audience? Where is John Taber?

John, we should have you right up here. You were supposed to be up here. [Applause.]

I am happy to bear eloquent testimony to the fact that John ^{er} is one of the truly fine people in the House of Representatives. If I dared take time on the program I could give you a sample out of my own life.

Strom Thurmond, would you rise please? [Applause.]

Are there other Members of the Senate or House here?

Senator Fulbright is way back there. I don't know why the chairman of the Foreign Relations Committee went that far back into the audience, but apparently he has things on his mind.

Congressman Rabaut of Michigan. Mr. Congressman, will you stand up? [Applause.]

Congressman Anderson of Montana. [Applause.]

Senator Saltonstall. [Applause.]

Congressman Boland of Massachusetts is here. I am going to ask him to stand up. [Applause.]

May I say that all of us—some 46 Senators who have served in the House of Representatives—are as proud as we can be to be known as Sam Rayburn's boys. It is a matter of tremendous regret to me that the Speaker of the House of Representatives, beloved on both sides of the aisle, found it impossible to be here today.

The Speaker sent me this note.

I regret very much that because of the situation on the floor of the House at the present time, I will be unable to be present for the ceremonies in connection with the conferring of the special Congressional Medal on Admiral Rickover. Please convey to him my very best wishes.

I trust that his outstanding abilities may continue to be used for the benefit of the welfare of the people of the United States and for the world.

With every good wish, I am

Sincerely yours,

SAM RAYBURN.

Senator Kuchel, you were supposed to do some reading. [Applause.]

He got back there and so, as is customary, he loses the floor. I will read then a little note which the Vice President of the United States sent over.

It is a genuine honor for me to be able to extend my congratulations to Vice Adm. Hyman G. Rickover in connection with the special tribute being paid him today.

No man could be more deserving than Admiral Rickover of the special Congressional Gold Medal being presented to him on this occasion. His vision, skill, and tenacity in successfully directing the development and construction of the world's first nuclear-powered submarines has added immeasurably to our military strength. And his contribution in the development of the world's first large-scale nuclear-power reactor devoted exclusively to production of electricity opens new vistas for progress for the United States and the world in the years ahead.

I regret that I am unable to be personally present at the ceremony today and I hope, through this message, I can convey in small measure the great debt of gratitude every American owes to him for the unique service he has given our Nation.

RICHARD NIXON.

[Applause.]

May I just say that I know the Vice President planned to be here but there are some matters arising today which made it impossible for him to be here in person. I appreciate his sending this message along as I do the action of the Speaker.

Because of a situation in the Senate, which is in session, I am going to break the program just a little bit and present to you a very fine team. As everyone knows, the Senate has been extremely fortu-

never the past few years in having a majority leader and a minority leader who were able to work together and who were able to preserve that great feeling of comradeship that we like to have in the Senate of the United States.

First of all it will be my pleasure to present to you the dynamic leader of the majority in the Senate of the United States whose vision, whose courage, and whose drive are bringing great rewards to the American people, the Honorable Lyndon Johnson of Texas. [Applause.]

**STATEMENT OF HON. LYNDON B. JOHNSON (TEXAS), THE
MAJORITY LEADER IN THE SENATE OF THE UNITED STATES**

Senator JOHNSON. Mr. Chairman, my colleagues in the Congress, Admiral Rickover, and my fellow Americans, Congress is made up of a very proud group of men and women. We take pride in our work, in its results, and in many achievements. But there is nothing in which we take more pride than we do in the work of the Joint Committee on Atomic Energy. That committee is presently headed by my friend, the junior Senator from New Mexico, Mr. Anderson. He is the kind of legislator that every State ought to have at least one of—experienced in the executive branch of the Government, a graduate of the Appropriations Committee of the House of Representatives where they spend the money, and of the Ways and Means Committee where they raise the money.

He came to the Senate and in a very short time the late Vice President Alben W. Barkley assigned him to the Joint Committee on Atomic Energy. I don't think I exaggerate when I say I believe this committee, under the leadership of Clinton Anderson and Carl Durham, has the complete confidence of the Members of the U.S. Senate.

I am very proud that along about the time of my birthday last year, Clint Anderson came to me in a hurry and said that he had a little resolution that didn't cost much money but would bring great results to this Nation which he wanted passed by unanimous consent. Before I had a chance to call it up I found that he was going to pass it by unanimous consent because he had practically every Member of the Senate as sponsor of it.

That is the reason we are here today. We meet here to honor a man and to honor an achievement—to honor an uncommon man and an uncommon achievement. I heard Clinton Anderson introduce my delightful and wise and talented friend from Georgia, under whom I served 12 years, as the outstanding "expert on naval affairs." Clint, I am going to correct you and I want you to accept an amendment. I am going to strike the word "naval," and substitute "military"—because one of the outstanding experts in this country on our armed services is Carl Vinson.

Now, notwithstanding the provisions that Uncle Carl has made for the armed services throughout the years—and he has been a zealot, he has been a perfecter, he has been a defender, he has been an aggressor, he has attempted to see that they had more than some of them wanted and to take away some that people didn't want to give—nevertheless when it came to launching this uncommon man on this uncommon venture, we had to renovate a restroom to provide him with an office. We hadn't made a provision for that in our services.

However, as a result of his dynamic personality, as a result of his outstanding leadership, as a result of his ability to command men and respect, today we occupy a position of leadership in at least one field that would not be ours except for Admiral Rickover.

So we meet here today to honor you and as a result of the resolution initiated by this great committee, Admiral, I think we should say to the rest of the world that you are our secret weapon. You are a symbol of the "can do" man. There are plenty of us who can find 15 reasons why something that ought to be done, can't be done, but there are very few of us who can cut through red tape, slash through the "can't do" folks and get on with the job. You have done that. You have brought pride to the Navy. You have been an inspiration and a stimulating example to every young man in this country.

I asked a friend of mine this morning over a cup of coffee what he thought I ought to say this afternoon. He said, "Not very much but I think you might say that I want to send my boy to the Naval Academy because Admiral Rickover has demonstrated what a scientist with education and determination can do for the world. I think that is what I am going to ask my boy to do." I don't think there is a finer tribute could be paid to you than for the fathers of the land and the sons of the land to want to follow in your footsteps.

It is a great privilege to be here with you. I express the gratitude of a grateful Nation for the many successful jobs that you have done that will help us to preserve peace not only for this Nation, but for freedom loving people everywhere. [Applause.]

Chairman ANDERSON. Now it is my privilege to present the other part of the Senate leadership team. He is a man who, like Senator Johnson, had his early training in the House of Representatives, who early established a fine reputation there and who as a Member of the U.S. Senate has quickly risen to a position of prominence and leadership in that body, the Honorable Everett Dirksen, minority leader of the U.S. Senate. [Applause.]

STATEMENT OF HON. EVERETT M. DIRKSEN (ILLINOIS), THE MINORITY LEADER IN THE SENATE OF THE UNITED STATES

Senator DIRKSEN. My friend and chairman, Senator Anderson, our very distinguished guest, Admiral Rickover, my friends, associates, and colleagues. I suppose, Admiral, if I were thinking in terms of any other kind of an award that might be bestowed upon you today, we might ask the Navy to set up a new rank or a new classification and just call it subnik and confer it upon you, sir. That probably would go a long way.

But I am delighted to be here today to pay testimony and to congratulate you and to think in terms of a slightly larger implication of this ceremony. It is rather easy to classify and to recognize those impellent forces that carry men on to action. Probably at the head of the list we would set self-preservation because it is the deepest and most enduring thing in the human life. Next to that we might set acquisition of property because in all of us there is a pardonable desire to acquire a little something in this mundane journey.

Then we might set reputation; not merely the reputation that ensues from a blameless life, but rather the reputation that ensues from achievement and recognition that causes men, like fuel to the

firmly strive for it and in the doing they enrich not only themselves but enrich their own country and mankind. Probably it might be referred to as a vanity, but if it is, it is one that is the most pardonable vanity and it is the most justifiable vanity that I know.

And so, Admiral, today as we do testimony to you, and as we congratulate you on extraordinary achievement, I like to think that this great Republic has not yet gotten so ponderous, has not yet gotten so bureaucratic, has not yet gotten so impersonal that we cannot express our gratitude and appreciation for those who through fidelity and dedication to service and devotion have enriched the country and have enriched their fellow man. I hope, therefore, that people will take account of this day as a testimony to the fact that there is recognition, and in proportion, as we tap one of the great and impelling powers that has carried mankind along the march of progress for so long.

And so I am delighted, Admiral Rickover, to have a small part in this ceremony; first to congratulate you, second to pay my respects and finally to utter the earnest hope that it will be something of a reminder to all people—men and women, young and old, rich and poor—that there is still an expressible gratitude within the capability of this country.

I congratulate you, sir. [Applause.]

Chairman ANDERSON. Weren't those two fine statements from these fine Senate leaders? They have to leave us now. They have to return before this program is over. Let's give them a hand as they go back to their jobs. [Applause.]

I have been waiting for the arrival of a particular person so I could make two introductions. Now I would like to ask Secretary Gates of the Navy and the Chief of Naval Operations, Adm. Arleigh Burke, to please stand for a moment. [Applause.]

Thank you both very much for being here to honor this naval officer.

We are going back to the questions for a few minutes. Then we will come back to the introduction of the members of the Joint Committee and the business of the afternoon, at which, after all, we have not yet arrived.

Admiral, would you tell us a little bit about the future of Shippingport? It is a great nuclear powerplant. What about its future plans? Can you furnish us for the record a history of the project since its inception?

(The history referred to is contained in the appendix, p. 59.)

STATEMENT OF VICE ADMIRAL HYMAN G. RICKOVER—Resumed

Admiral RICKOVER. The Shippingport project was authorized by Congress so that the United States could learn about the real problems of atomic power by actually building and operating this first large-scale central station atomic powerplant.

We broke ground for that plant in September 1954, and on December 2, 1957, it first started operating. We designed, developed and constructed that plant in just about the same time it takes to build a conventional central station plant. To date, the Shippingport plant has generated more than 280 million kilowatt-hours of electric power. It is running right at this minute at its rated output of 60,000 kilowatts.

The plant was designed by the Bettis Laboratory at Pittsburgh, Pa., which is operated for the Atomic Energy Commission by the Westinghouse Electric Corp. It is being operated by the Duquesne Light Co., and it is furnishing electric power to the city of Pittsburgh.

The reactor core of that plant has already lasted longer than we expected it would. For example, we expected that the "seed" part of the core—that is a technical term—would only last for 3,000 full power hours. It has already run more than 4,400 full power hours and we expect it will last as high as 6,000. Similarly, the remaining portion of the core, the "blanket," we expect will run for twice what we anticipated.

In order to continue with progress we must design new reactor cores, so about a year ago, after obtaining approval from the Atomic Energy Commission and getting the research and development funds from the Congress, we started to design a new core. Recently, after considerable design work, we found that we could design that core to generate about 150,000 kilowatts of electrical power instead of the 60,000 which the plant is currently generating. I have asked the Atomic Energy Commission for funds to make the necessary alterations to increase the generating capacity of the plant to permit utilizing the full 150,000 kilowatts.

At Shippingport we run a school where we train operators from U.S. utilities and from those in foreign countries in the operation of central station atomic plants. Since Shippingport is the only one in the United States—in fact the only one in the world—which was designed for the sole purpose of producing atomic power, this school should prove to be very valuable for other atomic powerplant operators.

In designing and building the Shippingport plant, we used the same system we are using for developing our naval plants.

The naval program is conducted by a combined Atomic Energy Commission, Navy, congressional, and industrial team. The joining of a civilian and a military organization, together with congressional interest and help, and industrial know-how affords us the opportunity to work fast—which is inherent in a totalitarian state—while at the same time retaining the advantages of a democracy. The control of money for our program is still retained by the elected representatives of the people and the congressional committees provide us with counsel and supervise us. This meeting today is a living example that the Congress, who represent our people, can call a public servant to account for what he does. This, of course, the people in a totalitarian state cannot do.

At Shippingport we have learned many lessons. The Shippingport project led the way in developing uranium oxide for use in large scale reactors. Uranium oxide is a brownish powdery material which we use for fuel instead of metallic uranium. Nearly all other designers of large scale reactors in the United States have now adopted uranium oxide. The European countries, as well, have adopted it. The various units such as the pumps, the pressure vessel, the pressurizer, the reactor control, the reactor control drive mechanisms, and a thousand other items which we developed at Shippingport are also being copied by other reactor designers. We are proud of the compliment of being copied both here and abroad. That, of course, is one of the main reasons for the Shippingport project.

"I have learned so much from the Shippingport project—and from the development of naval reactors too—I wish I had time to tell you more about it.

Chairman ANDERSON. Could you give us a list to insert in the record?

Admiral RICKOVER. Yes, sir. I would be glad to.

(The material referred to will be found in the appendix, p. 71).

Admiral RICKOVER. It is frequently said that the electricity from the Shippingport reactor is expensive. It is necessarily so. In 1854, when electric power was first being discussed in this country, scientists and engineers said that it would never be practicable because they proved it would cost about \$2 a kilowatt-hour. The Shippingport station is in somewhat the same position for atomic power as electricity from coal was about a hundred years ago. True, our costs are high, but it must be borne in mind that we are operating this plant primarily to develop scientific and technical information and not merely for the sake of producing electricity.

STATEMENT OF HON. CLINTON P. ANDERSON—Resumed

Chairman ANDERSON. I see out in the audience Congressman Yates from the home district of our distinguished guest. Would you stand up please? [Applause.]

The program calls for comments by members of the Joint Committee and my comments will be in connection with something entirely different, but I do want to present the members of the Joint Committee who are here. Will you each stand please?

Mr. Westland of Washington. [Applause.]

Mr. Aspinall of Colorado. [Applause.]

Mr. Bates of Massachusetts. [Applause.]

Mr. Hosmer of California. [Applause.]

Mr. Van Zandt of Pennsylvania. [Applause.]

Mr. Holifield of California. [Applause.]

Senator Pastore of Rhode Island. [Applause.]

Senator Hickenlooper of Iowa. [Applause.]

Senator Gore of Tennessee. [Applause.]

Senator Aiken of Vermont. [Applause.]

Senator Jackson of Washington. [Applause.]

Senator Bennett of Utah. [Applause.]

I am their spokesman in this next matter. There is a resolution of the Joint Committee on Atomic Energy, which is in your program, but I shall read the text of the resolution and then present to Admiral Rickover the original text with the signatures of all the members of the Joint Committee.

Whereas Vice Adm. Hyman George Rickover, U.S. Navy, has served his country faithfully and with great honor as a naval officer; and

Whereas as a result of his unstinting drive, organizational ability, and technical leadership, the United States produced the world's first nuclear-powered ships; and

Whereas Admiral Rickover has dedicated his efforts and creative ability to the furtherance of the U.S. efforts to continue its nuclear technological lead in the world today; and

Whereas the advances in reactor technology made under the direction of Admiral Rickover have resulted in the development and construction of the first full-scale nuclear powerplant in the United States; and

Whereas Admiral Rickover for many years, in testimony before the Joint Committee on Atomic Energy, has willingly given the committee the benefit of his knowledge and advice and thus greatly assisted the committee in fulfilling its responsibilities; and

Whereas in recognition of the achievements of Admiral Rickover and his team in the field of military and peaceful uses of atomic energy, the Congress of the United States has awarded to him a special gold medal: Now, therefore, be it

Resolved, That the members of the Joint Committee on Atomic Energy do hereby express their appreciation of the great accomplishments of Admiral Rickover and his assistance to the Joint Committee over the years; and be it further

Resolved, That the members of the Joint Committee on Atomic Energy do hereby convey to Admiral Rickover their heartfelt congratulations on the occasion of the award to him this day of the Congressional Gold Medal.

Admiral Rickover, it is a joy to present this to you on behalf of the Joint Committee on Atomic Energy. [Applause.]

While the press photographers are getting a picture I am going to say to you that the next report from a Member of Congress will come from the vice chairman of the committee who is alternately the chairman of the committee and who, in my opinion, is one of the truly fine Members of the Congress of the United States and certainly one of the finest men we could possibly have on the Joint Committee, Carl Durham of North Carolina. [Applause.]

**STATEMENT OF HON. CARL T. DURHAM (NORTH CAROLINA),
VICE CHAIRMAN, JOINT COMMITTEE ON ATOMIC ENERGY**

Representative DURHAM. Thank you very much, Mr. Chairman, Admiral Rickover, and distinguished guests. It is certainly a very great occasion for me this afternoon. I might say, Admiral, that the sun shines brighter today than it did in 1946, 1947, and 1948, those struggling days in first initiating your idea and other ideas that came from the laboratories. Although it has been said many times, I would also like to say in connection with this occasion that no great man accomplishes very much without the loyal support of his wife and associates. It gives me a great deal of pleasure this afternoon to look back in the audience and see the faces of Mr. Simpson, the General Manager, and others from Bettis Laboratory who have made up, I believe, one of the greatest teams of scientific personnel ever put together anywhere in the world. Those of you who have not visited there and have not looked at it should certainly do so.

Admiral, on behalf of my colleagues on the Joint Committee and also speaking for myself personally, I want you to know how greatly we appreciate what you and your excellent team have done for the United States and the free people of the world.

Under your personal direction, the Naval Reactors Branch of the Atomic Energy Commission, and the Navy Bureau of Ships have succeeded in obtaining for the United States world leadership in nuclear ship propulsion which, today, cannot be challenged anywhere in the world. The five U.S. nuclear submarines currently at sea and the many more nuclear submarines and surface ships under construction and planned serve as testimony to your early foresight, dedicated devotion, and determined effort.

I would like to say at this point also that I, as a member of this Joint Committee, want to thank every member of the Appropriations Committee of the House for the way in which they have backed this program without hesitation.

For outstanding accomplishments in the naval program alone are sufficient to induce a grateful Nation to honor you which we are attempting to do here this day. In addition, however, your countrymen are indebted to you and to your team for the fact that the United States of America has today in operation the first full-scale nuclear powerplant devoted exclusively to the production of electricity at Shippingport, Pa.

We on the Joint Committee through long and close association know the tremendous obstacles and difficulties you had to overcome to achieve these accomplishments for the United States.

We on the Joint Committee are honored today to join with our colleagues in the U.S. Congress and, on behalf of a grateful Nation, to thank you and your team for what you have done with the hope that you will be able to continue in the years to come in your important work. [Applause.]

Chairman ANDERSON. I have two telegrams which I desire to read. One is from Albany, N.Y., addressed to Vice Adm. Hyman G. Rickover:

New York State shares in the pride and satisfaction that I know you and all of your friends must feel today. This recognition by Congress of your pioneering achievements in atomic energy is certainly most appropriate and well deserved. It is especially gratifying to New Yorkers who are privileged to have some of your most important work carried on within our borders. Congratulations.

NELSON A. ROCKEFELLER.

[Applause.]

Then there is a wire from Schenectady.

Congratulations, from the city of Schenectady, on gold medal, a most appropriate honor in view of your important role in development nuclear power ships. This is a tribute well earned.

MAYOR KENNETH S. SHELDON.

What a bad Chairman I am. I notified Senator Hickenlooper that I would appreciate it if he would move down here and he said, "Am I supposed to say anything?" I had forgotten to notify him, but that isn't necessary because Senator Hickenlooper is one of the real pioneers in the work of the Joint Committee, a long time ago its chairman and steadily one of the finest members that we have, regular in his attendance and devoted to his work.

I am happy indeed to present to you the distinguished senior Senator from Iowa, Senator Hickenlooper.

**STATEMENT OF HON. BOURKE B. HICKENLOOPER (IOWA), A
MEMBER OF THE JOINT COMMITTEE ON ATOMIC ENERGY**

Senator HICKENLOOPER. Thank you, Senator Anderson. Congressman Durham, my colleagues, Admiral Rickover, and guests, this is indeed a significant milestone in the development of science in the United States and in the national defense. Those of us who have been in this atomic energy business since its inception have seen some fantastic and, from the standpoint of a few years ago, unbelievable developments.

This accomplishment, for which we are honoring Admiral Rickover today, is one of the great series of accomplishments of America. We started out almost 200 years ago and we made the breakthrough on political accomplishments in which we established the greatest exper-

iment in human living that the world had ever seen. Then going down to the practical we established the clipper ships—and that was quite an accomplishment for those days. We came along and did a lot of other things. We dug the Panama Canal. Then skipping to the modern age we developed the ability to produce fission of the atom so that useful power in quantities could be released. Now we have succeeded in pioneering in that great field of almost unexplored portions of the earth, the undersea regions, by the successful building of atomic submarines which are true submarines and whose true element is under the surface of the water rather than on it.

We have not always honored sufficiently those who have spearheaded these developments in the past, but today we are honoring most deservedly and most enthusiastically Admiral Rickover whose courage, drive, foresight, and determination have done more perhaps than that of any other one man to develop this breakthrough in a new area, not only for industrial and peacetime uses but for the military in the defense of our country.

I have known Admiral Rickover for a great many years, I have watched him and his activities and I assure you that he is a dedicated American. He is a great American. He has done a tremendous job for his country and perhaps in the long run, the job for the world will overshadow the benefits to his country.

Admiral Rickover, I am honored indeed to participate here today in this ceremony in which you receive this medal from the Congress of the United States, but I am more honored in having been able over the years to participate with you in some small way through committee activities and otherwise in the development and fruition of this great new step forward in atomic progress.

Thank you. [Applause.]

Chairman ANDERSON. Thank you and now the final speaker before the presentation.

I am going to introduce to you the man to whom we all have to turn when a Navy problem comes up within the committee; a man who has had experience with the Navy, who is a naval captain and who knows what the Navy is supposed to do and never lets the joint committee forget. If there is anyone in a Navy uniform who wants to know who is the staunchest Navy defender in Congress, I will say it is the next speaker, one of the most lovable, likeable and friendly members of our committee, whom we are all privileged to call our friend, Jim Van Zandt. [Applause.]

**STATEMENT OF HON. JAMES E. VAN ZANDT (PENNSYLVANIA),
A MEMBER OF THE JOINT COMMITTEE ON ATOMIC ENERGY**

Representative VAN ZANDT. Senator Anderson, Admiral Rickover, my colleagues, ladies and gentlemen, this is a happy occasion for the Members of the minority on the House side. We have worked with the majority on both sides of this committee to make possible this unique event here today, an event when we honor not only a distinguished naval officer, but a distinguished American who through his perseverance and his insistence has given to his country an item of national security of which we are most proud.

If you will pardon a personal reference to the Admiral, I would like to mention that when I joined the Joint Committee immediately

After my separation from the Navy back in 1946, I was told there was a fellow in the Navy Department, by the name of Rickover who was very much interested in the development of a nuclear-powered submarine. Having been a sailor in the Navy when they had coal ships and knowing the problems we have when we take on fuel oil today, I asked about this nuclear power in ships and was given a complete rundown. It was a matter of a year or more until I met Admiral Rickover and said to him, "What can I do?" He said, "Just keep quiet and get reelected." That was the beginning of a long period of friendship I have enjoyed with the Admiral. He has made many friends and he has made many enemies, but he has had one objective and that is the development of nuclear power not alone for the submarine, but for the other types of craft so necessary to the Navy.

While we honor him today I would like to take the privilege of paying honor to others. We have here today Arleigh Burke, Chief of Naval Operations, who has stood up and fought for the program. I see Admiral Mumma who heads the Bureau of Ships who stood up in the same way and supported Admiral Rickover as did the Secretary of the Navy from my own State of Pennsylvania, Tom Gates.

As I look around I see some of those devoted officers of the Navy and civilians with whom Admiral Rickover has surrounded himself and in whom exists an esprit de corps the like of which I have never found in my some 40 years of experience in the Navy. Also here today is Captain Wilkinson who commanded the *Nautilus*, Commander Calvert, Captain Laning. I am sorry Commander Anderson is not here and Commander Behrens who is commissioning today the USS *Skipjack* at New London. All of these officers have played a part. So today while we honor Admiral Rickover we also honor those naval officers and likewise the enlisted men of the Navy who have made possible this program and who will take these submarines, these carriers, cruisers and destroyers to sea and fight for America and in so doing give the American people the security to which we are entitled.

I congratulate you, Admiral Rickover again on behalf of the minority Members of the House side of the committee. [Applause.]

STATEMENT OF HON. CLINTON P. ANDERSON—Resumed

Chairman ANDERSON. Just privately he did a pretty good job of speaking for all of us. Now that he has done that, I think there are three captains here who ought to stand up:

Captain Wilkinson, the first nuclear submarine commander, now commander of a nuclear squadron. Will you stand up, Captain? [Applause]

Commander Calvert of the *Skate*. [Applause.]

Commander Brooks of the *Sargo*. [Applause.]

Captain Laning, former commander of the *Seawolf*. [Applause.]

John (Chairman McCone), would you come up here and help me?

I asked Mr. McCone to come over. This is not a part of the program, but he has been so helpful in the work that Admiral Rickover has done and is doing, that I did not want this ceremony to go on without the Chairman of the Atomic Energy Commission.

On instructions of the Congress of the United States, in behalf of the American people, with their gratitude and appreciation, it is my privilege today to present to you that recognition which a democracy can give to its deserving citizens.

Different countries have different ways of rewarding distinguished and meritorious achievements. In Great Britain a man who was personally responsible for giving his country a position of world leadership in submarine warfare might well be elevated to knighthood; in Belgium such a man might receive the Order of the Crown. Holland might bestow on him the Order of the Lion and Sweden the Order of the Polar Star. France could give him the Legion of Honor or Greece the Order of the Redeemer.

But this United States is not a country of heraldry. Our high awards, such as the Congressional Medal of Honor, are usually reserved for valor on the battlefield. For this reason, the Congress of the United States, beginning with the birth of our Nation in 1776, has ordered gold medals struck to honor the Nation's outstanding citizens. The first gold medal bestowed by congressional resolution was given to General Washington in 1776. The medal honored him in connection with the siege of Boston.

Since that time the Congress has ordered gold medals bestowed on a long list of distinguished citizens: Cornelius Vanderbilt, Cyrus Field, the Wright Brothers, Thomas Edison, Charles Lindbergh, General George Marshall, General John Pershing, General Billy Mitchell, and the famed Army Surgeon General Walter Reed. The most recent recipients were Vice President Alben Barkley in 1949 and Dr. Jonas Salk in 1958.

Incidentally we ran a special research project to find out how many admirals before you had been presented with gold medals by act of Congress and the research wasn't extensive enough so I don't guarantee it, but as far as I have been able to determine you are the third U.S. Navy admiral to be so honored. The other two were the famed Polar explorer, Richard Byrd, and the man who made such a contribution to World War II, Fleet Adm. Ernest J. King. That, I am sure, is illustrious company but no better than you deserve. A gold medal was presented to John Paul Jones, but he was never an admiral in the Navy of this country. He was an admiral in the Russian Navy. Silver and bronze medals have been presented to other naval heroes, among them Admiral Perry and Admiral Dewey.

I have no further wish to test your patience. On behalf of the people of America, I hand you this symbol of your success, a medal of achievement from the Congress of the United States, with the hope that it will remind you of your great services to the country, our great devotion to what you have done and the long years you have been associated with the Navy of the United States.

I congratulate you in behalf of the Congress of the United States. [Applause.]

Admiral RICKOVER. Senator Anderson, Mr. Durham and other distinguished members of the Committee and the Congress, ladies and gentlemen; there are times when one is too deeply moved to express his feelings. How can I put into words my gratitude, as I stand before you—the busy leaders of our great country who have taken time out from your heavy responsibilities—to honor me. It is not



FACE OF THE MEDAL



BACK OF THE MEDAL

enough that I thank you from the bottom of my heart. I speak not only for myself but for all the devoted and hardworking members of the naval reactors group when I pledge that we shall continue our work with renewed enthusiasm and strength. We shall let nothing deter us from building a nuclear Navy in the shortest possible time.

My colleagues and I know—and I am confident it will become known to everyone—that without the Committee's active help on countless occasions, and the continuous support of the Congress, we should not now have a single nuclear ship.

For your never-failing understanding, your friendship, and your kindness in awarding me this medal, I thank you. [Applause.]

Chairman ANDERSON. On behalf of the Congress and the Joint Committee on Atomic Energy may I thank each one of you for being kind enough to be here this afternoon and to say I know Admiral Rickover well enough to know that if just one or two of you—or maybe all of you—want to shake his hand, this is a good occasion to do it.

Thank you very much.

(Whereupon at 3:45 p.m. the meeting was adjourned.)

APPENDIX

APPENDIX 1

RADIOACTIVE WASTE DISPOSAL FROM U.S. NAVAL NUCLEAR-POWERED SHIPS.

(Date: January 1959; prepared by T. J. Iltis and M. E. Miles, Nuclear Propulsion Divisions, Bureau of Ships, Department of the Navy)

(Approved by: H. G. Rickover, vice admiral, USN, Assistant Chief of Bureau for Nuclear Propulsion)

I. SUMMARY

The purpose of this report is to: (1) describe the sources and nature of radioactive wastes from U.S. naval nuclear-powered ships, (2) outline and discuss the established waste disposal procedures used for these ships, and (3) summarize the measurements made to detect any effect of wastes discharged by the first ships on the radioactivity of their harbor environs.

The basic criterion adopted for disposal of radioactive waste from U.S. naval nuclear-powered ships is that disposal should not increase the average concentrations of radionuclides in the surrounding environment by more than one-tenth of the maximum permissible concentrations for continuous exposure listed in National Bureau of Standards Handbook 52. Actual data from the operating ships shows that the radioactivity of their wastes is consistently low and has had no detectable effect on the radioactivity of their environment.

II. INTRODUCTION

A. General description of U.S. naval nuclear powerplants

All nuclear-propelled U.S. naval ships now planned, in construction, or in operation are powered by pressurized water reactors. In these reactors, pressurized water circulating through the reactor core picks up the heat of the nuclear reaction. The reactor coolant passes through heat exchangers which transfer the heat to water in a steam system. The steam system water is converted to steam and is then used as the source of power for the propulsion plant as well as for the auxiliary machinery.

B. Principal sources of radioactive waste

The principal source of radioactive waste from all nuclear-powered naval ships is the reactor coolant water which contains small quantities of activated impurities. The largest amounts of reactor coolant water are discharged when this water expands as a result of bringing the reactor plant up to operating temperature. This normally happens a few times per month on each ship and the quantity of coolant water discharged on each heat-up averages about 500 gallons. The nature of the radioactivity in the coolant water and the procedures established for its disposal are described in detail in the main body of this report (sec. III).

There are other sources of radioactive waste derived from the operation of naval nuclear powerplants which require only infrequent waste disposal considerations. These include disposal of (a) the ion exchange resin that is used to purify the coolant water of the reactor plant, (b) reactor shield water, (c) solid wastes from maintenance operations, and (d) special wastes from laundry or decontamination operations. The nature and procedures for handling these wastes from infrequent operations are discussed in section IV of this report.

Aside from the above-mentioned sources of radioactive waste, it should be noted that the direct radiation emanating from the hull of any nuclear-powered naval ship is designed to be insufficient to cause any detectable activation of the sea water.

C. Fission products

In addition to activated impurities, the reactor cooling water may contain trace amounts of fission products. These come from minute quantities of uranium impurity in the reactor structural materials. The large quantities of fission products that are produced by the fission process of the reactor are retained where they are born: metallurgically bound within the fuel alloy. They cannot get out of the fuel elements unless by a very remote possibility the reactor itself were to melt down. The plant is protected against this possibility by its inherent safety characteristics and by a "fail-safe" protection system, although the possibility of such an accident cannot be completely eliminated. If the ship were sunk, it is expected that the reactor core could remain submerged in sea water for decades without release of fission products, since the zirconium protective cladding on the fuel elements corrodes only a few millionths of an inch per year. The steam system is entirely separate from the reactor system, and a failure in the steam system would not endanger the reactor nor release fission products or activated impurities.

D. Environmental effects

In order to confirm the adequacy of waste disposal procedures for naval nuclear-powered ships, surveys are being conducted of the radioactivity in the environment around ports where nuclear ships are being built and operated. These surveys cover periods both before and after commencement of operation of the reactors. A description of these surveys and some results obtained to date are discussed in section V of this report.

III. REACTOR COOLANT WASTE

A. Nature of reactor coolant

In order to establish waste disposal procedures, the radioactive nuclides in the reactor coolant must be identified. The radioactive isotopes of most concern result from activation of the small amounts of corrosion and wear products of plant surfaces and from activation of small amounts of impurities in the coolant water. All nuclides normally present in significant amounts in the reactor coolant of operating naval reactors and prototypes have been identified and their concentrations determined. These determinations are performed during initial operations of the reactors, and at intervals thereafter coolant samples are analyzed for the long-lived (greater than several days half life) nuclides. These analyses have shown that the concentrations of radioactive nuclides in reactor coolant a few minutes after sampling for naval nuclear propulsion plants are approximately as shown in table I. The table shows for comparison the tolerances used for dumping reactor coolant in restricted waters, to be discussed in section III B of this paper. Significant increases in coolant activity would be indications of reactor plant malfunction; therefore, continued reactor operation with the concentration of any nuclide above dumping tolerance is not expected and would not normally be permitted.

TABLE I.—Concentrations of radionuclides in reactor coolant

Measure activities of coolant in microcuries per cubic centimeter

Nuclide	Half life	Maximum	Average	Dumping tolerance in $\mu\text{c/cc}$
Mn ⁵⁶	2.5 hours.....	9.3×10^{-2}	2.2×10^{-2}	15.
Co ⁶⁰	5.2 years.....	2.5×10^{-2}	5.7×10^{-6}	2.
Fe ⁵⁹	45 days.....	2.8×10^{-3}	1.5×10^{-4}	1×10^{-2} .
Ni ⁶⁶	2.56 hours.....	1.3×10^{-3}	1.6×10^{-4}	1.9.
Cr ⁵¹	27 days.....	5.5×10^{-3}	1.0×10^{-5}	50.
Na ²⁴	15 hours.....	2.0×10^{-2}	8.0×10^{-4}	3×10^{-1} .
Cu ⁶⁴	12.8 hours.....	9.1×10^{-3}	1.5×10^{-5}	8.
Ta ¹⁸²	112 days.....	5.6×10^{-2}	7.3×10^{-3}	10.
P ³²	1.87 hours.....	6.8×10^{-2}	1.2×10^{-2}	90.
W ¹⁸⁷	24 hours.....	9.0×10^{-3}	3.3×10^{-4}	9×10^{-2} .
Gross activity measured 15 minutes after sampling.....	1.5×10^{-1}	5.0×10^{-2}	3.0.
Gross activity measured 120 hours after sampling.....	3.6×10^{-2}	3.1×10^{-3}	1×10^{-1} .

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Complete results of the nuclide identification program performed on *Nautilus* and the coolant water are shown in appendix B. Detailed analyses of *Nautilus* reactor coolant were made every 1 to 2 months during the operation of the first core and at less frequent intervals for the second core. No new nuclides appeared in these analyses. The gross 15-minute activity has remained below a normal operating limit of 0.3 microcuries per cubic centimeter ($\mu\text{c/cc}$). Similar results have been obtained for the *Skate* and other naval reactors already operating. Nevertheless, initial and periodic checks on the activity of the nuclides present in the reactor coolant of each new ship will continue to be made to detect changes that may affect plant operation or waste disposal procedures.

Fission products occur in very small concentrations in reactor coolant because of uranium impurity in core structural materials. The concentrations of fission products in reactor coolant from this source are shown in table II, along with their tolerances for waste disposal. (The very short-lived fission products are not shown in the table since their tolerances are relatively high.) Since a rise in fission product concentrations would indicate a fuel element defect that might lead to further plant operational or maintenance difficulties, continued operation of a naval reactor with fission products concentrations above waste disposal limits would not normally be permitted.

TABLE II.—Concentrations of fission products in reactor coolant

Nuclide	Half life	Concentration, $\mu\text{c/cc}$	Dumping tolerance, $\mu\text{c/cc}$
Total iodine.....	Variable.....	5×10^{-4}	To be conservative 1×10^{-3} is normally used.
I^{131}	8 days.....	1×10^{-5}	3×10^{-3} .
Total strontium.....	Variable.....	5×10^{-5}	To be conservative 1×10^{-4} is normally used.
Sr^{90}	28 years.....	5×10^{-5}	8×10^{-5} .
Sr^{89}	54 days.....	5×10^{-6}	7×10^{-3} .
Ba^{140}	13 days.....	1×10^{-6}	2×10^{-4} .
Ce^{144}	285 days.....	1×10^{-7}	4.0.
Cs^{137}	30 years.....	1×10^{-8}	1.5×10^{-1} .

Two other radionuclides that may be present in reactor coolant but produce no waste disposal problems are argon-41 and tritium. Argon, present as a constituent in small quantities of air dissolved in reactor coolant, becomes activated as argon-41 and may reach concentrations up to 0.7 $\mu\text{c/cc}$. Argon-41 has a short half-life (1.9 hours); it is gaseous and thus it will mostly escape to the atmosphere upon discharge. It is not an ingestion hazard, and calculations have shown that if all the argon-41 in the coolant were released as a cloud, persons exposed to the cloud would receive only a negligible external radiation dose. Since argon-41 is no waste disposal problem, it will not be further discussed in this report.

In some of the reactors the primary coolant water is treated with a few parts per million of lithium hydroxide to raise the pH (alkalinity) of the coolant and thereby reduce corrosion of the system materials. The lithium will undergo a neutron reaction in the reactor core and form small amounts of tritium in the coolant. Experience with the PWR plant at Shippingport, Pa., which uses this same lithium hydroxide treatment, has shown that the tritium activity in primary coolant will consistently remain below 0.3 $\mu\text{c/cc}$. This concentration of tritium activity is far less than dumping tolerance of 7 $\mu\text{c/cc}$ established for tritium and thus it does not constitute a waste disposal problem.

B. Criteria and procedures for disposal of reactor coolant

The basic criterion adopted for disposal of coolant is that disposal should not increase the average concentrations of radionuclides in the surrounding environment by more than one-tenth of the maximum permissible concentrations for continuous exposure listed in National Bureau of Standards (NBS) Handbook 52. Application of this criterion has led to the waste disposal instruction for use by all U.S. naval nuclear-powered ships, included as appendix A to this report. This instruction was reviewed and concurred in by the U.S. Public Health Service, the Bureau of Medicine and Surgery of the Navy, the Reactor Development and Biology and Medicine Divisions of the AEC, and the Atomic Energy Applications Division of the Office of the Chief of Naval Operations. The instruction states that for discharge in port, reactor coolant gross activity must be less than 3 $\mu\text{c/cc}$ and the fission product iodine¹³¹ must be below 10^{-3} $\mu\text{c/cc}$. For discharge in the open sea, the instruction specifies no restriction because the quantities of waste

are small, the activities are normally well below the above dumping tolerances and the dilution obtained in the open sea is very much greater than in port.

The development of simple shipboard control procedures from the basic criterion stated above is discussed below in summary and then in detail:

1. A dilution factor is first determined by considering the frequency and quantities of coolant that are discharged and the dilution factors that are available in harbor waters. It has been established that in these waters a dumping tolerance of 100 times the NBS Handbook 52 tolerance for any specific nuclide is conservative.

2. By equally scaling up the activities of all the individual nuclides until the first nuclide reaches its dumping tolerance, it is determined that when the gross coolant activity is $3 \mu\text{c/cc}$ all nuclides are below their respective dumping tolerances. This gross activity then becomes the shipboard limit for disposal of reactor coolant during operation.

3. A similar scaleup is performed for the coolant after reactor shutdown. This condition is different from the operating condition above since all short-lived nuclides in the reactor coolant have decayed. The gross activity limit becomes $0.1 \mu\text{c/cc}$ for this case.

4. For the unexpected condition where fission product concentrations might become significant, the fission product that is closest to dumping tolerance is determined. A shipboard radiochemical procedure is established for determination of this nuclide. Experience on all naval ships to date indicates that this worst nuclide is iodine¹³¹ with a dumping tolerance of $3 \times 10^{-3} \mu\text{c/cc}$.

Each of the above steps is explained in more detail as follows:

1. *Dilution factor and definition of dumping tolerance.*—Because coolant is normally discharged in small quantities (average less than 500 gallons per discharge) it has been assumed that the discharged water will almost immediately be diluted in the harbor water by a factor of at least 1,000.¹ This assumption has been checked by actual measurements of activity in the water alongside the *Nautilus* while the ship was discharging reactor coolant at the Electric Boat Division dock in Groton, Conn. These measurements showed that when the ship was discharging water at about $2 \times 10^{-2} \mu\text{c/cc}$ the harbor water alongside the ship remained at background level of about $2 \times 10^{-7} \mu\text{c/cc}$, representing a dilution factor of at least 100,000.

To be conservative, a dilution factor of only 1,000 has been assumed. With this factor, dumping tolerances in the Navy instruction (appendix A) are set at 100 times the maximum permissible concentrations for continuous exposure listed in NBS Handbook 52. This will insure that disposal will meet the basic criterion of not increasing the average concentrations of radionuclides in the environmental water by more than one-tenth of the NBS Handbook 52 concentrations. The dumping tolerances in this report and in appendix A then are defined as 100 times the concentrations listed in NBS Handbook 52.

2. *Gross activity limit during reactor operation.*—As noted previously a complete analysis of all the significant radionuclides in the reactor coolant is made for each naval ship. (See table I and appendix B.) If these concentrations of nuclides in the reactor coolant are scaled up for a gross coolant activity of $3 \mu\text{c/cc}$, one may observe (see table III) that the concentrations of all nuclides are below dumping tolerance. On this basis, a shipboard procedure is used to verify that gross activity is below $3 \mu\text{c/cc}$. This procedure is easy to perform by ship personnel and provides ready control for coolant waste disposal purposes. In actual experience the gross activity is nearly always below $0.3 \mu\text{c/cc}$. Significant increases of coolant activity above this level would be indications of plant malfunction and continued reactor operation would normally not be permitted. Hence the normal limit imposed for reactor operating reasons is one-tenth the waste disposal limit of $3 \mu\text{c/cc}$.

¹ A volume of water equal to the displacement of the ship would be more than enough to accomplish this dilution.

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TA III.—Comparison of nuclide activities with dumping tolerance (all activities in $\mu\text{c/cc}$)

Nuclide	Column A, nuclide activity from table I scaled up to gross activity = $3 \mu\text{c/cc}$	Column B, dumping tolerance (100 times Handbook 52)	Ratio, column A/ column B
Mn ⁵⁶	1.3	15.0	0.09
Co ⁶⁰	3.6×10^{-4}	2.0	.002
Fe ⁵⁹	9.0×10^{-3}	1.0×10^{-2}	.90
Ni ⁶³	9.6×10^{-3}	19.0	.0005
Cr ⁵¹	6.0×10^{-4}	50.0	.00001
Na ²⁴	4.8×10^{-3}	8.0×10^{-1}	.006
Cu ⁶⁴	9.0×10^{-4}	8.0	.0001
Ta ¹⁸²	4.3×10^{-1}	10.0	.04
Fr ¹⁸	7.2×10^{-1}	90.0	.008
W ¹⁸⁷	1.9×10^{-2}	9.0×10^{-2}	.21

3. *Gross activity limit after reactor shutdown.*—Within several days after reactor shutdown there are no longer significant quantities of short-lived nuclides; the coolant activity is now largely composed of long-lived isotopes such as iron 59 and cobalt 60. A different gross activity limit is needed for waste disposal after shutdown, since if the water has a gross activity as high as $3 \mu\text{c/cc}$, some of these nuclides could be above their dumping tolerances. Examination of table I and appendix B shows that iron 59 has concentrations closest to dumping tolerance and that its highest concentration in the coolant more than 48 hours after shutdown is less than 10 percent of the gross activity. On this basis, if the gross activity is less than $0.1 \mu\text{c/cc}$ 48 hours or more after shutdown, all nuclides including iron 59 will be below dumping tolerances. Table IV illustrates this point. On the basis of these data the instruction to ships, appendix A, uses the limit of $0.1 \mu\text{c/cc}$ for times beyond 48 hours after reactor shutdown.

TABLE IV.—Reactor coolant activity 48 hours after shutdown (scaled up to a gross activity of $0.1 \mu\text{c/cc}$ assuming the most adverse Fe⁵⁹ concentrations)

Nuclide	Half life	Measured coolant activity ($\mu\text{c/cc}$)	Dumping tolerance ($\mu\text{c/cc}$)
Fe ⁵⁹	45 days	1×10^{-4}	1×10^{-4}
Co ⁶⁰	5.2 years	1.2×10^{-3}	2
Cr ⁵¹	27 days	2.6×10^{-3}	50
Na ²⁴	15 hours	3.2×10^{-2}	8×10^{-1}
Cu ⁶⁴	12.8 hours	1.5×10^{-2}	8.0
Ta ¹⁸²	112 days	2.6×10^{-2}	10
W ¹⁸⁷	24 hours	1.5×10^{-3}	9×10^{-2}
Gross activity		1.0×10^{-1}	1×10^{-1}

4. *Fission products.*—Analysis of the fission product concentrations in the coolant (shown in table II) shows that iodine 131 comes the closest to its dumping tolerance. The relative amounts of all these fission products has remained consistent on all naval reactor plants operated to date. For shipboard control of coolant waste disposal then, a radiochemical analysis for iodine is performed daily to determine that iodine 131 concentration is below $10^{-3} \mu\text{c/cc}$. This will insure that all other fission products are below their respective dumping tolerances.

IV. WASTES FROM INFREQUENT OPERATIONS

Reactor plant operations also produce other radioactive wastes that require less frequent disposal than reactor coolant. This section discusses these wastes which include ion exchange resin, reactor shield water, solid wastes from maintenance operations, and special wastes from laundry or decontamination operations.

A. Ion exchange resin

The reactor coolant is continuously being filtered and purified by passing a small bypass flow through an ion exchange resin. This resin becomes exhausted and is

replaced approximately every 6 months. Table V shows the radioactivity associated with the spent resin. Short lived nuclides are not included since the quantities present shortly after reactor shutdown are insignificant compared to the long-lived nuclides shown.

TABLE V.—Radioactivity of spent ion exchange resin ¹

Nuclide	Half life ²	Maximum activity ¹ curies
Co ⁶⁰	5.2 years.....	10.0
Co ⁵⁸	71 days.....	.5
Fe ⁵⁹	45 days.....	.5
Cr ⁵¹	27 days.....	.3
Mn ⁵⁴	300 days.....	.2
Hf ¹⁷⁸	70 days.....	1.0
Total.....	12.5

¹ Maximum radioactivity expected based on measurements from operating plants.

If resin replacement is necessary in port, the resin is dumped to a disposable catch tank. The catch tank is subsequently sealed and buried by land or sea in accordance with approved procedures.

Resin discharge at sea can take account of the great dilution available in the ocean. When dumped overboard the resin will sink and as it sinks the radioactive ions on the resin are rapidly replaced by ions of the sea water. Thus, within a few minutes the radioactivity has transferred from the resin to the sea water in the wake of the ship where it will readily disperse. Assuming conservatively that the wake is no longer than the path of the ship itself, the distributed activity from the resin results in a sea water gross concentration in the ship's wake of less than 10^{-3} $\mu\text{c/cc}$. Even at this concentration all nuclides are below NBS Handbook 52 permissible concentrations. In addition, subsequent action of wind, wave, and current will rapidly decrease these concentrations. On this basis the Navy instruction appendix A, allows resin disposal in the ocean. However, in order to avoid any possibility of having such discharges increase the radioactivity to which people are exposed, restrictions stated in appendix A are placed on ship location with respect to land, to other ships, and to fishing areas during resin discharge.

B. Reactor shield water

Some attenuation of the radiation emanating from the reactor core is accomplished by using water in a shield tank around the reactor. This shield water will seldom if ever be dumped during the life of a ship. Two-tenths percent potassium chromate is used in this water as a corrosion inhibitor to protect the steel surfaces inside the tank. Neutron activation of the potassium chromate and impurities in the shield water produce small concentrations of radionuclides as shown in table VI. Since the concentrations are well below dumping tolerance, no waste disposal restrictions for radioactivity are necessary as disposing of shield tank water.

TABLE VI.—Radionuclides in shield tank water

Nuclide	Maximum observed activity, $\mu\text{c/cc}$	Dumping tolerance, $\mu\text{c/cc}$
K ⁴²	0.2.....	1.
Cr ⁵¹	0.5.....	5.
Fe ⁵⁹	1×10^{-4}	1×10^{-2} .

C. Solid wastes

Solid radioactive wastes from nuclear ships result primarily from maintenance operations. Such materials include metal scrap, pieces of insulation, rags, sheet plastic, and paper. These solid wastes are given by the ships to shore or tender facilities for subsequent packaging and burial in accordance with approved procedures.

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D. Contamination and laundry wastes

Other operations associated with reactor plants require disposal of radioactive liquids. Decontamination of radioactive tools and equipment and laundering of radioactive anticontamination clothing may be performed on some ships. Discharge of resulting liquids is permitted by appendix A in harbors if no nuclide concentrations exceed dumping tolerance. To insure that this criterion is met, the radioactive decontamination and laundry wastes from the ships are held up for monitoring and treatment by ion exchange if necessary.

It should be noted that all of the above wastes from infrequent operations, with the exception of shield water, derive their contamination from radioactivity produced in the reactor coolant water. They will therefore contain the same radionuclides as the reactor coolant.

V. ENVIRONMENTAL EFFECTS

In order to verify the adequacy of the ship waste disposal procedures of appendix A, surveys are being conducted of the radioactivity in the environment around ports where nuclear ships are being built and operated. These surveys cover periods both before and after commencement of operation of the reactors. The surveys are being made in cooperation with the U.S. Public Health Service and are being conducted by State and local public health organizations and the shipyards. Included in the surveys are measurements of the radioactivity of water and atmospheric fallout, and sometimes marine organisms, fish, shellfish, mud, and vegetation.

The greatest amount of experience with these surveys to date has been obtained in the New London, Conn., area where the U.S.S. *Nautilus* has operated for 4 years and the U.S.S. *Skate* has operated 1 year. The waste disposal records of these ships are shown in tables VII and VIII. They are presented for later comparison with environmental survey results, and they may be summarized as follows:

Average gallons dumped in New London Harbor per month	625.
Average number of discharges per month	7.
Average number of gallons dumped in a single discharge	90.
Maximum 15-minute activity at any single discharge	$2.0 \times 10^{-1} \mu\text{c/cc.}$
Average 15-minute activity of water dumped	$2.0 \times 10^{-2} \mu\text{c/cc.}$
Average 120-hour activity of water dumped	$4.5 \times 10^{-3} \mu\text{c/cc.}$

In addition to the above data from *Nautilus* and *Skate* on disposal at New London, a review of coolant activity on all operating ships indicates the activity of the reactor coolant water is always low, averaging $2.5 \times 10^{-2} \mu\text{c/cc.}$ and never reaches the normal limit of $0.3 \mu\text{c/cc.}$ Moreover, the logs indicate that at no time has water of an activity greater than $0.3 \mu\text{c/cc.}$ been disposed of in harbor or at sea.

TABLE VII.—U.S.S. "Skate" reactor coolant discharged in New London Harbor

Date	Gallons	Average 15 minute activity
December 1957		
January 1958	485	1.75×10^{-2}
February 1958	844	1.47×10^{-2}
March 1958	120	1.43×10^{-2}
April 1958		
May 1958	130	$.90 \times 10^{-2}$
June 1958		
July 1958		
August 1958	806	$.83 \times 10^{-2}$
September 1958		
October 1958		
November 1958	578	$.15 \times 10^{-2}$
December 1958	316	$.83 \times 10^{-2}$
	328	$.34 \times 10^{-2}$

TABLE VIII.—USS "Nautilus" reactor coolant discharged in New London *br

Date	Gallons	Average 15 minute activity	Date	Gallons	Average 15 minute activity
March 1955	255	1.26×10^{-2}	February 1957	354	2.00×10^{-2}
April 1955	300	$.23 \times 10^{-2}$	March 1957		
May 1955	1,357	2.11×10^{-2}	April 1957	800	$.70 \times 10^{-2}$
June 1955	148	$.65 \times 10^{-2}$	May 1957	880	$.67 \times 10^{-2}$
July 1955	998	2.41×10^{-2}	June 1957		
August 1955			July 1957		
September 1955			August 1957	800	3.36×10^{-2}
October 1955	366	$.30 \times 10^{-2}$	September 1957		
November 1955	1,444	1.29×10^{-2}	October 1957		
December 1955	417	1.91×10^{-2}	November 1957		
January 1956			December 1957		
February 1956	2,268	1.78×10^{-2}	January 1958		
March 1956	1,128	2.97×10^{-2}	February 1958	2,380	$.90 \times 10^{-2}$
April 1956			March 1958	1,378	3.06×10^{-2}
May 1956	2,236	1.41×10^{-2}	April 1958	1,608	2.76×10^{-2}
June 1956	612	$.89 \times 10^{-2}$	May 1958		
July 1956			June 1958		
August 1956			July 1958		
September 1956			August 1958		
October 1956			September 1958	1,256	1.56×10^{-2}
November 1956			October 1958	540	1.41×10^{-2}
December 1956			November 1958	1,428	4.56×10^{-2}
January 1957	340	1.00×10^{-2}	December 1958	696	3.01×10^{-2}

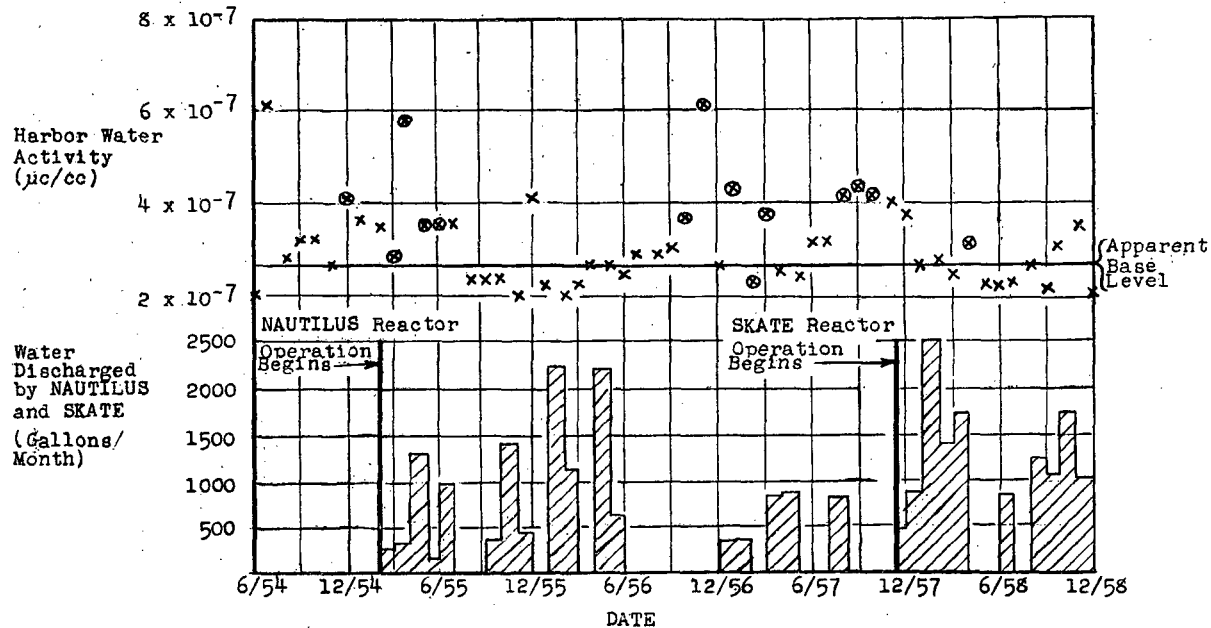
As noted above, a program was initiated before *Nautilus* began operation to survey periodically the activity of the New London Harbor environs. This survey was carried out by the Connecticut Department of Health, the Connecticut Water Commission, and the Electric Boat Division. An analysis of the effects of discharging of the reactor plant wastes on the activity of the Thames River can be made by considering the discharges presented in table VII and VIII together with the pre- and post-operational survey data obtained by the Electric Boat Division. Figure 1 presents the record of the *Nautilus* and *Skate* discharges at or near the Electric Boat dock together with the results of the operational surveys of water activities in the immediate area of the dock. The data show that the post-operation survey measurements all fall well within the range of the preoperational measurements even during period of maximum discharge from the ships. The data further indicates that the only increases in the activity of the river water samples bear no relation to the operation of nuclear submarines, but occurred during periods when nuclear weapons fallout was detected in rain and snow samples.

Examination of the additional survey data taken by the Connecticut Department of Health and the State Water Commission reveals that nearly all points surveyed both pre- and post-operational, showed activity below the minimum detectable limit. Some scattered pre- and post-operational data points show activities ranging up to twice the minimum detectable activity. These points bear no correlation with *Nautilus* discharges or with location respective to the Electric Boat dock where the *Nautilus* discharges were centered.

One must conclude from this survey data that the controlled disposal of radioactive wastes from the *Nautilus* and *Skate* has had no detectable effect on the radioactivity of the environment. The surveys will continue as more ships go into operation at New London and other ports to detect any possible effects of the naval ships on environmental radioactivity. Surveys are now underway at Portsmouth Naval Shipyard, N.H.; Mare Island Naval Shipyard, Calif.; and Bethlehem Steel Shipbuilding Division, Quincy, Mass. Additional surveys will soon be initiated at Newport News Shipbuilding & Drydock Co., Virginia, and Ingalls Shipbuilding Corp., Pascagoula, Miss.

FIGURE 1

Activity of Water in New London Harbor Near Electric Boat Division



x Normal survey. Each point represents the maximum of about 60 measurements per month.

⊗ Survey point coincides with above-background fallout from nuclear weapons

APPENDIX A

BUSHIPS INSTRUCTION 9890.5

From: Chief, Bureau of Ships.

To: Distribution list.

Subject: Disposal of radioactive effluents from U.S. naval nuclear-powered ships.

Enclosure: (1) Maximum permissible concentrations of radioisotopes in effluents for discharge within 12 miles from shore.

1. *Purpose.*—To establish procedures and limits for the disposal of radioactive effluents from U.S. naval nuclear-powered ships.

2. *Cancellation.*—This instruction cancels and supersedes the following:

(a) BuShips ltr SSN-571(590) ser 590-1808 dtd May 31, 1955.

(b) BuShips ltr Ser. 1500G-660 dtd September 26, 1957.

3. *Scope.*—This instruction applies, during construction or operation, to all U.S. naval nuclear-powered ships equipped with pressurized water reactor plants.

4. *Reactor coolant sampling.*—The following analyses are performed using shipboard-type Geiger-Mueller counting equipment for reactor plant operational control, and to obtain information for disposal of reactor coolant:

(a) A sample of reactor coolant is taken at least once daily and measured for short-lived activity at 15 ± 2 minutes after sampling. At least once a week the same 15-minute sample is allowed to decay for 120 ± 6 hours and measured again for long-lived activity.

(b) The concentrations of fission products in the reactor coolant water are determined by analyses performed daily for iodine activity and monthly for strontium activity.

5. *Procedures for disposal of reactor coolant water.*—

(a) When the ship is more than 12 miles from shore, reactor coolant water and other effluents containing reactor coolant as the only radioactive contaminant may be discharged directly overboard without restriction.

(b) Reactor coolant water and other effluents containing reactor coolant as the only radioactive contaminant may be discharged directly overboard within 12 miles from shore, or at dockside, provided—

(1) the daily iodine analysis and monthly strontium analysis indicate that concentrations of fission products are less than 10^{-3} microcuries per milliliter ($\mu\text{c}/\text{ml}$) of iodine 131 and less than 10^{-4} $\mu\text{c}/\text{ml}$ of strontium 90;

(2) when the reactor is in operation or has been shut down for less than 48 hours, the daily measurement of gross degassed activity, 15 minutes after sampling, does not exceed 3 $\mu\text{c}/\text{ml}$;

(3) when the reactor has been shut down for 48 hours or more, the daily measurement of gross degassed activity, 15 minutes after sampling, does not exceed 0.1 cc/ml.

(c) If the conditions in paragraph 5 b above are not met, reactor coolant water should not be discharged overboard within 12 miles from shore. Under these conditions reactor coolant water may be discharged to a dockside retention tank for disposal by a shore facility.

6. *Procedures for disposal of spent demineralizer resin.*—

(a) At sea, spent demineralizer resin may be discharged overboard when the ship is more than 12 miles from shore, provided—

(1) the ship has headway on,

(2) other ships are not within 3 miles, and

(3) the ship is not in known fishing areas.

(b) Except as provided above, spent demineralizer resin should not be discharged overboard. At dockside, resin may be discharged to a retention tank for disposal by a shore facility.

7. *Procedures for disposal of other radioactive effluents.*—

(a) When the ship is more than 12 miles from shore, radioactive effluents derived from other propulsion plant fluid systems, shipboard decontamination, and laundry may be discharged directly overboard without restriction.

(b) For discharge directly overboard within 12 miles from shore or at dockside, the radioactivity of liquid effluent derived from propulsion plant fluid systems, shipboard decontamination, and laundry must be less than the values listed in enclosure (1).

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8. Records.—

(a) Records shall be maintained of the measurements of paragraph 4 as well as the type of discharge, total quantity, time, and location of discharged radioactive effluents.

(b) After the first 6 months of operation, the records obtained in accordance with the preceding requirement should be submitted to the Bureau of Ships for review.

9. *Effective date.*—This instruction is effective upon receipt.

H. G. RICKOVER,

Assistant Chief of Bureau for Nuclear Propulsion.

Distribution list:

29W SSN (only 571, 578).

L1 Navshipyds (only PTSMH, Mare).

L3 Supships-Incord (only Groton, Quincy, NPTNWS, Pascagoula).

L3O Subase.

29W PCO Swordfish.

29W PCO Sargo.

24G Comsublant

24G Comsubpac.

21 Cinclantfit.

21 Cincpacfit.

BSTR, Pittsburgh (5).

BSTR, Schenectady (5).

ABSTR, Windsor (3).

A3 CNO (OP36).

A5 Burned.

USAEC, Division of Biology and Medicine.

USAEC, Advisory Committee on Reactor Safeguards.

USAEC, Division of Reactor Development.

USAEC, Division of Licensing and Regulation.

Military Liaison Committee, USAEC.

U.S. Public Health Service, Division of Sanitary Engineering Services.

[Enclosure 1]

Maximum permissible concentrations of radioisotopes in effluents for discharge within 12 miles from shore

(Derived from National Bureau of Standards Handbook 52)

Isotope	Concentration ($\mu\text{C}/\text{ml}$)	Isotope	Concentration ($\mu\text{C}/\text{ml}$)
Unidentified beta or gamma emitters or any undetermined mixtures of beta or gamma emitters.	1×10^{-3}	Unidentified alpha emitters or any undetermined mixtures of alpha emitters.	1×10^{-4}
Ba ¹⁴⁰ +La ¹⁴⁰	2×10^{-1}	Na ²⁴	3×10^{-1}
Cl ³⁶	3×10^{-1}	Nb ⁹⁵	4×10^{-1}
Cd ¹⁰⁹ +Ag ¹⁰⁹	7	Ni ¹⁵⁹
Ce ¹⁴⁴ +Pr ¹⁴⁴	4	Po ²¹⁰	3×10^{-3}
Cl ³⁸	2×10^{-1}	Pu ²³⁹	1.5×10^{-4}
Co ⁶⁰	2	Ra ²²⁶ +1 dr.....	4×10^{-6}
Cr ⁵¹	50	Rb ⁸⁶	3×10^{-1}
Cs ¹³⁷ +Ba ¹³⁷	1×10^{-1}	Rn ²²² +dr.....	2×10^{-4}
Cu ⁶⁴	8	Ru ¹⁰⁶ +Rh ¹⁰⁶	10
Fe ⁵⁵	90	Sr ⁹⁰	7×10^{-3}
Fe ⁵⁹	4×10^{-1}	Sr ⁹⁰ +Y ⁹⁰	8×10^{-3}
Fe ⁵⁹	1×10^{-3}	Th-natural.....	5×10^{-3}
H ³ (HTO or T ₂ O).....	7	U-natural.....	7×10^{-3}
I ¹³¹	1×10^{-3}	Xe ¹³³	4×10^{-1}
K ⁴²	1	Xe ¹³⁵	1×10^{-1}
Mn ⁵⁶	15	Y ⁹¹	20
Mo ⁹⁹	1400	Zn ⁶⁵	6

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APPENDIX B

Summary of radionuclide analyses on "Nautilus" and "Skate" reactor coolant

PT. 1. USS "NAUTILUS" (ALL ACTIVITIES IN $\mu\text{C}/\text{CC}$)

Dumping tolerance	15 min. gross 3.0	120 hr gross	Mn ⁵⁵ 15	Co ⁶⁰ 2	Fe ⁵⁹ 1×10 ⁻³	Ni ⁶³ 1.9	Cr ⁵¹ 50
DATE							
May 1955	1.4×10 ⁻¹	4.9×10 ⁻⁴	9.3×10 ⁻²	8.1×10 ⁻³	2.6×10 ⁻⁵		1.2×10 ⁻⁵
June 1955	8.2×10 ⁻²	8.9×10 ⁻³	2.0×10 ⁻²	2.7×10 ⁻³	8.9×10 ⁻⁴	1.8×10 ⁻⁴	
July 1955	8.2×10 ⁻²	3.0×10 ⁻³	1.3×10 ⁻²	9.1×10 ⁻⁴	3.6×10 ⁻⁴	5.5×10 ⁻⁴	1.0×10 ⁻⁴
August 1955	2.2×10 ⁻¹	3.3×10 ⁻³	1.0×10 ⁻²	1.2×10 ⁻³	5.3×10 ⁻⁴	8.9×10 ⁻⁴	2.8×10 ⁻⁵
October 1955	1.5×10 ⁻¹	1.0×10 ⁻²	7.3×10 ⁻³	2.5×10 ⁻²	2.8×10 ⁻³	5.0×10 ⁻⁴	3.4×10 ⁻³
November	4.5×10 ⁻²	1.4×10 ⁻³	9.8×10 ⁻³	6.1×10 ⁻⁴	1.1×10 ⁻⁴	9.3×10 ⁻⁵	1.6×10 ⁻³
December 1955	1.3×10 ⁻¹	3.3×10 ⁻³	3.4×10 ⁻²	9.9×10 ⁻³	1.5×10 ⁻³	1.3×10 ⁻³	6.5×10 ⁻⁴
February 1956	8.1×10 ⁻³	1.2×10 ⁻³	9.2×10 ⁻³	5.6×10 ⁻⁴	7.4×10 ⁻⁵	3.8×10 ⁻⁴	2.4×10 ⁻³
April 1956	1.3×10 ⁻¹	3.6×10 ⁻³	6.4×10 ⁻²	1.6×10 ⁻³	2.2×10 ⁻⁴	1.5×10 ⁻³	9.1×10 ⁻³
June 1956	7.0×10 ⁻²	9.0×10 ⁻⁴	1.3×10 ⁻²	1.4×10 ⁻⁴	4.1×10 ⁻⁵	2.3×10 ⁻⁴	5.9×10 ⁻⁶
July 1956	4.7×10 ⁻²	4.4×10 ⁻⁴	4.5×10 ⁻³	3.8×10 ⁻³	2.0×10 ⁻³	2.6×10 ⁻⁴	5.9×10 ⁻⁶
August 1956	1.5×10 ⁻¹	4.8×10 ⁻²	7.0×10 ⁻³	8.3×10 ⁻³	1.7×10 ⁻³	1.2×10 ⁻³	1.3×10 ⁻³
October 1956	4.6×10 ⁻²	2.5×10 ⁻³	1.1×10 ⁻²	1.2×10 ⁻³	1.6×10 ⁻⁴	5.0×10 ⁻⁵	1.4×10 ⁻⁵
December 1956	5.1×10 ⁻²	1.2×10 ⁻³	1.8×10 ⁻³	6.5×10 ⁻⁴	9.0×10 ⁻⁵	2.8×10 ⁻⁴	8.8×10 ⁻⁵
February 1957	5.8×10 ⁻²	1.4×10 ⁻³		5.8×10 ⁻⁴	5.1×10 ⁻⁵		3.0×10 ⁻⁵
March 1958	2.3×10 ⁻²			4.5×10 ⁻⁴	4.8×10 ⁻⁵		8.2×10 ⁻⁵
August 1958				2.1×10 ⁻⁴	1.7×10 ⁻⁵		4.3×10 ⁻⁴

Dumping tolerance	Na ²⁴ 3×10 ⁻¹	Cu ⁶⁴ 8	Ta ¹⁸² 10	Fr ¹⁸ 90	W ¹⁸⁷ 9×10 ⁻²
DATE					
May 1955	2.0×10 ⁻⁴	2.9×10 ⁻⁴			4.7×10 ⁻³
June 1955	1.0×10 ⁻⁴	3.4×10 ⁻⁴	5.2×10 ⁻⁵	5.5×10 ⁻³	3.6×10 ⁻³
July 1955	2.0×10 ⁻⁴	6.8×10 ⁻⁴	1.4×10 ⁻³	2.5×10 ⁻³	1.3×10 ⁻⁴
August 1955	2.1×10 ⁻⁴	1.8×10 ⁻³	6.8×10 ⁻³		1.1×10 ⁻³
October 1955	5.0×10 ⁻⁴	2.1×10 ⁻³	2.9×10 ⁻²	6.8×10 ⁻³	1.3×10 ⁻³
November 1955	5.4×10 ⁻⁵	1.9×10 ⁻⁴	1.2×10 ⁻³	8.2×10 ⁻³	1.4×10 ⁻³
December 1955	6.2×10 ⁻⁴	1.4×10 ⁻³	1.7×10 ⁻²	1.5×10 ⁻²	9.5×10 ⁻⁴
February 1956	2.5×10 ⁻⁴	1.4×10 ⁻⁴	1.8×10 ⁻⁴	2.7×10 ⁻²	1.5×10 ⁻⁴
April 1956	4.1×10 ⁻⁴	3.0×10 ⁻³	4.5×10 ⁻³	6.8×10 ⁻³	7.7×10 ⁻⁴
June 1956	4.8×10 ⁻⁵	7.9×10 ⁻⁵	5.7×10 ⁻⁵	1.9×10 ⁻²	1.8×10 ⁻⁵
July 1956	4.9×10 ⁻⁵	3.5×10 ⁻⁵	7.6×10 ⁻⁵	8.6×10 ⁻³	1.8×10 ⁻⁴
August 1956	2.7×10 ⁻⁴	4.7×10 ⁻³	2.2×10 ⁻³	3.0×10 ⁻²	9.0×10 ⁻³
October 1956	1.1×10 ⁻⁴	1.0×10 ⁻⁴	1.8×10 ⁻⁵	5.1×10 ⁻³	1.3×10 ⁻³
December 1956	1.0×10 ⁻⁴	9.3×10 ⁻⁵	6.7×10 ⁻⁶	2.0×10 ⁻²	3.0×10 ⁻⁴
February 1957		1.1×10 ⁻⁴	3.0×10 ⁻⁵		
March 1958					1.5×10 ⁻⁵
August 1958					4.1×10 ⁻⁴

PT. 2. U.S.S. "SKATE" (ALL ACTIVITIES IN $\mu\text{C}/\text{CC}$)

	15 min- utes gross	120 hours gross	Cr ⁵¹	Fe ⁵⁹	Co ⁵⁸	Co ⁶⁰	Mn ⁵⁴	Zr-Hf	W ¹⁸⁷
Dumping tolerance	3.0		50	1.0×10 ⁻²	2	2.0	1.3×10 ⁻¹	4×10 ⁻¹	9.0×10 ⁻³
1967									
October	1.7×10 ⁻²	1.1×10 ⁻⁴	2.5×10 ⁻⁶	1.7×10 ⁻⁷	1.4×10 ⁻⁷	1.0×10 ⁻⁷	1.6×10 ⁻⁶		1.8×10 ⁻³
November	1.1×10 ⁻²	7.5×10 ⁻⁴	4.5×10 ⁻⁷	2.4×10 ⁻⁶	3.6×10 ⁻⁶	2.2×10 ⁻⁶	2.5×10 ⁻⁵	1.2×10 ⁻⁷	2.3×10 ⁻³
1968									
January	2.3×10 ⁻²	1.7×10 ⁻⁴	2.7×10 ⁻⁵	2.4×10 ⁻⁵	3.2×10 ⁻⁵	3.6×10 ⁻⁵	3.6×10 ⁻⁶	6.4×10 ⁻⁷	3.1×10 ⁻³
February	1.7×10 ⁻²	2.3×10 ⁻⁴	7.3×10 ⁻⁷	4.6×10 ⁻⁶	7.0×10 ⁻⁶	4.9×10 ⁻⁶	3.7×10 ⁻⁵	3.8×10 ⁻⁵	2.1×10 ⁻³
March	3.2×10 ⁻²	2.3×10 ⁻⁴	1.5×10 ⁻⁵	1.3×10 ⁻⁵	2.4×10 ⁻⁵	1.7×10 ⁻⁵	5.1×10 ⁻⁵	2.8×10 ⁻⁷	2.9×10 ⁻³
May	8.0×10 ⁻³	9.3×10 ⁻⁴	3.0×10 ⁻⁵	3.1×10 ⁻⁵	7.6×10 ⁻⁵	1.1×10 ⁻⁴	6.5×10 ⁻⁵	3.6×10 ⁻⁶	2.1×10 ⁻³

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APPENDIX 2

EAR. HISTORY OF THE PRESSURIZED WATER REACTOR (PWR) AT SHIPPING-PORT, PA. PREPARED BY THE NAVAL REACTORS BRANCH, AEC

On April 22, 1953, the National Security Council, the President approved the elimination of the large ship reactor project from the defense program. This project, known as the CVR, was instituted on the basis of a military requirement set up by the Joint Chiefs of Staff. That requirement stated that the CVR was to be a shore-based prototype of a single shaft for a large naval vessel such as an aircraft carrier, and to be used, after completion, to produce power and plutonium.

The decision to cancel the CVR project was influenced by the views of R. M. Kyes, Deputy Secretary of Defense, and Robert LeBaron, Assistant Secretary of Defense for Atomic Matters. H. G. Rickover, then captain, USN, in a memorandum dated May 15, 1953, to Gordon Dean, Chairman, Atomic Energy Commission, reported these views as brought out in a conference held among R. M. Kyes, R. LeBaron, Assistant Secretary of the Navy for Air J. F. Floberg, and himself, on April 30, 1953. In this conference it was stated by R. LeBaron that private industry was ready to undertake this development. It was further indicated by R. LeBaron that the time scale as currently planned for the CVR would require an inordinately long period of time and that such a time scale was too great to make it worth while to continue with the project. He indicated that with private industry doing the work the plant could be developed and installed in an aircraft carrier much more quickly, probably by 1956. It was further indicated that the technical approach being taken to the CVR project might be wrong and that reactors of the type installed in the submarine prototype plant in Idaho or a similar type could be used in the CVR plant. H. G. Rickover suggested that since there was doubt that industry would undertake the job and that since he felt that the technical approach being followed was the right one, the decision to terminate the CVR should be held up for 4 to 6 weeks so that an opportunity could be afforded to clear up these points. R. M. Kyes would not agree to this and terminated the meeting with the statement that the decision to cancel the CVR stood.

As a result of the April 22, 1953, action of the President, H. D. Smyth, Acting Chairman of the Atomic Energy Commission, following a suggestion of Commissioner Thomas E. Murray, addressed a letter dated April 29, 1953, to the President. This letter referred to the President's decision that "The early development of nuclear power by the United States is a prerequisite to our maintaining our lead in the atomic field." To achieve this early development, we recommend that segments of the large ship and aircraft programs, essential to the development of civilian power, be continued vigorously even though the NSC has determined that these programs should "be eliminated as not required from the viewpoint of national security." The reason for our recommendation is the long recognized fact that these programs bear a vital relationship to the development of reactor technology leading to civilian power.

"It is true that the primary purpose of the large ship reactor program was to meet a high priority military requirement of the Joint Chiefs of Staff. We have depended on the program, however, as providing a principal basis for the ultimate construction of civilian powerplants. We are convinced that the pressurized light-water reactor, which is the heart of the planned large ship propulsion unit, offers a promising avenue of approach which must be pursued vigorously if the Nation is to get on with the job of attaining civilian power * * *.

"The Commission's recommended power policy recognizes the importance of utilizing the resources of private industry to the greatest extent possible. One of the main reasons the Commission is urging a change in the 1946 law is to obtain such industrial participation. However, it may well require a long period before the legal obstacles to privately financed work in this field are removed. In the meantime, the civilian power program would be marking time. We are convinced that even after statutory obstacles are removed, private industry will not assume a major part of the expensive, long-term development work that must precede the attainment of civilian power. This is the unanimous opinion of the Commission and is based upon its assessment of the state of the technology, its many contacts with industry, and investigations made during the last 2 years by private groups.

"It is, therefore, the unanimous recommendation of the Commission " the pressurized light-water program and research, such as that on fluid fuel ors, be continued.

"Although we believe that private interests will not take the initiative and construct experimental power reactors, it is the opinion of the Commission that some private financial assistance may be obtained in connection with the design and construction by AEC of a civilian version of the proposed Navy reactor."

On May 5, 1953, at a meeting of Atomic Energy Commissioners Smyth, Murray, and Zuckert and General Manager Boyer, the Commission asked for a report from Dr. L. R. Hafstad, Director of Reactor Development, and H. G. Rickover, based upon the following ground rule: "The Commission asked authority to proceed on the study of a pressurized light-water reactor along the same central idea as the CVR to the point of constructing such a reactor with an electrical power output of 50,000 kilowatts and with an overall cost of approximately \$100 million."

On May 6, 1953, the President confirmed his earlier action to eliminate, as not required from the viewpoint of national security, the existing program for the large ship reactor. The President, however, adopted the recommendation of the Atomic Energy Commission that the pressurized light-water program and related research be continued, pending the availability of private financing, in the interests of nuclear power development. It was estimated that carrying the full program to completion would cost the Government approximately \$100 million unless private financing should become available before completion.

On May 13, 1953, in response to the May 5, 1953, request of the Commission, H. G. Rickover furnished to M. W. Boyer a plan of action for handling the light-water power reactor. In part, Rickover recommended as follows:

"Centralized control by Government—to insure carrying through of specified direction of the project and to fulfill Government responsibility for expenditure of funds.

"Firm decisions—to assure rapid progress and the avoidance of protracted studies.

"Close coordination between manufacturer and user—to insure a successful end product.

"Concentration upon the most difficult problems first—these govern the time scale."

H. G. Rickover further continued:

"As a basic premise, the slightly enriched light-water cooled and moderated reactor concept will be adhered to as has been planned for CVR in order to make maximum use of the study and development which has already gone into this project; this will permit the earliest possible construction. This principle will involve close administrative and technical coordination by the Government, of the industrial effort of Bettis, and of other organizations working on the problem."

On May 12, 1953, a revised budget estimate was furnished the Bureau of the Budget which included \$4,200,000 for beginning research and development and \$5 million for commencing construction of a PWR. On May 14, however, the funds for beginning construction of PWR in fiscal year 1954 were deleted from the 1954 budget estimates by the Bureau of the Budget.

On May 20, 1953, W. Sterling Cole, chairman, Joint Committee on Atomic Energy, Congress of the United States, wrote to the Honorable John Phillips, chairman, Independent Offices Subcommittee of House Appropriations Committee, in part, as follows:

"I would like to call your attention to a matter of great concern to me and my colleagues on the Joint Committee on Atomic Energy. * * *

"It is possible that the relations of the United States with every other country in the world could be seriously damaged if Russia were to build an atomic power-plant for peacetime use ahead of us. The possibility that Russia might demonstrate her 'peaceful' intentions in the field of atomic energy while we are still concentrating on atomic weapons could be a major blow to our position in the world. It could even disrupt the continued operations of our own weapon plants by stimulating friendly countries to cut off the vital uranium they now sell us—cut it off to avoid the charge at home that they are selling their atomic power birthright for American dollars.

"Needless to say, loss of American prestige as the leader in the field of atomic energy development might also result if Great Britain or other friendly foreign countries achieve commercial atomic power before we do. There have been announcements in Great Britain, France, Canada, Norway, and Australia, that competent teams of scientists and engineers are hard at work preparing to build atomic powerplants. There is little question but that they will succeed and do so

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with a few years. Yet in the United States, where we are spending billions of dollars every year on atomic energy, there is not a single atomic powerplant of commercial size under construction or even scheduled for construction in the next 18 months. * * *

"The first atomic power project began under the Manhattan Engineer District in 1946 at Oak Ridge. It failed a year later because of the inadequacy of the existing scientific and technical data. The second atomic power project ran its course from 1948 through early 1950 at the Knolls Laboratory in Schenectady, N.Y. * * * It was canceled before construction began in part because of the excessive cost in prospect for this design. * * * The third effort, in 1951-52, consisted of getting four groups of private companies to study the prospects for privately financed projects. All four groups expressed interest, but none offered to put up more than token money at this stage of development.

* * *
"Finally, Navy plans for an atomic powerplant prototype for an aircraft carrier were reviewed by the National Security Council and the Department of Defense and were eliminated as too long-term for the current budget. The so-called CVR aircraft carrier project happens to coincide with many aspects of commercial atomic power development. It was the last-ditch stand from which the Commission hoped to draw the design and operating experience for stimulating private commercial atomic power development.

"Cancellation of the aircraft carrier reactor resulted in a letter appeal from the Commission to the President and a special appearance before the Joint Committee. As a result, a completely civilian version of the aircraft carrier reactor was put back in the fiscal 1954 budget now before the Congress. This plant would produce 250,000 kilowatts of electric power. But the budget now before you contains only \$4,200,000 for continuation of research and development and nothing for construction.

* * *
"I would therefore like to recommend most earnestly that you give consideration to adding \$12 million to the plant and equipment part of the Atomic Energy Commission fiscal 1954 budget for the start of construction of at least one atomic powerplant designed to produce commercial electric power. This is the amount the Commission has stated to the Joint Committee would be the amount of which construction could be certain to start this coming year * * *.

"In 1946, the 79th Congress declared it to be 'the policy of the people of the United States that * * * the development and utilization of atomic energy shall * * * be directed toward improving the public welfare, increasing the standard of living, strengthening free competition in private enterprise, and promoting world peace.' It is vital that we get on with peacetime atomic power.

"Scientists and engineers the world over have declared commercial atomic power possible now. We must be about the business of building at least one plant as a demonstration to American industry and to the world that it is possible, economic, and truly practical."

In addition to the Rickover plan of May 13, 1953, and as a further consequence of the May 5, 1953, request of the Commission, an alternate plan was submitted to L. R. Hafstad by S. McLain of the Production Reactors Branch, AEC. Under this plan it was assumed that the objective of the new PWR program would be to construct and operate a reactor by 1959 which would produce industrially significant blocks of electric power as cheaply as the best currently available technology would permit, and which would show conclusively actual cost and the technical areas of high cost in which further savings might be made, looking toward ultimate economic power. It was further recommended that system analyses of both pressurized light- and heavy-water reactors should be reviewed with target date of January 1, 1954, for the decision concerning the reactor to be constructed. Under this plan it was felt that the organization which would be evolved to carry forward the program should include elements reflecting the point of view of the utility companies and their engineering associates, the point of view and experience of manufacturers of equipment, and contributions from AEC laboratories such as Argonne National Laboratory.

On May 22, 1953, H. G. Rickover and S. McLain met in the office of M. W. Boyer, General Manager. Boyer opened the meeting by reading a memorandum written by Commissioner Murray in which the latter indicated that he desired no commitments as to the organization or contractual aspects of the proposed light-water pressurized reactor program until his return to Washington about June 2, 1953. Boyer then stated that in his opinion the philosophy must be

adopted of definitely deciding to build a reactor and not to do studies and investigations beyond a limited point.

It was also agreed that the fuel element was the most difficult and important item and should be given highest priority and precedence. Subsequent to this meeting McLain and Rickover met to arrange the basis for work which they would jointly do in the next few days. It was agreed that neither would go to Westinghouse or to Argonne or to any other contractor during this period or ask them to make any studies.

On June 16, 1953, the Commission met in executive session and approved a pressurized water reactor program for the development and construction of a pressurized light-water reactor plant. At this meeting the Commission further noted that Westinghouse would be continued as the principal prime contractor responsible for this development and also noted that in the interest of continuity and early completion, responsibility for this project within the Division of Reactor Development would be assigned to the Naval Reactors Branch. This action was in accordance with the plan earlier submitted by H.G. Rickover.

During the month of June 1953 the independent offices appropriation bill was being considered by the House of Representatives. On June 9, 1953, the Commission pointed out in a letter to the chairman of the Independent Offices Subcommittee of House Appropriations Committee that no provision was made in the 1954 budget for beginning construction of a civilian power reactor. It was stated that if \$7 million was provided, essential work for initiating construction of such a reactor could be undertaken in fiscal year 1954. This proposal received congressional support, and the independent offices appropriation bill as finally signed by the President in July 1953 contained language as follows:

"Provided further, That in addition to funds allocated for research and development for a reactor which will advance technology toward both ship propulsion and the generation of industrial power and for design of such atomic power reactor, the Commission may expend from funds provided under this head such sum as may be necessary, not to exceed \$7,000,000, for the beginning of construction of such reactor, without regard to any other provision of this Act."

On July 8, 1953, W. Sterling Cole, chairman, JCAE, in a letter to Lewis L. Strauss, Chairman, AEC, stated, in part, as follows:

"It now appears likely that the provision in your fiscal 1954 appropriation relating to the start of construction of atomic powerplants will be approved by the Congress. This provision, as you know, will permit the Commission to spend up to \$7 million from appropriate construction funds for the start of construction of atomic powerplants which will be able to contribute to the technology needed for further development of practical and economic civilian powerplants."

"As is indicated in the attached copy of my letter of May 20, to Mr. John Phillips, chairman of the House Independent Offices Appropriation Subcommittee, this provision will establish a program initiated by the Congress. This is in contrast to those programs recommended by the executive branch and approved by the Congress. In this sense, it is being imposed on the Commission outside of the recommendations submitted to the Congress by the President with his fiscal 1954 budget message."

"The Joint Committee has a more than usual interest, therefore, in just how this program is carried out. Any advantage which it has been hoped might be gained from a demonstration of the interest of the United States in peaceful application of atomic energy might, for example, be impaired if administration of the program results in too heavy emphasis on the Navy aspects of the objectives. Such impairment might result from Navy direction, extensive Navy specifications, and the inevitable 'leaked' new articles referring to aircraft carrier reactor prototypes."

"It appears to be the intent of the Congress to provide a substantial advance in technology to the future benefit of both civilian and Navy applications of atomic power. In setting up the administrative framework for carrying out the provision, therefore, care must be exercised to avoid any commitment to reactor systems based on any particular civilian or Navy specifications such as pressures, power ratings, or other features which might prevent the systems from ever allowing extrapolations with regard to the economics of the power generated."

"It would be very much appreciated, therefore, if you would arrange to inform the committee in some detail of the specific administrative and organizational plan by which you propose to effectuate this provision for construction of atomic powerplants."

"I believe that this proposed administrative structure should be submitted for the perusal of the Joint Committee before it is put into effect. I am aware of the

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fact as of this date it is not yet certain whether the final provision will be stated in terms of one reactor or more than one, but in either event the committee will still want to know how the Commission plans to administer the program. In order that this review of the proposed plan will in no way delay execution of the provision, it would be helpful if your plan could be available for our examination before the recess of Congress."

In its meeting on July 9, 1953, the Atomic Energy Commission reaffirmed its action taken at the executive session on June 16, 1953, approving the program and assignment for the development and construction of a pressurized light-water reactor plant. The July 8, 1953, letter from W. Sterling Cole quoted above was available to the Commission at this meeting.

On the same date, L. R. Hafstad, Director of Reactor Development, dispatched a teletype to A. Tammaro, Manager, Chicago Operations Office, AEC, with a copy to Lawton D. Geiger, Manager, Pittsburgh area office, AEC. The text of this teletype was as follows:

"The AEC has authorized reorientation of the CVR program. The new objective has been set as a pressurized light-water reactor powerplant, with the basic reactor design of the old CVR program, primarily for the purpose of the generation of civilian electrical power, but secondarily for possible use in a naval application should a future requirement for this type develop. This program is designated 'PWR' (pressurized water reactor).

"The general features of this reactor are expected to be—

- "(a) Generation of at least 60,000 kilowatts of useful electric energy.
- "(b) Use of light-water cooled and moderated, slightly enriched uranium type of reactor.
- "(c) Six hundred pounds per square inch saturated or higher steam conditions.
- "(d) Fuel element life as long as possible between chemical reprocessings (initial goal in excess of 3,000 MWD/T).
- "(e) Refueling with minimum shutdown period.
- "(f) Simplified reactor control system.
- "(g) Central station type turbine and electrical generating equipment.
- "(h) Conventional central station steam, electric, and other auxiliary systems.
- "(i) Commercial standards of equipment.
- "(j) Use of concrete for shielding.
- "(k) Minimum possible construction cost of the plant.
- "(l) Minimum possible operating cost of the plant consistent with the above requirements.

"All work will be terminated on items in the former CVR program aimed specifically at ship design and testing directed solely at meeting specific Navy requirements. Orderly closeout and the preparation of terminal reports for this work is authorized.

"Westinghouse will be continued as the principal prime contractor responsible for this development. Responsibility for this project within the Division of Reactor Development has been assigned to the Naval Reactor Branch, who will discuss the detailed program with you and your staff and with the contractor.

"No public announcement is presently planned regarding this program reorientation. Any relations with interested public utilities will be handled by the Commission in Washington for the time being."

The technical features outlined in the teletype above were conceived by the Naval Reactors Branch. These were transmitted to Westinghouse through Lawton D. Geiger, manager, Pittsburgh area office, AEC, for guidance in developing the design of the plant.

On August 5, 1953, Chairman Strauss replied to the July 8 letter of W. Sterling Cole, chairman, JCAE, as follows:

"This is in response to your letter of July 8 regarding the pressurized light-water reactor.

"In all recent planning for construction of a central station atomic powerplant we have worked on one principal assumption, that the United States should start construction of a power reactor now—rather than continue research and development looking to the 'last word' in an economical power reactor. Because large-scale engineering and operational experience are essential for rapid technological development, we believe that only by moving into the construction phase can we fulfill the requirement of the President which recently held that the early development of nuclear power by the United States is a prerequisite to maintaining our lead in the atomic field. And your most effective assistance on

obtaining construction funds for a power reactor in the 1954 House independent offices appropriation bill demonstrates your complete agreement on this issue.

"Acting on this assumption, AEC recommended to the President on April 29 that a pressurized light-water reactor (PWR) be constructed. Construction of such a reactor can be started this fiscal year because of past development work on the recently canceled project for the Navy. Fortunately, as you pointed out in your letter to Mr. Phillips dated May 20, attached to your letter to the Commission of July 8, 'The so-called CVR aircraft carrier project happens to coincide with many aspects of commercial atomic power development.' We are convinced that substantial delays would result if an attempt were made to develop some other reactor system for this first civilian powerplant.

"Moreover, the need for early completion of this power reactor has led us to conclude that the PWR project should be continued in its present contractual and organizational framework, namely, with Westinghouse as the prime contractor and the Reactor Development Division, Naval Reactors Branch, as the responsible Government supervising agency. It is our judgment that much time and momentum would be lost by turning over this project to a new contractor or a different unit for governmental control.

"Although the appropriation act contains a general authorization to the Commission to build a reactor that will advance both civilian central station power technology and naval propulsion technology, you may rest assured that this reactor will be as you described it in your letter to Mr. Phillips of May 20—'a completely civilian version.' No compromise or hybridization is planned or needed because of this congressional language. In view of the withdrawal of military support for the CVR, no naval engineering will be introduced into this design if it would cause any delay or increase the cost or affect the economical functioning of this reactor for its primary purpose as a central station powerplant. However, in our opinion, in the design and building of the PWR, useful technology having application to naval propulsion reactors will inevitably be developed.

"We also believe that the PWR project will be a focus of interest and activity for private enterprise and that its actual construction will stimulate offers for private support both in the supplying of components and in the overall development and operation of the resulting nuclear powerplant.

"You stated in your above-mentioned letter to Mr. Phillips: 'I do not know whether the first civilian powerplant will produce power at less cost than conventional plants.' Nor does the Commission, and it should be understood that in proceeding with this program the Commission is making no representation that the PWR will produce power at competitive costs.

"I trust that this outline of our planning will make clear to you that in executing the PWR program, there will be no subordination of the primary civilian power objective to military considerations."

On October 22, 1953, Commissioner Thomas E. Murray, in a speech before the electric companies public information program in Chicago, Ill., officially announced the start of the PWR program. He said, in part, as follows:

"I am very glad to be able to tell you officially today that the Commission has embarked on a program to construct a full-scale power reactor. It will produce a minimum of 60,000 kilowatts of electrical energy with good possibilities of much higher output. We hope to have it in operation in 3 to 4 years. This is America's answer—its significant peacetime answer—to recent Soviet atomic weapons tests. It should show the world that even in this gravest phase of arming for defense America's eyes are still on a peaceful future.

"You should know that there has been much talk and perhaps guarded criticisms among some scientists and some industrial groups of the choice of the particular reactor design that we have selected for our first large-scale reactor. I might hazard a guess that part of this attack was generated by the fact that the design chosen was inherited from a naval project. Be that as it may, let me assure you that it was not selected at random but is one of several studied for some time and approved by the entire reactor fraternity—and in addition that this particular reactor was much further along than any of the alternate systems.

* * * * *

"Supervision of the project has been delegated to our Reactor Development Division. The Director of this Division, Dr. Lawrence R. Hafstad, has assigned the immediate responsibility for the job to Rear Adm. H. G. Rickover, the Navy reactor expert. Some of our friendly critics have been reported as being somewhat concerned about the psychological effect of a Navy man in charge of this first industrial reactor construction. Let me tell you that this choice was based solely on the admiral's unique experience and accomplishments in building propulsion

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poverty actors for the Commission and for the Navy. We have assured ourselves that only Navy aspect which the admiral will bring to this work is his title."

On November 2, 1953, the manager of the Chicago Operations Office, AEC, established a Contract Board for the selection of an architect-engineer for the PWR project. As of November 23, 1953, the Contract Board had reviewed the qualifications of over 80 firms and had reduced the list of firms considered qualified to 8. In the latter part of November and in early December members of the Contract Board visited each of these eight firms and in late December recommended the names of three to the manager, Chicago Operations Office, AEC.

Action on final selection of an architect-engineer was held in abeyance in view of the Commission's action of December 7, 1953, in renewing its invitation to private industry to submit proposals for the investment of risk capital in the PWR project. In this invitation the Commission said that it encouraged further evidence of industry's interest in private investment for the purpose of obtaining firsthand experience with the new technology involved in building and operating a large-scale reactor designed specifically for power-producing purposes. A deadline for submission of proposals by companies or organizations interested in participating was established as February 15, 1954.

On December 15, 1953, Chairman Strauss of the AEC responded to an earlier letter of the chairman, Joint Committee on Atomic Energy and set forth the manner in which the Commission had selected the principal contractor for the development of the PWR reactor and how the Commission had determined the type of reactor to be constructed. Admiral Strauss' letter is quoted in part as follows:

"In my letter to you of August 5, 1953, I stated the basis on which the pressurized water reactor program rests: 'That the United States should start construction of a power reactor * * * rather than continue research and development looking to the "last word" in an economical power reactor.'

"In selecting the type of power reactor to construct, the Commission considered that the pressurized light-water reactor represented the type of power reactor on which the most work had been done. This technology had been advanced through the submarine thermal reactor development, construction, and operation and through the work on the large ship reactor. The Commission, after fully considering the technical merit of the project, unanimously decided to proceed with the light-water cooled type of reactor which had demonstrated through the successful operation of the submarine thermal reactor mark I its ability to produce large quantities of useful power for protracted periods of time.

"In selecting the contractor to be responsible for the development, design, and construction of the reactor itself and for the development of the primary coolant system no ordinary selection process was possible. The selection was made on the basis of the work completed by Westinghouse, and experience of the company in the light-water reactor field, and the qualification of the Bettis Laboratory staff to carry out the project.

"I am hopeful that the above information on the reasons for the Commission's selection of Westinghouse and the pressurized light-water reactor is helpful to you. The basis of both actions was of course our strong desire, which I know is shared by your committee, to get on with the development of atomic power by construction of a large-scale experimental nuclear powerplant of the type which seemed to provide the best assurance of successful operation."

In anticipation of the receipt of proposals from industry, on January 29, 1954, L. R. Hafstad appointed a board under the chairmanship of A. Tammaro, manager, Chicago Operations Office, for evaluation of any PWR participation proposals which might be received. In addition to this board, another board was appointed to evaluate various Commission-owned facilities with the end in view of locating PWR at one of these in the event that satisfactory proposals from industry were not forthcoming. A. Tammaro was also designated chairman of this latter board.

In early February the board for evaluation of Commission-owned facilities visited sites at Oak Ridge, Tenn.; Portsmouth, Ohio; Paducah, Ky.; and Savannah River. A report was submitted to the Director of Reactor Development listing these sites in order of preference in the event that it was determined that the PWR should be constructed at one of these.

By February 15, 1954, nine broad-scale proposals for participation by industry in the PWR project had been received. On February 19, 1954, the Evaluation Board recommended to L. R. Hafstad that certain of these be eliminated from further consideration and that the Board proceed to hold discussions in the field with officials of those which remained.

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Accordingly, on March 2, 1954, a subcommittee of the Evaluative Board headed by H. G. Rickover began visits to organizations in Pennsylvania, South Carolina, Louisiana, New York, and New England. The final proposals received detailed evaluation by the entire Board in Washington and a recommendation was submitted to the General Manager.

On March 11, 1954, the Commission authorized the General Manager to enter into discussions with the Duquesne Light Co. of Pittsburgh, Pa., as a basis for detailed contract negotiations. The Commission further approved the location of the PWR on land owned by the Duquesne Light Co. at Shippingport, Pa., a small town on the Ohio River approximately 25 miles west of Pittsburgh. The approval of the site location was the result of a preliminary opinion on the suitability of the site made by C. Rogers McCullough, Chairman, Advisory Committee on Reactor Safeguards, and two other members of the Committee on March 9, 1954. A portion of this letter is quoted below:

"DEAR MR. NICHOLS: Mr. A. Tammara, as Chairman of the Board of Evaluation of PWR Participation, has asked for a preliminary opinion on the suitability of the site proposed by Duquesne Power & Light Co. at Shippingport, Pa., from the point of view of hazards. It is my opinion in consultation with two members of the Advisory Committee on Reactor Safeguards that this site is suitable provided that the reactor system is so designed that containment of radioactive material can be guaranteed beyond reasonable doubt. It is a general view, based on preliminary information, that this is a reasonable requirement and one that can be attained. This rigid requirement rests upon the fact that the Ohio River, below the site in question, is one of the most heavily used sources of domestic and industrial water in the United States.

"It is my understanding the PWR will be a reactor installation only and no chemical separation will take place at this site.

"These conclusions are consistent with the preliminary information given a subgroup of the Advisory Committee on Reactor Safeguards on January 22, 1954 * * *"

On March 14, 1954, the Commission released to the press the information that negotiations were underway with the Duquesne Light Co. A portion of this release is quoted below:

"Lewis L. Strauss, Chairman of the Atomic Energy Commission, announced today that a proposal submitted for participation by the Duquesne Light Co. of Pittsburgh, Pa., in the construction and operation of the Nation's first full-scale central station nuclear powerplant is the most favorable to the Government and that the AEC is negotiating a formal agreement with the company. The Duquesne Co. submitted one of nine major proposals to the Commission.

"Under the Duquesne proposal the company would—

"1. Furnish a site for the entire project and build and operate a new electric generating plant at no cost to the Government.

"2. Operate the reactor part of the plant and bear the labor costs thus entailed.

"3. Assume \$5 million of the cost of research, development, and construction of the reactor portion of the plant.

"4. Pay the Commission at the rate of 48.3 cents per million B.t.u.'s of steam used in the turbines for the first year; the rate increasing annually until it reaches 60.3 cents in the fifth year.

"5. Waive any reimbursement by the Government of costs incident to termination of the contract.

"The Chairman estimated that, including revenues from the sale of steam generated by the reactor, the company's proposal would reduce by an estimated \$30 million the expenditures the Government would have to make during the period of construction and 5 years of operations if it undertook the full cost of the project.

"The proposed plant site is on land presently owned by the company in the Greater Pittsburgh area. The reactor design will incorporate safety features developed through 10 years of experience with reactor operation.

"The Westinghouse Electric Corp. has a contract with AEC to develop, design, and construct the reactor portion of the plant. The reactor is expected to generate sufficient heat to produce a minimum of 60,000 kilowatts of saleable electricity in addition to meeting the electricity requirements of the plant itself. The actual sufficient heat to produce a minimum of 60,000 kilowatts of saleable electricity in capacity of the reactor may turn out to be somewhat greater than the minimum of 60,000 kilowatts design and foreseeing this possibility the company would design its generating plant with some reserve capacity.

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"It is not expected that this first plant will produce electric power at costs comparable with power from conventional fuels. The project has been undertaken in order to gain more design and technological experiences than could be obtained otherwise, such as from a smaller plant, and to provide firm cost estimates for the future."

On March 18, 1954, A. Tammaro, manager, Chicago Operations Office, and Philip A. Fleger, chairman of the board, Duquesne Light Co., signed a memorandum of understanding which would serve as the basis of more detailed contract negotiations to follow. The definitive contract was signed on November 3, 1954.

Details of the contract between the Atomic Energy Commission and the Duquesne Light Co. are available elsewhere. One extract, however, will be quoted in order to demonstrate the reasons for which the PWR was built.

"It is anticipated by the parties that the information to be gained by the construction and operation of the pressurized water reactor will probably permit a major advance toward realization of civilian nuclear power and that such information is expected to lead to further technical advances in subsequent power reactors. It is recognized that this first full-scale nuclear powerplant will be of a developmental nature and will be operated with the primary objective of gaining information and advancing reactor technology rather than with an objective of furnishing dependable power and maintaining a high load factor. The parties expect to make every effort to demonstrate the practicability of nuclear central station power and to make the cost of such power as low as possible. Based on present technological knowledge, it is unlikely that power from this first nuclear central station will be competitive in cost with power from conventional plants."

During the months of February and March 1954, the Subcommittee on Research and Development of the Joint Committee on Atomic Energy, Congress of the United States, held a series of meetings to review and evaluate the 5-year reactor development program proposed by the Atomic Energy Commission. With respect to the PWR, it was the consensus of the testimony that as a demonstration of the serious intent of the United States to develop peacetime uses of atomic energy for both ourselves and our allies, and as a tool to help gain operating experience on a full-scale plant, the continuation of construction of one large-scale plant such as the pressurized water reactor was important. On March 12, 1954, a meeting was held between representatives of the Joint Committee and the Atomic Energy Commission in order to insure that both the committee and the Commission were in agreement on continuation of the project, that they appreciated its limitations, and had a clear conception of what it could be expected to accomplish. At that meeting, the Commission gave a detailed presentation of the purpose of, and the prospects for, the pressurized water reactor. Strong assurances were given to the committee that every effort would be made to incorporate into the pressurized water reactor all promising ideas which would help make it more economic and would not unduly delay its completion.

In April 1954, as a result of the recommendation of the Contract Board, which had convened the previous November, the General Manager approved the selection of the Stone & Webster Engineering Corp. to perform the architect-engineering services associated with the design of the nuclear portion of the PWR project. It was specified that the work to be done by Stone & Webster would be accomplished under subcontract to the Westinghouse Electric Corp. The subcontract as finally negotiated provided for the reimbursement of actual cost from Government funds and the payment to Stone & Webster of a fee of \$1 for the services rendered.

On April 19, 1954, an organizational meeting was held in Pittsburgh among representatives of the Naval Reactors Branch and the Pittsburgh area office, AEC, and of the Duquesne Light Co. At that meeting, at which H. G. Rickover was senior Government representative and P. A. Fleger, chairman of the board, was senior representative of the Duquesne Light Co., the division between the Atomic Energy Commission and the Duquesne Light Co. of design and financial responsibility for the components, systems, and facilities of the PWR plant was established. This division of responsibility was subsequently made a part of the definitive contract between the Commission and the Duquesne Light Co.

In implementation of another agreement made at the meeting of April 19, on April 27, 1954, Commission and Bettis representatives began a series of 20 lectures to the Duquesne Light Co. These lectures were designed to acquaint Duquesne personnel with the organization and relationships which existed between the Commission and its prime contractor Westinghouse and, in addition, to inform them of the status of design and development on the PWR project.

In turn, Duquesne Light Co. representatives later gave a series of five lectures to Commission representatives to acquaint them with utility company problems.

On September 6, 1954, the official groundbreaking for the PWR took place at Shippingport, Pa. At this ceremony President Eisenhower, in Denver, Colo., placed a wand containing a source of neutrons close to a fission detector. The resulting current, flowing through wires across the country, started up an unmanned bulldozer which performed the first excavation at the Shippingport site. In addition to the President, who spoke on television, speakers at the site included the Honorable W. Sterling Cole, chairman, Joint Committee on Atomic Energy, Congress of the United States; Adm. Lewis L. Strauss, Chairman, Atomic Energy Commission; Gwilym A. Price, president, Westinghouse Electric Corp.; and Philip A. Fieger, chairman of the board, Duquesne Light Co.

The last major subcontractor on the PWR project whose selection involved the use of a contractor selection board, was the Dravo Corp. of Pittsburgh, Pa. This organization performed the installation work on the nuclear portion of the plant under subcontract to Westinghouse. The subcontract, which was forwarded by Westinghouse to the Commission for approval on October 11, 1955, provided for reimbursement of actual costs incurred and for the payment to Dravo of a fee of \$1 for services rendered.

Actual construction at Shippingport began in May 1955, and the plant achieved full power in December 1957. Details of the design, development, and construction which took place during this period are contained in a book entitled "The Shippingport Water Reactor," published by the U.S. Atomic Energy Commission for the 1958 Geneva Conference on Peaceful Uses of Atomic Energy. However, because of the complexity of the job and the number of contractors and subcontractors concerned with the work, the following remarks will be made concerning the administration of the project.

As stated earlier, responsibility for the PWR project within the Division of Reactor Development, AEC, was assigned by the Commission to H. G. Rickover of the Naval Reactors Branch. The Naval Reactors Branch gave technical approval of all nuclear plant parameters, performance requirements, and details of design and development upon recommendation by Bettis. The Chicago Operations Office, AEC, approved the design of nuclear plant facilities, structures, and equipment outside the primary system provided they met or were compatible with parameters and performance requirements previously approved by the Naval Reactors Branch.

In each of the major participating organizations, a PWR project officer or project manager was appointed with sole responsibility for following and expediting the design, development, and construction of the PWR. In Bettis plant, projectization was carried out to the extent that the Westinghouse engineers and scientists assigned to the PWR project had no responsibilities in connection with other projects.

Prior to the beginning of major construction, a PWR integrated schedule committee was established on February 7, 1955, at a joint meeting of principal representatives of the Naval Reactors Branch, the Pittsburgh area office, the Duquesne Light Co., and the Westinghouse Atomic Power Division. This committee functioned under the chairmanship of J. H. Barker, Jr., PWR project officer, Naval Reactors Branch. The objective of this committee was to prepare an integrated schedule for all major items of production and construction required to meet a March 1, 1957, construction completion date for all phases of the plant except for the nuclear core. The name of this committee was later changed to the PWR coordinating committee and its responsibilities were expanded to include the following:

- (a) Review of PWR construction progress at regular intervals to ascertain that design, installation, and construction of facilities was proceeding in accordance with requirements of the schedule.

- (b) Determination of action necessary to resolve specific problems affecting the construction schedules, referring these matters to appropriate principals if policy was involved or if the committee could not, of itself, agree on a course of action.

- (c) Coordination of activities, such as design and construction of facilities or installation of components, which required the cooperation of more than two organizations for accomplishment.

Membership on the committee was expanded to include representatives of the Stone & Webster Engineering Corp., Burns & Roe, Inc., and of the Dravo Corp. as these organizations became active in the work at Shippingport. The PWR coordinating committee held 36 meetings extending from February 1955 to April 1957.

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On May 2, 1957, H. G. Rickover met at Shippingport with representatives of the Westinghouse, and of the Duquesne Light Co. The purpose of this meeting was to discuss and to take action on important work tasks necessary to complete construction, test, and startup of PWR, especially those tasks requiring extensive advanced planning. As a consequence of this meeting, the PWR coordinating committee was disestablished and a new committee called the PWR operations committee was formed. The function of this committee, which was likewise under the chairmanship of J. H. Barker, Jr., was to study and take such action as might be necessary in order that the PWR plant might achieve full power in the calendar year 1957. The operations committee held 42 meetings between May 1957 and December 23, 1957. On the latter date, the committee was dissolved inasmuch as full power had been achieved at 11:10 a.m. that morning.

One of the principal actions of the PWR operations committee was to set up various task groups to follow and plan for critical tasks which might affect the ultimate achievement of full power operation. These task groups considered such operations as reactor assembly, reactor fueling, core and head installation, core assembly, and instrumentation checkout. The task groups met approximately once a week and submitted a formal report to the PWR operations committee at its regular meeting.

In addition to the foregoing, numerous management techniques were used by H. G. Rickover to insure close control over the PWR project. A critical items report was submitted weekly by the Westinghouse PWR project manager. Commencing in February 1957 a daily teletype from the Shippingport site was dispatched to principals in Washington and in Pittsburgh which provided information on such matters as progress of welding, installation of components, labor problems, and other items which might affect completion of the project on schedule. Finally, personal inspections of the work at Bettis and of the construction at Shippingport were made regularly by H. G. Rickover. At these meetings, in which key principals of the organizations involved participated, problems were discussed freely and future plans of action were established.

INFORMATION AND LIAISON WITH OTHER AGENCIES

Throughout the course of the design and construction of the PWR project every effort was made to disseminate information as widely as possible. This was done for three reasons: First, to make sure that appropriate official bodies were given an opportunity to review design and operating procedures; second, that the public in general would be provided with information as to the progress of the plant; and third, that reactor technology developed in the program would be given rapid and widespread dissemination.

The Commission has an Advisory Committee on Reactor Safeguards, recognized by amendment to the Atomic Energy Act of 1954, which consists of specialists in the various fields appropriate to the study of reactor safety. This Committee reviews the design and operating procedures for each proposed reactor and advises the Commission as to the safety aspects. Operation of a reactor cannot commence without a formal review and approval by the Commission.

The initial contact with the Advisory Committee on Reactor Safeguards (ACRS) was made by H. G. Rickover, members of his staff, and representatives of Bettis plant on January 22, 1954. At this meeting a subcommittee of the ACRS agreed that the Shippingport site and the proposed conceptual design of the plant container appeared satisfactory.

On April 21, 1954, J. H. Barker, Jr., PWR project officer, presented to the ACRS a more detailed discussion of the Shippingport site including site photographs, hydrological, meteorological, and seismological data. In January 1955, the U.S. Weather Bureau was requested to set up equipment at Shippingport to gather meteorological data and the collection of this data began in April 1955.

On May 7, 1955, the entire ACRS held a meeting at Bettis plant at which a presentation and a discussion of safeguards problems was held. On August 31, 1955, at their 14th meeting, the ACRS considered further details of the PWR site and recommended to the Commission that the Shippingport site be considered acceptable. On October 19, 1955, the PWR subcommittee of the ACRS discussed the PWR project, and on January 3, 1956, at its 16th meeting, the ACRS heard a complete summary of the status of the PWR project from a reactor safety standpoint and in a subsequent letter to the AEC, stated that, "the committee is well impressed with the progress being made in defining the behavior of the system under steady State and transient conditions. The committee sees no

new problems in connection with this reactor which would alter its previous recommendations."

On November 1, 1957, the ACRS heard the final PWR safeguards report and in a letter dated November 4, 1957, to the Chairman, Atomic Energy Commission, stated as follows: "On the basis of the information presented, the Committee is convinced that adequate safeguards have been incorporated into the design and construction of the pressurized water reactor and adequate operating procedures have been worked out to insure that it can be operated at design power with an acceptably low risk to the health and safety of the public." The safeguards reports are available to the public in chapter 19 of the book entitled "The Shippingport Water Reactor," referred to earlier.

In addition to the review by the advisory committee on reactor safeguards, close contact was maintained with official bodies of the State of Pennsylvania. These included those bodies which have jurisdiction over pressure vessels installed for use in the Commonwealth and those which have jurisdiction over public health.

With respect to use of State codes and regulations in the design of the PWR plant, the policy of the AEC was stated in August 1954 as follows:

"As a matter of general policy, for that portion of the plant which will be the property of the Government and for Duquesne Light Co. property within the reactor area and located on land leased to the Government by Duquesne Light, States codes should be observed where material and equipment are of such a nature that provisions of existing codes are obviously applicable. For those items and facilities which are not defined under existing codes, every effort will be made to comply with those provisions which are most applicable. * * * With respect to radiation exposure and disposal of waste, either industrial or radioactive, State regulations, where and if existing, shall be observed unless standards of the AEC are more stringent. In this case, the latter requirements shall be applicable."

Since the State recognized applicable ASME codes, vessels and equipment constructed by qualified vendors and stamped with National Board numbers were accepted without any special administrative procedure or review by the industrial board of the State Department of Labor and Industry. A study showed that all nuclear plant components covered by the ASME codes could be built as standard ASME code vessels with the exception of the plant containers and certain safety devices and appurtenances.

In the latter cases, meetings were held at Harrisburg, Pa., to resolve code classifications for the components in question. These components received a "Pennsylvania Special" classification. A discussion of the applicable codes and details of the exceptions taken to standard ASME codes may be found in AEC report WAPD-PWR-974, "Pressure Vessel and Piping Codes Applicable to the PWR Reactor Plant."

As early as July 1954, officials of the Pennsylvania State Department of Health were informed as to the Commission's plans with respect to the PWR project. In September 1955, a formal presentation was made to members of the Ohio River Valley Water Sanitary Commission, to representatives of the Pennsylvania State Department of Health, and to representatives of the Commission and of the Public Health Service. In addition to the presentation, these individuals were taken on a tour of the Shippingport site where the proposed plans were explained to them in the field. Extremely close liaison was maintained with the U.S. Public Health Service. In 1955, E. D. Harward, assistant sanitary engineer of the Public Health Service, was assigned to the Pittsburgh area office of the Commission on a full-time basis to follow problems in connection with PWR and other projects.

It was early decided to apply to the State for a permit to discharge industrial and radioactive waste into the Ohio River. Cooperation of the Public Health Service and branches of the Commission was obtained in drawing up and reviewing the permit application with the State; this permit was granted on September 12, 1957. In addition, the Commission and Public Health Service representatives worked closely with the State officials in developing radiation regulations for the Commonwealth of Pennsylvania, which were subsequently enacted into law.

With respect to providing information to the general public, four seminars were held to acquaint representatives of industry with the problems in connection with the PWR. The first three of these, held in March and August 1954, and May 1955 were classified in nature inasmuch as the PWR project had not, at that time, been fully declassified. The fourth seminar, held in Pittsburgh on December 2, 1955, was addressed to ranking officials of industry and was designed to acquaint them with problems which would be encountered in developing and constructing a large-scale nuclear power station. This seminar was completely unclassified and minutes of the proceedings were subsequently published. All information regarding the PWR is now unclassified.

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During the course of construction at Shippingport, approximately 10,000 visits were made to the site and the facilities. In early 1957 it was found necessary to limit visits to the site because of interference with construction, but as of this date, visits have been resumed under the sponsorship of both the Duquesne Light Co. and the Atomic Energy Commission.

Following an extensive program of hydrostatic testing and checkout of instrumentation, the reactor first achieved criticality on December 2, 1957. On December 18, 1957, at 12:39 a.m., the main generator was synchronized and, as provided for in the contract, the Duquesne Light Co. assumed responsibility to the Commission for the operation of the plant. In the early morning of December 18, 1957, power was first furnished to the Duquesne Light system. On December 23, 1957, the plant first achieved its full power design capability of 60,000 kilowatts of net electrical power on three loop operation. From December 24 to December 28, 1957, the plant made, without incident, a continuous 100-hour full power run at 60,000 kilowatts of net electrical power.

APPENDIX 3

TECHNICAL BENEFITS DERIVED FROM THE NAVAL REACTORS AND SHIPPINGPORT PROGRAMS

It would be difficult to pinpoint all of the benefits which result from a development program as broad as that supporting the naval reactors and Shippingport projects. Perhaps the simplest way to present the story is to start by mentioning a few basic developments of obvious significance and then to summarize some of the lesser known specific technical achievements accomplished by one project. The Shippingport project, being completely unclassified, provides an appropriate example for this discussion.

Zirconium and hafnium are good examples of naval reactor developments of wide application and significance. Until the time we started with the naval program these metals were mere laboratory curiosities and were available only in extremely small quantities. The cost of zirconium at that time was about \$500 a pound and hafnium cost many thousands of dollars a pound. Zirconium now costs about \$10 a pound. Zirconium and hafnium are found together in nature. They are contained in abundance in sands which are available in Florida, among other places. Zirconium is a good structural material for nuclear reactor cores. It does not absorb neutrons. Hafnium, on the other hand, absorbs many neutrons. Therefore, we use it for control rods used to shut the reactor down. It is a strange thing that these two rare metals with such dissimilar nuclear characteristics are found in nature together. We have learned how to separate them at a relatively low price and to produce them by the ton in reactor-grade purity.

More than three commercial companies are now making zirconium and hafnium in the United States, and we are currently using these metals, which were once very rare, in large quantities. They are also being used by others who are designing and building nuclear powerplants.

Another item where we have contributed, is the development of a new reactor core fuel material—uranium oxide. The Shippingport project developed this material as the result of a very extensive development program, after we found that uranium in metallic form would just not do the job. Uranium oxide is now being used by many people designing nuclear power reactors, both in the United States and abroad.

Over the period of the last 10 years, we have developed a great deal of basic reactor physics and heat transfer data, and the analytical techniques for applying these data to reactor design. Many other reactor designs here and abroad are now based on these basic data and these techniques.

Essential parts of any nuclear powerplant are the pressure vessels, the pumps, valves, and the reactor control-rod mechanisms. The naval reactors and the Shippingport programs developed nearly all of the technology for this equipment which, again, is now available for use in the United States and abroad. When you remember that the pressure vessel of the Shippingport reactor is over 30 feet high, more than 10 feet in diameter, more than 8 inches thick, and weighs 250 tons, you will realize what a problem this was. The Shippingport reactor pressure vessel was the most difficult ever built. We have now built up a sufficiently broad base that we can buy reactor vessels, pumps, valves, reactor control mechanisms, and other essential reactor plant equipment from any of several companies—and now so can other reactor designers, who thus benefit from our experience.

ADVANCEMENTS IN REACTOR TECHNOLOGY DUE TO THE SHIPPINGPORT SUR-
TIZED WATER REACTOR (PWR) PROJECT

The PWR project has been and is continuing to be an important tool for making significant advances in the technology of pressurized water reactors. These advances started from the beginning of the design of the first PWR core, have continued through its development and manufacture, and are continuing at present through the testing of this core and the development of a complete replacement core (PWR core 2). Some of these specific gains in reactor technology are described briefly below. They cover: atomic powerplant operating experience; fuel and nuclear poison technology; reactor physics; reactor control; reactor thermal, hydraulic, and mechanical design; basic heat transfer studies; reactor core instrumentation; fuel element failure detection system; plant transient behavior; refueling procedures; primary coolant water radiochemistry; disposal of radioactive wastes; development of large reactor plant components.

First of all, as a complete powerplant the PWR has demonstrated how a pressurized water reactor can be integrated into a large utility's electrical power system. The reactor has demonstrated its ability to produce continuously its rated steady power and to respond to load transients with complete safety and without any operating problems. The plant has shown itself to be suitable for operation as a base load station or a peak load station or as a combination of both.

Two major contributions of PWR reactor have been in the field of physics and fuel technology. The PWR has demonstrated the validity of the "seed and blanket" concept in that:

(a) It is feasible to obtain large amounts of power from a "blanket" of natural uranium and ordinary water by using a "seed" or small highly enriched core as the driving element.

(b) That it is possible to control the entire reactor core by using control rods only in the relatively small seed volume.

(c) That this type of core possesses the favorable dynamic response and negative temperature coefficient of a small highly enriched core and yet has the power capabilities of a large reactor core.

In the field of fuel metallurgy, the PWR project has been responsible for the development of uranium oxide (UO_2) as a fuel material for large power reactors. This has been and is continuing to be a major contribution in the field of reactor fuel materials. Extensive testing both in-pile and out-of-pile was performed to permit the use of bulk UO_2 . Through continuing in-pile tests and the operation of the PWR core 1 we expect to find what limitations exist in the use of this fuel material. There is a large number of variables involved, such as fuel temperatures, heat fluxes, fuel element shapes, fuel-to-clad clearance, etc., which can vitally affect the behavior of this material under irradiation. In PWR core 1 the UO_2 is in pellet form and is contained in zirconium alloy (zircaloy-2) rods. In the development of PWR core 2, the replacement core, we are developing a UO_2 compartment plate-type element which has promise of having higher performance elements than the rod-type elements.

The specific advances in reactor technology are summarized as follows:

I. FUEL TECHNOLOGY

A. Radiation and corrosion-resistant uranium alloys

The initial fuel materials development work at Bettis led to the formulation of alloys of uranium which possess high irradiation stability as well as good corrosion resistance to high temperature water. This was accomplished by stabilizing the body-centered cubic phase by additions of molybdenum and/or niobium. Both the fabrication technology required to completely sheath these alloys in zircaloy cladding as well as the heat treatment and compositional variables important in securing materials of suitable performance capabilities were established. The effects of irradiation on both dimensional and chemical stability were measured. A byproduct of this development was the discovery of "reversion" in alpha-transformed alloys to the gamma phase condition and the explanations developed for this phenomenon serve to clarify the nature of the fission process in fuel materials. A development effort, more restricted in scope, was devoted to uranium alloys of the U_3Si composition. Again fabrication conditions and irradiation stability were established; here also the property changes occurring as a result of irradiation serve to reveal important basic characteristics of the fissioning process.

B. UO₂ fuel material development

The reactor materials contribution of PWR in this field has been the accumulation of information from both in-pile and out-of-pile experiments to permit use of bulk UO₂ as a reactor fuel material. The in-pile experiments have served to set a rational basis for interpreting the thermal performance of UO₂ fuel elements. They have revealed the relations of characteristics of the fuel material (density, extent of sintering, composition, porosity, etc.) and fuel element design (fuel-clad clearance, allowable heat flux, internal atmosphere, etc.) to fuel element behavior. They have permitted formulation of a rational to relate release of fission products, both within the cladding and to the coolant to operational and material characteristics. Continuing experiments as well as experience with Shippingport operation will serve to reveal material limitations to the burnup of this type of fuel element.

Out-of-pile experiments have revealed limitations imposed on fuel element fabrication or operation by Zr-UO₂ reactions. They have furnished information necessary for explanation and prediction of the thermal performance. They have revealed the relations between microstructure, density, characteristics of initial UO₂ powder, sintering times, temperatures, and atmosphere, etc. Continuing experiments are anticipated to permit relating ionic mobility in UO₂ to composition and to the related problem of fission product mobility.

C. The fuel component (the UO₂ pellet)

Mass production techniques were developed for conversion of non-free-flowing UO₂ powder to high density, sintered, precision-dimensioned fuel pellets. Free-flowing granules were made by incorporating an organic binder with the UO₂ powder. Compaction was done by employing a pressure of 125 tons/in² at a rate of 20 pellets/minute. (Normal industrial powder metallurgical practice does not exceed 75 tons/in²). Sintering at a temperature of 1,675° C. for 8 hours produced pellet whose nominal density of 94 percent was controlled within plus or minus 1 percent. Precision dimensional tolerances of plus or minus 0.0005 in on the pellet diameter were obtained by grinding at rates of 25 pellets per minute. These fuel manufacturing techniques have since been adopted for use by a large segment of the reactor industry.

D. UO₂ fuel configurations

As indicated previously, UO₂ in pellet form and inserted in cylindrical rods was developed as the fuel element configuration for PWR Core 1. The information obtained in the course of this development revealed the feasibility and desirability of developing UO₂ in plate form. The potential advantages lie in improved heat transfer performance and in reduction of fuel element fabrication costs. Consequently UO₂ in the compartmented plate type form is being actively pursued for use in PWR core 2.

E. Ceramic oxide seed development

The high degree of irradiation stability exhibited by UO₂ has prompted investigation of other ceramic oxides as matrices, particularly for the incorporation of enriched UO₂. Techniques for the fabrication of UO₂ with oxides of aluminum, zirconium, calcium, and beryllium (with the UO₂ present in various particle size ranges) have been developed, and pertinent properties measured out-of-pile. In-pile information has been obtained on several of these mixtures and further such tests are presently under way. Information already available has indicated the high degree of stability of the ZrO₂-UO₂-CaO fuel as well as the poor stability of the Al₂O₃-UO₂ fuel. This information is not only of direct value with respect to development of highly enriched ceramic fuel materials but also serves to reveal the structural and chemical factors important in determining radiation stability of ceramic fuels in general. For each of the oxides listed above, fuel element fabrication techniques are being developed to permit the incorporation of these materials in potentially useful forms.

F. Zircaloy development

Application of zircaloy as a cladding for UO₂ fuel elements and the consequent in-pile and out-of-pile tests which were performed have served to reveal new facets of zirconium technology, particularly with respect to the pickup of hydrogen by zirconium from high temperature water systems, the effects of irradiation thereupon, and the behavior of hydrogen dissolved in zirconium. The susceptibility of zirconium to hydrogen pickup in high temperature water and its acceleration under irradiation were revealed by in-pile loop tests. Further development, particularly in relation to the PWR core 2 plate development program, revealed the role of nickel contained in zircaloy in accelerating or increasing this absorption

of hydrogen, and has pointed the way toward development of a class of zirconium alloys free of this injurious element. Finally, both in-pile and out-of-pile tests have revealed the redistribution of hydrogen in zirconium under thermal and stress gradients and have furnished the basis for explanation and prediction of this phenomenon.

G. Development of bonding and joining techniques for zircaloy-2

PWR core 2 fuel element development has prompted the formulation and further development of several techniques for bonding zirconium. A technique known as eutectic diffusion bonding has been developed, in which zircaloy surfaces coated with small thicknesses of Cu or Fe are heated to a temperature sufficient to melt a eutectic of these materials with zirconium, thus forming a metal-brazed joint from which the bonding metal can subsequently be diffused into the zirconium. This joining or bonding method has been shown to be capable of producing joints of high mechanical strength as well as good corrosion stability. Further developments initiated for PWR core application include an intensive evaluation of the application of the pressure bonding process for bonding zircaloy components, in which the bonding is achieved by simultaneous application of high temperatures and pressures.

H. Lumped burnable poison material development

To permit extension of core life in PWR cores, there are under investigation various metallurgical techniques for incorporating B^{10} in the concentrations and lump sizes required from nuclear considerations. Two methods are under investigation at present, the one involving fabrication of zircaloy-clad stainless steel- B^{10} alloys in concentrations up to 2 w/o B^{10} , the other consisting of incorporating high density hot pressed B_4C as wafers or platelets in bonded zircaloy-2 compartments. These materials are presently under intensive investigation with respect to radiation limitations, out-of-pile properties and behavior, and suitability for fabrication to dimensions necessary for reactor core application. A byproduct of this investigation has been the development of techniques for metallurgically bonding zirconium to stainless steel.

I. Alternate control rod material development

Investigation of potential replacements for hafnium as a control rod material for PWR has resulted in development of a silver-base alloy containing about 15 percent indium and 5 percent cadmium, which has promise for reactor application. In the course of this development an analytical technique was developed for accounting for the metallurgical changes produced by neutron absorption, and techniques were developed for improvement of creep properties either by grain size control or by use of directly extruded powders. The investigation was extended not only to material development but also to fabrication techniques for full size control rod components. Release of activity from the control rods as a result of plant accident conditions involving dissolved air in the coolant was measured and circumvented by the development of high quality nickel plating procedures which can be applied to full size rod components.

J. Irradiation testing technology

In the course of development of PWR fuel elements it has been necessary continually to refine and advance the art of inpile testing as well as that of post-irradiation hot laboratory examination. Most significant in this connection has been the development of technology permitting the exposure of fuel elements both to irradiation and high-temperature water even under conditions such that the fissile material is exposed directly to the circulating coolant. Such a development was necessary not only to assess fuel element stability under combined conditions of corrosion and irradiation but also to permit prediction of, as well as curative measures for, the effects of fission product release through fuel element clad defects into the coolant.

A second major development undertaken in this connection was the use of zircaloy inpile tubes as containment for high temperature, high-pressure loop systems. This work, which results in more efficient use of test reactor neutron flux, is expected also to furnish valuable ancillary information applicable to prediction of the life of zircaloy for pressure tube in reactor application. Another aspect of inpile technology of potentially broad application is the development of pressure tubes for use in high flux reactors such as ETR in which high values of gamma heating as well as irradiation-induced mechanical property changes introduce severe limitations to design. Experience with operation of such units is expected to yield considerable information concerning the applicability of the design con-

cepts employed. Hot laboratory techniques developed for postirradiation examination of WR fuel elements are also of particular interest with respect to the information gained on handling of relatively large fuel element specimens irradiated to high burnups and obtaining applicable data on metallographic structure, chemical analysis of fuel and cladding, and gaseous fission product release from the fuel.

K. Zircaloy tubing and end capping of Zircaloy fuel rods

From the start of the PWR project the fabrication of zircaloy tubing having the desired integrity was considered a serious problem. Zircaloy had never been fabricated to this shape and all commercial tubing manufacturers were completely unfamiliar with the fabrication characteristics of this material. The only known process of fabricating tubing consisted of drilling bars at a cost of over \$100 per foot of finished product.

As a result of an all-out development effort, a satisfactory process for fabricating acceptable zircaloy tubing was developed. Approximately 150,000 feet of tubing were fabricated meeting the rigid dimensional and material characteristic requirements necessary; i.e., adequate corrosion resistance and leak tightness when subjected to a 50,000 p.s.i. proof test. Yields of final quantities of tubing were comparable to those obtained on other nonferrous materials such as aluminum. As a result of this development zircaloy tubing of various sizes is now available to all reactor designers.

An important and difficult problem that had to be solved in the manufacture of rod type fuel elements was that of sealing the zircaloy tubes with zircaloy end plugs. It was found that a significant amount of porosity would develop in these closure welds and such techniques and equipment had to be developed to overcome this. Finally, an automatic setup for performing these welds was developed and the losses in the welding of these fuel rod end caps was reduced to a very negligible number.

L. Fission products—Release and distribution

The necessity of running inpile tests with deliberately defected fuel elements in order to assess the amount and distribution of fission products that would be released from unintentionally defected elements in the reactor was recognized. An empirical correlation (escape coefficient) was developed relating the rate of release of activity from the fuel to its concentration in the fuel. It was found that, in general, those isotopes which present the greatest hazard from the standpoint of surface contamination are least likely to escape from the fuel. The escape coefficient concept has been adopted by other groups designing UO_2 -fueled reactors, and the values of this coefficient developed by PWR have been used in their calculation. Concurrently with the determination of escape coefficients, the relative affinities of specific radionuclides for absorption on pipe surfaces at high temperature have been measured. These measurements have for the first time permitted a realistic evaluation of the accessibility hazards expected from failure of fuel elements in pressurized water reactors. Only by this means can the fate of each radioactive isotope released be determined, and the radiation fields resulting from soluble versus deposited activity calculated.

II. PHYSICS

The PWR core 1 is demonstrating the suitability of a seed and blanket type core for the generation of large quantities of electrical power for a public utilities system.

The research and development activities occurring as an integral part of the program leading to the design and operation of PWR cores at Shippingport have provided information and insight into a number of areas in reactor physics and nuclear design which are applicable to reactor development in general.

A. Extended burnup of high uranium content fuels—reactivity behavior

Two phases of the PWR program are providing valuable information with regard to the long-lived reactivity behavior of natural uranium fuels. These are: (1) The exposure of up to 10,000 megawatt day-ton (average) which the blanket of the first core will receive if three or four seed lives are completed; and (2) the long term reactivity gains program, which is providing an opportunity to study, under controlled conditions, the reactivity effects associated with exposures of up to 30,000 megawatt day-ton for natural uranium fuel. Such information is vital to a power reactor program involving high uranium 238 content material in reactors of very extended lifetimes and high power. The analysis which is

planned for selected irradiated fuel elements from the core 1 blanket. Including destructive testing will provide information on this subject several years before it will be available elsewhere.

B. Physics measurements at Shippingport

The data obtained from the extensive testing program carried out at Shippingport provides a basis for evaluating the analytical model used in reactor design which has not been available from the operation of other existing power reactors. The data have been obtained in a form which is directly comparable with that obtained from calculations, and therefore the operation of the PWR at Shippingport represents the first thorough check of nuclear design methods against an operating large scale power reactor of long reactivity life.

C. Xenon-induced power oscillations in a large power reactor

The presence of extensive nuclear and thermal instrumentation in the PWR has enabled direct observation of xenon-induced instabilities. Although the possibility of such instabilities had been anticipated, the ability to observe and develop methods for their control in PWR has provided insight into the character of large reactor behavior which will be of direct application in the design of other large power reactors. In particular, the Shippingport experience has demonstrated that:

(1) Adequate instrumentation must be provided in the design of new plants so that the reactor operator can be aware of such oscillations; and (2) an informed reactor operator can easily control the magnitude of such oscillations so that the thermal capability is not exceeded in any local regions of the core. The relatively complete information obtained at Shippingport concerning the behavior of the reactor during an oscillation provides the basis for development of an analytical model which may assist future reactor designers to anticipate oscillatory tendencies in a design sufficiently early to minimize their effects.

D. Critical experimentation

The extensive series of experiments involving PWR mockup critical assemblies has led to the development of several useful experimental techniques. Among these are a method of determining reactor subcriticality by analysis of neutron flux data, a method for obtaining excess reactivity information from moderator height measurements on critical assemblies, and a technique for simulating elevated moderator temperatures in a cold reactor by use of a foamed plastic material. Several innovations in the field of data reduction also have resulted. These include devices for the precise measurement of control rod positions and moderator heights, and a method of automatic compensation for the decay of activities induced in the foils used in flux plotting experiments.

E. Information on the reactor properties of water-moderated, slightly enriched uranium lattices

The TRX critical program, designed to provide basic information on the reactor characteristics of lattices of uranium 238 rods, moderated by light water, was financed in large measure by, and also was motivated by, the PWR project. The information obtained as a result of this program represents one of the most significant contributions to the development of reactor physics technology thus far made in the United States. The development of digital computer codes for use in nuclear reactor design, while somewhat separate from the TRX program, has found its basis in the data provided by the TRX.

F. Self-shielded burnable poisons

An integral part of the development effort on a second core for Shippingport has been the work associated with the analysis of self-shielded poisons for a long-lived, high-power reactor. The emphasis which has been placed on the core 2 objectives has stimulated the development of analytical methods for the treatment of such poisons which would not otherwise be in existence. Such analytical ability is essential to the design of any long-lived power reactor, since in this case control rods alone are not capable of providing sufficient reactivity control. The analytical work and associated experimental effort which has been devoted to the burnable poison problem represent a substantial contribution to the field of power reactor design.

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III. CORE INSTRUMENTATION

The WR project is contributing significantly to the development of compact flow and temperature sensing instrumentation for the determination of the absolute and relative power production in the various parts of reactor cores. In addition, instrumentation has been developed for the measurement of the axial temperature distribution in fuel plates and the detection and location of a failed fuel element. Features which have and are being developed can be categorized as follows:

(A) Accommodate instrumentation, components, and leads within the restricted space available in a compact pressurized water core and in a manner which will not interfere with core refueling procedures. This overall problem required development to accomplish conventional functions such as the joining and sealing of groups of sampling and sensing tubes and the use of flow measuring devices.

(B) The development of new devices to perform new functions for which there was little precedence. Example: The development of a device for obtaining representative mixed samples of the effluent flow from each fuel assembly in order to detect whether any of its elements has failed.

(C) The development of in-pile thermocouples and means for readily replacing these thermocouples in the event of their failure.

(D) The development of a complete core instrumentation system which would not affect the safe operation of the reactor in the event that any part of this system were damaged.

A large amount of testing both in-pile and out-of-pile had to be performed to develop this kind of core instrumentation. Some of the proof testing was done in the naval reactor facility (S1W), Arco, Idaho.

IV. MECHANICAL DESIGN

Significant developments in the mechanical design and arrangements for pressurized water reactors have resulted from the PWR project. For example, the necessary technology was developed to fabricate large pressure vessels having walls over 8 inches thick and using a thin seal weld membrane for making the pressure vessel head joint leak tight. In addition, a large reactor pressure vessel head was developed with a large number of openings so that the reactor could be refueled through these ports in the head without having to remove the pressure vessel head.

Refueling methods were developed such that in PWR it would be possible to obtain information to evaluate various methods of refueling the reactor core; for example, refueling with the reactor vessel head on versus refueling with the reactor vessel head off, and in each case using water or solid shielded containers to provide the necessary radiation protection. Means for holding the fuel clusters in the reactor core and for orificing various sections of the core were developed for PWR core 1 and further advances are being made in these mechanical features in the design of the PWR core 2. All of these features should be applicable in the design of large-size power reactors. In carrying out these new designs special techniques are continuously being developed for calculating and determining the stresses in the various structures due to both pressure and thermal forces.

V. HEAT TRANSFER AND HYDRAULICS AROUND RODS

Adoption of zircaloy-clad oxide rods as the reference fuel element in the blanket region of the core necessitated the formation of a test program to establish the basic thermal and hydraulic parameters for parallel flow between rods. Essentially no such information on rods was available in the literature prior to the start of test work. The test program included isothermal, local boiling, and bulk boiling pressure drop tests and burnout heat flux tests.

In order that calculations could proceed prior to the availability of the test results, it was assumed that correlations obtained for flat plate fuel elements were valid for flow outside of rods. Through the performance of numerous tests it was concluded that both the burnout heat flux correlation and the heating and local boiling correlation obtained for rectangular channels could be conservatively applied to parallel flow outside of rods.

Significant information concerning thermal and hydraulic performance in pressurized water reactor core one has been made available through flow-measuring and temperature-sensing instrumentation. In combination, these two classes of

instrumentation have enabled detailed power-distribution analyses to be made which have confirmed the design predictions of core performance.

The flow-measuring instrumentation has shown that flow distribution through a multiregion orificed core such as pressurized water reactor can be accurately predicted from semiempirical analyses. Measurements of flow through prescribed assemblies of the core were within 1.5 to 2.2 percent of design, with standard deviations of the measurements being ± 2.5 percent. The four coolant inlet nozzles in pressurized water reactor are symmetrically located and spaced evenly around the core. Flow distribution was found to be within the preceding limits with either three or four coolant loops in operation.

The thermocouple instrumentation has required careful calibration and has yielded information which (1) has confirmed power-distribution predictions early in core life, (2) has shown that there is a shifting in power from the enriched seed to the natural uranium blanket, and (3) has provided a measurement of core power symmetry and deviations from symmetry.

A shift of approximately 3.7 percent in seed/blanket power sharing was predicted through nuclear-design studies in the interval of 1,000 to 3,000 EFPH. Thermocouple measured seed/blanket power sharing changed (in the proper direction) by approximately 4.7 percent over the same interval of core life.

Power oscillations across diametrically opposite segments of the PWR core were observed during a maximum xenon override test after approximately 400 EFPH. These oscillations have been monitored through core instrumentation. The period of oscillation has been established to be approximately 24 hours; the magnitude of oscillations has been maintained within prescribed limits (± 6 percent) oscillation have been permitted during certain operations, while in others they were effectively limited to ± 3 percent).

Static power asymmetries upon core startup have also been detected through core thermocouple instrumentation, which has become the basis for calibration of neutron flux detectors, subsequently used to monitor normal operations. Thermocouple evidence is available describing static asymmetries followed by shutdown, xenon buildup, and then during subsequent operations oscillations, the magnitude of which is directly proportional to the static asymmetries.

Information concerning power asymmetries as influenced by various coolant loop combinations will be available from "core asymmetry tests" which have yet to be performed.

VI. COOLANT TECHNOLOGY

PWR has been the first pressurized water reactor to operate from initial startup with the coolant controlled at high pH with a lithium-base ion-exchange resin. In-pile loop tests had early demonstrated that deposition of corrosion products on fuel element surfaces and buildup of radioactivity in the loop are less under high pH operation than at neutral pH. The radiochemical behavior of the PWR system seems so far to confirm these indications.

Advances have also been made in chemical technology associated with the reactor coolant. In particular, new devices have been invented and developed for continuous dissolved hydrogen and oxygen analysis; the concept of continuous sampling of coolant and analysis by a train of instruments was developed for PWR and successfully applied. As a result of PWR-supported work, new knowledge has been gained concerning the performance of base-form ion exchangers for pH control and fission product removal.

VII. REACTOR PLANT COMPONENTS

The main coolant pumps in PWR are the largest hermetically sealed pumps built to date. Their design was based on extrapolation of data from much smaller units and were as far as the manufacturers could reasonably go in 1954. Based on their experience with these units, pump vendors are now willing to make another step change to higher power and pumping capacities.

Similarly, the reactor vessel, steam generators, valves, and other reactor plant components constitute a significant increase in size over previously available equipment.

REPORTING AND DISSEMINATION OF INFORMATION

Many people do not realize the large amount of technical information that the naval and the Shippingport programs are making available to everyone, including all foreign countries. Early in 1957 we established the following policy:

1. All information on the Shippingport reactor is unclassified.

2. naval reactor technology is unclassified.
3. any design and military information remained classified.

In line with this policy we reviewed at that time all of the classified reactor reports issued by our program and we released several thousand publications for dissemination to people working on other reactors.

In addition, we arranged for the Bettis and the Knolls Atomic Power Laboratories to regularly publish unclassified reports several times a year reporting all of the latest developments in naval reactor technology.

We also encouraged our contractors to report their work in technical papers published as Government reports, or in professional journals, or presented before technical societies.

As a result of these actions, the naval reactor laboratories have published—all unclassified and available to everyone—several hundred technical progress reports, several hundred topical reports as Government publications, more than a thousand technical papers in professional journals or meetings, and several thousand technical memorandums, specifications, or drawings. I believe that in the reporting and dissemination of really useful technical information, the naval reactors and Shippingport programs need take a back seat to no one.

I will cite one example which illustrates the kind of technical information we are reporting. The Bettis Laboratory published, in connection with the 1958 Geneva Conference on Peaceful Uses of Atomic Energy, a selection of papers reprinted from their periodic unclassified report on naval reactor and Shippingport technology. The scope and detail of these papers is indicated by their titles, which follow:

REACTOR AND PLANT ENGINEERING

"Hydraulic Test Program for Reactor Core Components," R. Atherton and L. H. Harman.

"Determining Performance Characteristics of a Saturated Steam Pressurizer for Nuclear Power Applications," J. R. Maxwell.

"A Review of Two-Phase Flow Relations," J. S. Busch and J. M. Carpenter.

"Formal Heat Transfer Solutions for Reactor Design," J. S. Busch.

"Transient Temperature Distribution in Pressure Vessels," J. S. Busch, J. P. DeVries, R. C. Nicoll, and R. A. Oerth.

"Study of the Force-Deflection Characteristics of a Belleville Spring," J. E. Meyer.

"Design and Operating Characteristics of a Bed Filter for an In-Pile Test Facility," L. A. Waldman.

REACTOR METALLURGY

"Metallurgical Design and Properties of Silver-Indium-Cadmium Alloys for PWR Control Rods," I. Cohen, E. F. Losco, and J. D. Eichenberg.

"Solubility of Enriched Boron and Boron Compounds," E. S. Byron, J. F. Thompson, and S. W. Porembka.

"A Metallographic Examination of Zirconium and Zirconium Alloys," E. L. Richards and E. A. Wright.

"The Effect of Heat Treatment on the Corrosion Resistance of Zircaloy-2 and Zircaloy-3," J. G. Goodwin.

"The Chemical Displacement Plating of Zirconium and Zircaloy," F. M. Cain, Jr.

"Problems Associated With Uranium Contamination of Zirconium and Zirconium Alloys," B. F. Rubin, P. W. Frank, R. S. Gilbert, and K. H. Vogel.

"X-Ray Examination of Irradiated Uranium Dioxide," E. R. Boyko, J. D. Eichenberg, R. B. Roof, Jr., and E. K. Halteman.

REACTOR CHEMISTRY AND PLANT MATERIALS

"Out-of-Pile Dynamic Loop Tests of Irradiated Fuel Materials," L. A. Waldman and W. T. Lindsay, Jr.

"Corrosion and Erosion of Sintered UO_2 Compacts in High Temperature Water," J. M. Lojek, W. T. Lindsay, Jr., and P. Cohen.

"The Effect of Oxygenated Water on Clad-and-Defected UO_2 Fuel Specimens," J. M. Lojek and W. T. Lindsay, Jr.

"Magnetic Properties of Type 400 Series, 17-4 PH, and AM 355 Stainless Steels," J. V. Alger.

"The Effect of Surface Finish and Galvanic Coupling on the Corrosion Resistance of ASTM A-212 Carbon Steel in Primary and Secondary Water," L. R. Scharfstein.

"Corrosion of Shield Tank Materials in Lithium Chromate Solutions," Rau and K. Jakobson.

"Removal of Radioiodine from PWR Plant Container Air," A. S. Kesten.

REACTOR PHYSICS AND MATHEMATICS

"Review of Methods Used in Control Rod Analysis for Reactor Design at Bettis," A. F. Henry

"Two Dimensional Burnup of a Cell," W. D. Kimball.

"Resonance Capture in Heterogeneous Systems," S. Stein.

"Half-Height Cadmium Slab," R. S. Halgas and M. Bender.

"Critical Experiments on Water-Moderated Lattices of Slightly Enriched Uranium Dioxide (UO_2) Fuel Rods," J. R. Brown.

"Nuclear Design of a Fuel Assembly for an Irradiation Proof Test," S. Sandhaus.

"Synthesis of Three-Dimensional Power Shapes—Application of Flux-Weighted Synthesis Technique," W. N. Lorentz.

"The Use of the Equivalent Bare Core Model for Calculating the Criticality of Slab-Type Reactors and a Comparison to Experiment," R. S. Wick and J. D. Butler.

"Thermal Flux Depressions in Materials Containing Fuel and Boron," R. J. Neuhold and G. F. Boger.

"An Inverted Reactivity Effect," L. O. Herwig and E. R. Sanford.

"Thermal Equivalent Σ_p for Cadmium-Silver Control Rods," A. J. Calio.

"A Lemma of Stieltjes," R. S. Varga.

"Reactor Criticality and Nonnegative Matrices," G. Birkhoff and R. S. Varga.

"Few-Group Fitted Parameters," P. A. Ombrellaro.

"A New Version of the Multigroup Fourier Transform Code for Calculation of Fast Group Parameters," E. Gelbard and H. Bohl.

"The WANDA Spatial Code," O. J. Marlowe and E. Gelbard.

"CANDLE—A One-Dimensional Few-Group Lifetime Depletion Code," E. M. Gelbard, G. W. Hoffman, O. J. Marlowe, and P. A. Ombrellaro.

But the most important vehicle we have for getting out technical information is a series of technical handbooks which we are publishing. They are quite comprehensive and they are all unclassified except for one which contains classified design information. These naval reactors handbooks are:

Published

"Liquid Metals Handbook," first edition, edited by R. N. Lyon, June 1950; second edition, edited by R. N. Lyon, June 1952; third edition, (sodium-NaK supplement) edited by C. B. Jackson; first printing, June 1955; second printing (revised), November 1955; (available from Superintendent of Documents, Washington 25, D.C.).

"Metallurgy of Zirconium," edited by B. Lustman and F. Kerze, Jr., July 1955 (published by McGraw-Hill Book Co., New York).

"The Metal Beryllium," edited by D. W. White and J. E. Burke, July 1955 (published by American Society for Metals, Cleveland).

"Bibliography of Reactor Computer Codes, Report AECU-3078," edited by R. S. Brodsky, December 1955 (available from Superintendent of Documents, Washington 25, D.C. This compilation is being kept current by the Nuclear Codes Group Quarterly Newsletter, inquiries should be sent c/o New York University, AEC Computing Facility).

"Reactor Shielding Design Manual," edited by T. Rockwell III, March 1956 (published separately by Government Printing Office, McGraw-Hill Book Co., New York, and D. Van Nostrand Co., Princeton, N.J.).

"Corrosion and Wear Handbook for Water-cooled Reactors," edited by D. J. DePaul, March 1957 (published separately by Government Printing Office and McGraw-Hill Book Co., New York).

Naval reactor physics handbook, A. Radkowsky, chairman of editorial board. Volume II, "The Physics of Pressurized Water Reactors," edited by S. Krasik, March 1959 (confidential); volume III, "The Physics of Intermediate Spectrum Reactors," edited by J. R. Stehn, September 1958.

In preparation

Naval reactors physics handbook, A. Radkowsky, chairman of editorial board. Volume I, "The Physics of Naval Reactors; Basic Techniques," edited by A. Radkowsky.

"Metallurgy of Hafnium," edited by E. T. Hayes and D. E. Thomas.

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"Properties of Uranium Dioxide," edited by J. Belle.

"Reference Heat Transfer and Fluid Flow Handbook," edited by J. Zerbe.

"Nuclear Reactor Design Manual," edited by N. J. Palladino, I. H. Mandil
and B. F. Langer.

"Reactor Plant Piping Handbook," edited by M. Shaw.

"Irradiation Testing and Hot Lab Techniques," edited by D. M. Wroughton,
T. J. Glasson and R. R. Roof.

"Nuclear Poison Materials for Reactor Control," edited by W. K. Anderson and
J. S. Theilacker.

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REVIEW OF NAVAL REACTOR PROGRAM AND ADMIRAL RICKOVER AWARD

HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY CONGRESS OF THE UNITED STATES EIGHTY-SIXTH CONGRESS FIRST SESSION ON REVIEW OF NAVAL REACTOR PROGRAM AND ADMIRAL RICKOVER AWARD

APRIL 11 AND 15, 1959

Printed for the use of the Joint Committee on Atomic Energy



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NOTE

The Joint Committee hearing of April 11, 1959, was held aboard the U.S.S. *Skipjack* at sea while the nuclear submarine was establishing new records for speed and depth of operation. The record of that hearing except for deletions of classified information is hereby made a part of the printed record.

The hearing of April 15, 1959, was in open public session for the purpose of presenting to Vice Adm. Hyman G. Rickover a special congressional gold medal in recognition of his achievements in successfully directing the development and construction of the world's first nuclear-powered ships and the first large-scale nuclear power reactor devoted exclusively to production of electricity. The hearing also included a review by Admiral Rickover of the naval reactor program which is hereby made a part of the printed record.

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REVIEW OF NAVAL REACTOR PROGRAM

SATURDAY, APRIL 11, 1959

CONGRESS OF THE UNITED STATES, JOINT COMMITTEE ON ATOMIC ENERGY.

The Joint Committee on Atomic Energy met pursuant to call at 8 p.m., in the ward room of the U.S.S. *Skipjack*, at sea, Hon. Clinton P. Anderson (chairman of the Joint Committee) presiding.

Present: Senators Clinton P. Anderson, John O. Pastore, Henry M. Jackson, and George D. Aiken; and Representatives Chet Holifield, James E. Van Zandt, and Jack Westland.

Also present: James T. Ramey, executive director; John T. Conway, assistant director, David R. Toll, staff counsel; and Edward Bauser, technical adviser, Joint Committee on Atomic Energy.

Vice Adm. Hyman G. Rickover, Assistant Director for Naval Reactors, Division of Reactor Development, Atomic Energy Commission; Comdr. William W. Behrens, U.S. Navy, commanding officer, SSN-585 *Skipjack*; and Carlton Shugg, general manager, electric boat division, General Dynamics Corp.

Senator ANDERSON. This is an official meeting of the Joint Committee on Atomic Energy. We meet this evening in executive session aboard the U.S. nuclear submarine *Skipjack*, more than 400 feet below the surface of the Atlantic Ocean and approximately 135 nautical miles out of New London, Conn.

We are present here today to receive a report from Vice Adm. H. G. Rickover, Assistant Chief for Nuclear Propulsion, Bureau of Ships, and Comdr. William W. Behrens, commanding officer of the U.S.S. *Skipjack* on the operation of this new nuclear submarine which completed its first sea trials on March 10, 1959, just 32 days ago. We are present here today also to observe for ourselves the operation of this outstanding submarine and thus obtain firsthand knowledge of what has been accomplished.

It was 4 years ago last month, on March 20, 1955, that the Joint Committee held a hearing aboard the U.S.S. *Nautilus*, the world's first nuclear submarine. We met as a committee below the surface of the Atlantic in approximately the same location we are now.

Congressmen Chet Holifield and James Van Zandt and Senator John Pastore who are present here today were among those who were with me that memorable day 4 years ago aboard what was then the only nuclear submarine at sea. Since then five additional nuclear submarines have gone to sea: the *Seawolf*, the *Skate*, the *Swordfish*, the *Sargo*, and the *Skipjack*. This is a marvelous record of the accomplishments of Admiral Rickover and his splendid team.

On behalf of the committee, I wish to say how pleased we are to be aboard this, the newest addition to our nuclear undersea Navy, and to have the opportunity to meet the fine officers and crew of this submarine and to observe them in their important work.

STATEMENT OF VICE ADM. HYMAN G. RICKOVER, USN

Admiral RICKOVER. Thank you very much, sir. I want to say one thing right at the beginning, and that is that each one of these nuclear submarines constitutes a complete task force in itself. Each of these ships is able, on its own, to perform functions which outstrip the requirements placed on it. Sometimes people ask why these submarines are so big and complex; why don't we make them tiny? Some people would like to see nuclear submarines operate like airplanes—small craft with only a few people aboard, dashing out on a quick mission and then having to return to some protecting ship or base. I believe strongly that such a concept is a degradation of the tremendous potentiality of these ships. In a large surface-ship task force the Navy makes a tremendous investment to get a self-sufficient offensive capability where and when it wants it, with a capability for staying there and doing a job. Now in the nuclear submarine, we have such a capability at low cost. The ocean acts as its protecting screen and as its armor. As a result, the submarine can be made all weapon, rather than part weapon and part shield. Therefore we should look at each new improved feature which is added to the submarine as an increase in the effectiveness of this one-ship task force, rather than concern ourselves unduly over the fact that the submarine may be getting bigger than other submarines or bigger than somebody's idea of an underwater "pursuit ship".

Perhaps I have belabored this point but I think it is an important one.

With this concept in mind we lay out the machinery in these ships so that the ship's force can maintain it. We also provide installed spares of all important equipment wherever practicable. This permits the ships to stay at sea for several months and even to stay submerged for 2 months or more. It means we can operate throughout the whole Arctic region any time of the year and surface at will through the many openings or thin spots in the ice. It means that the ship does not have to return to a base for servicing after a few hours of operation as an airplane does, or as a "small" submarine with "aircraft-type engines" would.

The real significance of these polar voyages is that another large area of the world—larger than the whole United States—which was heretofore secure from war has now been exposed by these exploits. The entire northern coastline of Russia, formerly protected by the Arctic icepack, is now exposed. And of course the same applies to Alaska and to Canada.

So far as the ship is concerned, it is the fastest submarine in the world. It has made a speed of over (classified) knots. The highest previous speed for a nuclear ship was (classified) knots, by the *Nautilus*. These figures are classified. The *Skate* makes about (classified) knots. In this ship we made improvements to get it over (classified) knots. (Classified.) A surface ship often can't make her maximum speed because of the variable surface conditions of the sea or because of heavy weather; a nuclear submarine isn't affected by these weather conditions. Even diesel submarines are dependent on surface weather conditions to use their snorkel.

Our hard-worked diesel submarines now steam about (classified) miles a year at an average speed of less than (classified) knots. A

small fraction of this, less than 15 percent, is totally submerged. On the other hand, our nuclear submarines are now averaging about 40,000 miles a year of which as much as 90 percent is completely submerged.

Senator PASTORE. Does the performance of the *Skipjack* make the *Nautilus* obsolete?

Admiral RICKOVER. No, sir; the *Skipjack* does not make the *Nautilus* obsolete because even the *Nautilus* is so far superior to all others constructed before it. The performances of the *Skate*, *Nautilus*, and *Skipjack* are making all conventional submarines obsolete. They are making perhaps 800 to 900 submarines in the world obsolete.

Senator PASTORE. How do you account for the difference between the *Skipjack* and the *Nautilus*?

Admiral RICKOVER. The *Nautilus* is a two-propeller ship. Her hull shape is not designed for optimum performance submerged. The *Skipjack*, on the other hand, is designed to make maximum speed submerged. She has essentially no superstructure. You may remember when you came aboard there was very little room for people to walk around up there. Also, the fact that she has a single propeller gives her better propulsive efficiency.

Representative VAN ZANDT. What percent of your steampower are you using?

Commander BEHRENS. 85 percent.

Admiral RICKOVER. We are not putting out as much power from the reactor as it is capable of. The limitation comes in the machinery plant. Most of our problems on these ships, incidentally, have been with the conventional machinery and not with the reactor.

Representative VAN ZANDT. We are now turning over the machinery to its full extent?

Admiral RICKOVER. There are various limitations. At this particular moment our condenser vacuum is too good. If we were operating in warmer water we would get higher speed.

I would like to announce at this time, 8:26 p.m., e.s.t. on April 11, 1959, that the captain of the *Skipjack* has just reported to me that we are at a depth of (classified) feet, the greatest depth a submarine has ever been, and that we have attained a speed of (classified) knots, the highest speed any submarine has ever attained. This is the first congressional committee that has ever deliberated so deeply and so fast.

Senator ANDERSON. I am happy to participate in this second record-breaking action. The members of the Joint Committee are very confident that you and your team will continue to lead the world in this area. There is no argument about it. There may be arguments about other programs, but in this one there isn't.

Admiral RICKOVER. I would like to thank the gentleman of the Joint Committee. Without your constant help we would not have this submarine or any other of our nuclear-powered ships.

Senator ANDERSON. More money has already been spent on the nuclear airplane than all the research and development money spent on nuclear submarines, including the cost of your land prototypes and your laboratories, and all of your research and development, and the complete cost of the reactor plants for the first two nuclear submarines; isn't that correct, Admiral?

Admiral RICKOVER. Yes, sir.

Senator JACKSON. I know the entire committee congratulates the captain of the ship and the entire crew for the very competent job they are doing in getting the *Skipjack* ready for acceptance during these trial runs and for the new records they have just established.

Senator PASTORE. Would it violate any rules for us to say publicly we have done this?

Admiral RICKOVER. No, sir, not that you have traveled at a depth in excess of 400 feet, and that you traveled faster than any submarine has ever traveled. (See p. 24.)

Senator ANDERSON. That doesn't mean anything in itself. Has there been any published speed of any of the nuclear submarines?

Admiral RICKOVER. The only figure released publicly is that they can make over 20 knots and go deeper than 400 feet. The British say one of their submarines made 27 knots.

Senator ANDERSON. There are reasons why a nominal speed and depth are given?

Senator PASTORE. Are the figures 400 feet and 20 knots used because they are the figures for a conventional submarine?

Admiral RICKOVER. No; that speed was laid down by President Truman in a speech he made at the *Nautilus* keel laying. The President decided to say "in excess of 20 knots" and that is the figure that has been used since that time.

Senator ANDERSON. Will you tell us about reactor safety? The danger to the people on it? The danger to people who come near it? Is there any danger? Can you tell us that?

Admiral RICKOVER. Yes, sir. I would like to spend a little time on that, if I may. I think it's very important. First, before getting to the details of the safety of any one ship, I must tell you that there is a question in some people's minds as to whether the AEC has any responsibility at all for the safety of these ships once they have been turned over to the Navy.

Representative HOLIFIELD. I think the law is very clear on that. It was certainly intended to be. We have a copy of the act here. Let me read you the pertinent section from the law. The Atomic Energy Act of 1954 states:

CHAPTER 14, GENERAL AUTHORITY

SEC. 161. GENERAL PROVISIONS.—In the performance of its functions the Commission is authorized to—

b. establish by rule, regulation, or order such standards and instructions to govern the possession and use of special nuclear material, source material, and byproduct material as the Commission may deem necessary or desirable to promote the common defense and security or to protect health or to minimize danger to life or property;

And if that isn't enough, the Commission is authorized in the next paragraph (161c) to—

make such studies and investigations, obtain such information, and hold such meetings or hearings as the Commission may deem necessary or proper to assist it in exercising any authority provided in this act, or in the administration or enforcement of this act, or any regulations or orders issued thereunder.

This authority carries with it the responsibility to exercise that authority "to protect and to minimize danger to life or property."

The responsibility of the Navy for running its ships in no way relieves the AEC of the responsibility for protecting the public. After all, the AEC and its agents made the uranium, they designed

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and tilt the reactor, and they designed and built the reactor plant and its safety system. They reviewed its safety and then they turned it over to the Navy. Do you think they can now walk away and forget it?

Admiral RICKOVER. I don't, sir. I was just pointing out that some people in the Commission apparently think so. They seem to think the law isn't explicit on this point. They have lawyers researching it right now. They think that the AEC must either run the ships themselves or else forget about them.

Representative HOLIFIELD. But a reactor in a ship, when it's in a port, is just like any big reactor on land. In fact it may be closer to a lot of people than many central station reactors which are located out in the country. The AEC can certainly not look the other way whenever a nuclear ship comes into port and still claim responsibility for protecting the public from civilian reactors.

Senator ANDERSON. Admiral, how do you handle the safety when you turn one of these reactors over to the Navy?

Admiral RICKOVER. It's quite straightforward. Before the *Nautilus* reactor was started we drew up an agreement between the AEC and the Department of Defense which recognized that each agency had a responsibility where the safeguards aspect of naval reactors was concerned. Nobody questioned it then; it is only recently that the AEC responsibility in this area has been questioned. This agreement, and the memorandums of understanding between the AEC and the Navy which followed it, provided that the AEC would present the design of the reactor plant to the Advisory Committee on Reactor Safeguards for a safety review and that the results of this review would be forwarded by the AEC to the Navy for their guidance. The reactor plant would then become the responsibility of the Navy, except that the Navy was obligated to make available to the AEC all pertinent information and data concerning operation, including safety standards and operational experiences.

This arrangement has worked well. The Navy, after considerable study, has set up a procedure whereby nuclear ships do not go into ports without authorization from the Chief of Naval Operations. He makes the decision, but he seeks out the advice of the AEC. In accordance with the terms of the memorandums of understanding between the Navy and the AEC, this is done informally with me and my people on a day-to-day basis, and the Chairman of the AEC is officially informed whenever basic policy matters are involved. For example, the Chief of Naval Operations has sent letters to the Chairman of the AEC forwarding naval instructions for nuclear ships regarding operation, selection, and training of personnel, and maintenance and repair of the nuclear plants.

Representative HOLIFIELD. Admiral, since these naval instructions form the basic policy by which the Navy operates its nuclear ships, I would like to see them put into the record, along with Admiral Burke's letter to the AEC. (Admiral Burke's letter is classified and is on file with the Joint Committee.)

(The instructions referred to follow:)

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DEPARTMENT OF THE NAVY,
BUREAU OF SHIPS,
Washington, D.C., February, 25, 1958.

BU SHIPS INSTRUCTION 9890.4

From: Chief, Bureau of Ships.

To: Commander in Chief, U.S. Atlantic Fleet.
Commander in Chief, U.S. Pacific Fleet.
Commander Submarine Force, U.S. Atlantic Fleet.
Commander Submarine Force, U.S. Pacific Fleet.
Commanders, Submarine Squadrons.
Commanding Officers, All Submarine Tenders.
Commanding Officers, All Nuclear Powered Ships.
Commanders, All Naval Shipyards.
All Industrial Managers, USN.
All Assistant Industrial Managers, USN.
All Supervisors of Shipbuilding, USN, and Naval Inspectors of Ordnance.
Commanding Officers, U.S. Naval Ship Repair Facilities.
Commanding Officers, All U.S. Naval Submarine Bases.
Commanding Officers, All U.S. Naval Stations (BuShips).
Commandants, All Naval Districts and River Commands.

Subject: Repair and Maintenance of nuclear propulsion plants for naval ships.

Reference: (a) OPNAV Instruction 03000.5 of February 6, 1958; (b) BuPers instruction 1540.38 of December 31, 1957.

1. *Purpose.*—This instruction is to emphasize for nuclear-powered ships that:
 - (a) Any repair and maintenance to the propulsion plant must be accomplished in accordance with procedures specifically approved for that class of ship.
 - (b) Any changes to the propulsion plant must receive prior approval of the Bureau of Ships.

2. *General requirements.*—

It should not be assumed that repair and maintenance procedures prescribed for nonnuclear propulsion plants will be applicable to nuclear plants. Failure to follow procedures specifically approved for repair and maintenance of a nuclear plant could adversely affect reactor safety. Therefore, the instructions contained in the ship's powerplant manual must be strictly adhered to and any deviations which appear to be necessary must receive approval from the Bureau of Ships.

It may not always be apparent to personnel in working on propulsion components and systems of nuclear-powered ships that reactor safety may be involved. It is, therefore, of the utmost importance to insure that no inadvertent changes are made, through nominally routine maintenance, which could adversely affect reactor safety.

The longstanding requirement that any changes in a propulsion plant must receive prior approval from the Bureau of Ships is especially important for nuclear plants. This is necessary because of the possible consequences of a casualty in a nuclear plant and the obligation of the Navy to keep the Atomic Energy Commission informed of any changes which could affect reactor safety. The importance of providing the highest degree of safety in operation of nuclear-powered ships is established by the Chief of Naval Operations in reference (a). Reference (b) states the program of the Bureau of Naval Personnel for insuring that a high standard of selection, training, and qualification is maintained for operators of nuclear-powered ships.

3. *Effective date.*—This instruction is effective upon receipt.

H. G. RICKOVER,
Assistant Chief of Bureau for Nuclear Propulsion.

Distribution list:

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Representative HOLIFIELD. This operating instruction makes it clear that the Navy is responsible for operating their ships but that

Is the AEC has statutory responsibilities to protect the public. Is anyone objecting to that?

Admiral RICKOVER. There seems to be one school of thought that if the Navy is responsible for the ships then the AEC should stay out of it.

Representative HOLIFIELD. Even where the safety of the public is concerned?

Admiral RICKOVER. Apparently. I would assume myself that the Public Health Service and the Civil Aeronautics Authority in their respective fields would provide adequate legal precedent for an agency being held responsible for protecting public safety without being given policing authority; but this view is not universally accepted.

Representative HOLIFIELD. I certainly agree with your viewpoint on that. And I'm sure the public thinks so—which is also important. Why, if the AEC has no responsibility to protect the public, maybe we'd better look at their appropriations more closely. I've always thought that we were paying for this public protection. If not, we should eliminate some jobs. Have you been acting as if you had responsibility in this matter, or not, Admiral?

Admiral RICKOVER. I have always taken the stand that *res ipsa loquitur*, the action speaks for itself, and that the Atomic Energy Commission is responsible. Acting on this basis, I have worked with the Reactor Safeguards Committee since it was founded, and with its Chairman and other members of that Committee for many years before that. It was first an advisory committee without statutory authority. In 1957, I believe, that was changed and the Committee was established by statute. However, it still does not have independent status. It reports to the Chairman of the Atomic Energy Commission. At any rate, at the time we were developing the *Nautilus* we held frequent meetings with them and they passed on every phase of our design. Finally they approved our design and they approved our operating the reactor alongside the dock. Later they approved operating out of New London, and finally more general operation. The *Seawolf* wasn't approved by them for general operation because it was sodium cooled and the Reactor Safety Committee never did give us the same kind of approval to operate; for this reason we always restricted her operation.

The point is that we have always taken the attitude that it was our personal responsibility to the people in surrounding areas. As I interpret the Atomic Energy Act, the onus for protecting the public rests on the Atomic Energy Commission. The Safeguards Committee also looks to me and my people to give them personal assurance that we are watching the safeguards aspects of these ships closely.

I would like to illustrate this by reading you some excerpts from their letters to the AEC regarding naval reactors.

I understand that the AEC is furnishing your committee with copies of letters they have received from the Safeguards Committee. In the present context you might be interested in some excerpts. They fall into two categories: first, expressions of concern over the hazards of operating naval reactors in port; and second, expressions of their confidence in the close safeguards review which I and my people are giving these ships and their belief that such review should be continued.

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Representative HOLIFIELD. Admiral, may we have those for the record?

(The excerpts referred to follow:)

I. EXCERPTS FROM LETTERS FROM THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS) AND FROM THE ATOMIC ENERGY COMMISSION EXPRESSING CONFIDENCE IN, AND NECESSITY TO CONTINUE, CLOSE SAFEGUARDS REVIEW BY THE NAVAL REACTORS BRANCH

1. Excerpt from minutes of Advisory Committee on Reactor Safeguards transmitted by a letter from the Director of Reactor Development, U.S. Atomic Energy Commission, to the Chief, Bureau of Ships, on April 21, 1955:

"(d) These conclusions and recommendations are based in part on consideration of the high degree of training which has been given the present operators and the extent of technical review of design and operation presently being conducted. The committee feels that maintenance of high standards in both of these regards is essential to continued safe operation."

2. In transmitting these recommendations the Director of Reactor Development, AEC, stated:

"This program has borne the responsibility of establishing policy for the routine operation of a power reactor in a populated area, as well as for special problems associated with mobile reactors, and the satisfactory solution to the hazards problems achieved in the case of the *Nautilus* has been the result of continuing effort by the staff in the Naval Reactors Branch and the Bureau of Ships responsible for this program. Many of the problems involved have been unprecedented. It is important that future problems of this type receive the same careful and thorough attention."

3. Excerpt from letter from Chairman, ACRS, to General Manager, AEC, dated July 12, 1957, subject, "Fleet Operations, *Seawolf*."

"The committee considers that an important factor in achieving this safety record was the high quality and degree of review afforded by the Naval Reactors Branch of the Division of Reactor Development during design and initial operation of these ships.

"In order to insure continued safe operation of nuclear powered naval vessels the committee urges that such review be continued throughout the operation of all nuclear powered naval vessels. This review should include all aspects of design, operating procedures and operational plans which could affect reactor safety; it should also include training and qualification of personnel who operate or maintain naval nuclear propulsion plants."

4. Excerpt from letter from Chairman, ACRS, to Chairman, AEC, dated September 19, 1957, Subject: "U.S.S. *Skate*, SSN578":

"This conclusion is based, as was the case for the *Nautilus* and *Seawolf*, on the Committee's understanding that the same careful surveillance as was exercised by the Naval Reactor Branch in the design of the prior nuclear propulsion plants also will be applied to those aspects of design, training, operating procedures, and plans which could affect the reactor safety of the *Skate*."

5. Excerpt from letter from Chairman, ACRS, to Chairman, AEC, dated August 5, 1958, subject "S5W powerplant":

"The Naval Reactors Branch has demonstrated its ability to monitor the design and construction of nuclear powered vessels and to develop well-trained operating crews.

"The Advisory Committee on Reactor Safeguards, however, wishes to point out that nuclear power ships are not completely free from presenting a possible hazard to the public. There exists an ever-present low-level risk of release of radioactivity * * *

"The Committee reiterates that the prime assurance of safety during building, operating, and repairing nuclear ships at various locations depends upon the proper prior evaluation of potential hazards. This must be done for each new situation and at present, on a case-to-case basis, by persons having a detailed knowledge of the factors influencing reactor safety. This requires that the training of officers and crews of nuclear ships must continue to emphasize knowledge of reactors and reactor safety. It also means that the experience and technical judgement of the Naval Reactors Branch must be utilized to the maximum extent in evaluating such operations. The problem assumes increasing importance as the number of nuclear powered ships increases."

6. Excerpt from letter from Chairman, ACRS, to Chairman, AEC, dated November 12, 1958:

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"As the request of the Chairman of the Commission, Admiral Rickover described to the Committee the pertinent experience and lessons learned in the naval reactor program. The Navy's desire to bring nuclear submarines into various populous ports has resulted in considerably more of such operations than the Committee had envisioned when it first commented on nuclear submarine operation. The Committee wishes to repeat the point it has emphasized on previous occasions that entry of nuclear ships into populous ports cannot yet be considered routine or entirely without risk. In this situation, the Committee depends heavily on the technical judgment of the Naval Reactors Branch to evaluate the risk as compared with the necessity for each case. Such judgment by persons responsible for and experienced in the problems of reactor design and hazards evaluation should not be replaced by rules or by routine decisions by persons not knowledgeable in the technical factors involved.

7. Excerpt from letter from Chairman, ACRS, to Chairman, AEC, dated March 16, 1959:

"During the review of the SIC, Admiral Rickover commented on the recent sea trials of the *Skipjack*. It was stated that the nuclear powerplant of the *Skipjack* demonstrated completely its stability and reliability during radical maneuvering, thus proving the basic emphasis placed on safety by the naval reactors group during the design, construction, testing, and operation of naval reactor plants is worthwhile. The ACRS continues to consider it essential that such basic emphasis on safety be continued."

II. EXCERPTS FROM LETTERS FROM THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS), AND FROM THE ATOMIC ENERGY COMMISSION EXPRESSING CONCERN OVER HAZARDS OF OPERATING NAVAL REACTORS IN PORT

1. Minutes of the February 17, 1954, meeting of the ACRS:

"The committee again recommended for long-range planning that serious consideration be given to providing a truly safe base for nuclear powered ships where testing, unloading operations, etc., can be conducted without public hazards even under wartime conditions."

2. Letter of July 12, 1957, from the Chairman, ACRS, to General Manager, USAEC:

"The committee believes that the operation of the *Seawolf* should not be unrestricted and would like to see the Navy develop principles upon which suitable ports may be selected and designate certain specific ports for operation based upon an evaluation of the hazard problem."

3. Letter of September 19, 1957, from Chairman, ACRS, to Chairman, AEC:

"The committee is concerned that with increasing numbers of nuclear powered ships the risks associated with operations in populous ports is intrinsically larger. It is suggested that any plans for operations of nuclear ships take this fact into consideration. Since the continued safe operation of the Navy's nuclear powered ships has an important bearing on the development of the entire reactor program in this country, the committee would be interested in learning of any general plans and criteria which the Navy may be developing for the operation of nuclear vessels in port."

4. Letter of March 8, 1958, from Chairman, ACRS, to Chairman, AEC:

"The ACRS has received OPNAV 03000.5, BuShips 9890.4 and BuPers 1540.38. It is sympathetic to the position taken in which nuclear safety is to be insured primarily by the action and decisions of personnel trained specifically to deal with nuclear systems and their hazards.

"The committee endorses the present Navy practice to consult with and to be guided by the Naval Reactors Branch regarding reactor safety and operational procedures for nuclear powered ships. It considers this practice to be important and urges its continuance.

"To maintain the present admirable safety record of nuclear powered ships, the committee emphasizes the importance of keeping to a minimum consistent with military necessity the number of ports which nuclear powered naval ships may enter, pointing out that as the number of nuclear powered ships increase, consideration should be given to the designation of ports or bases where multiple berthing may be permitted."

5. In transmitting the above comments by memorandum dated April 8, 1958, the Director of the Division of Licensing and Regulation, AEC, stated:

"The three operational documents (OPNAV Instruction 03000.5, BuPers Instruction 9890.4, and BuPers Instruction 1540.38) seem to us to represent a good approach to the problems of operating criteria for nuclear vessels in coastal areas. We believe, however, that eventually the Navy may need to make more

definitive the boundaries and limitations of the guiding principles (a) to (a) of 3.d(1) of OPNAV Instruction 03000.5 within which vessel commanders make decisions in particular situations."

6. Memo from Director, Licensing and Regulation, AEC, to Director, Reactor Development, AEC, dated May 28, 1958, Subject: Proposed operation of the U.S.S. *Skate* (SSN-578) and *Skate* follow ships (SSN-579, 583, 584 and SSG(N) 587):

"In summary, it is our belief that there is reasonable assurance that the proposed operations of these submarines can be conducted without undue hazard to the health and safety of the public. However, as suggested in our previous memorandum of April 8 concerning the criteria and procedures developed by the Navy to assure safe operation of nuclear ships in populous areas, we believe that it may not be completely adequate to rely on the decisions and judgments of the commanding officers in all situations that might develop in the operations of nuclear powered vessels. Rather, it is our belief that eventually the Navy may wish to make more definitive the boundaries and limitations within which vessel commanders can make decisions concerning the operation of their ships in particular situations."

7. Memo from Director, Licensing and Regulation, AEC, to Director, Reactor Development, AEC, dated August 29, 1958, Subject: Hazards review of S5W core 2:

"In view of the increasing number of nuclear ships now in prospect, we recommend development of operational policies and procedures under which the present degree of safety will not decrease with increasing numbers of vessels. As we suggested in our comments with regard to the *Skate* follow ships, more definite guidelines should be available to ship commanders so that their decisions concerning operation near populated areas may rest on more deliberately prepared bases; and, as suggested by the ACRS, there is need for beginning the systematic development of environmental information on coastal areas in which nuclear ship operation is contemplated."

Representative WESTLAND. You say an order was sent out by CNO and it said a ship could go into a port only if absolutely necessary. That order becomes public. How would that affect the operations of a ship like the *Savannah*?

Admiral RICKOVER. I would imagine the people on the *Savannah* will take the same precautions.

Representative WESTLAND. The fact that CNO has come out with an instruction accepting the responsibility will be known. Won't that scare people?

Admiral RICKOVER. A number of people have asked me about it and I have always said—and the words are contained in the CNO instruction—that the operation of nuclear submarines is not entirely without reactor hazards but should be considered an acceptable risk. Our attitude is that we will not unnecessarily take a risk, even a remote one. We design the utmost safety into them. We review the design and fabrication in detail. Everything involving safety or radiation I get into personally. I am only talking about naval ships now, you understand. The merchant ship program is not mine. I'm sure you are aware that there is concern in some parts of the world about a nuclear ship going into a port. The Danes not letting the *Skate* in, and the attitude of the British about the *Skate* entering one of their ports are examples. As time goes on this may become more of an issue. I say that we have the responsibility to assure the public we are not taking any unnecessary or unreasonable risks.

Representative HOLIFIELD. The section of the law I quoted earlier makes it obligatory for the Commission to retain control of standards and criteria by which any of these reactors are built. That responsibility is centered in the Atomic Energy Commission.

Senator ANDERSON. Is that applicable both when in our waters or out?

Representative HOLIFIELD. I think that any ship that goes into international waters is subject to international law.

Admiral RICKOVER. Once it gets into international waters, the AEC has no control, but wherever it goes the AEC cannot completely escape blame if anything goes wrong with the reactor, because the national law applies.

In any case, the port authorities have the right to decide whether or not they will permit nuclear-powered ships, or any other type ship for that matter, into their ports. What we are doing is that we are trying to establish criteria and experience that will indicate to the public, and that they will gradually accept, that nuclear submarines are safe.

Senator PASTORE. Are we talking about American ports?

Admiral RICKOVER. You can't enter a foreign port either unless prior permission is obtained. The Chief of Naval Operations has ruled that no nuclear powered naval ship can go into any port unless authorized by him.

Now I will tell you just how safe these plants are and to what degree we control the radioactivity.

I have always insisted that reactor plant designs under my cognizance use all reasonable conservatism wherever radiation or radioactivity are involved. I am under continual pressure from many quarters to relax this conservatism by reducing the weight of radiation shielding. I have resisted these pressures and, as a result, our ships have been able to meet even the recently decreased permissible civilian radiation doses without changes in designs or operating procedures. In all matters where shielding, radiation, or safety are concerned, I personally go over the designs. I lay it all out and go over it in detail and approve it myself. No one else in my organization has that authority. I will not delegate that authority to anyone. I consider it that important.

We have gone about as far as we can in reducing radiation and increasing shielding. Further restrictions with regard to radiation or radioactivity could impair the military effectiveness of our nuclear-powered naval ships. This even applies to civilian reactors. Further radiation restrictions would also impose an intolerable expense and administrative burden on the civilian reactor program.

Because of the current interest by Congress and the public in these matters of radiation I have recently reexamined this subject in considerable detail and in particular the question of what it would mean to reduce the permissible radiation levels still further on our ships or at the Shippingport Atomic Power Station. I have reached the following conclusions:

First. Using present radiation standards, nuclear-powered naval ships and the Shippingport station provide adequate protection for the reactor plant operators and for the public.

Second. Radioactivity discharged to the environment by naval reactors and by the Shippingport station is insignificant; it has been shown to be so small as to have no detectable effect on the environment. The amounts of radioactivity discharged are trivial compared with that discharged by some other reactors now considered acceptable.

Third. Further lowering of the permissible levels of radiation and radioactivity would pose serious problems by requiring heavier shielding on ships, by restricting the performance of maintenance on

all reactor plants, by increasing the difficulty of controlling large quantities of radioactivity in air and waste water, and by complicating the problem of measuring and monitoring radiation and radioactivity.

I will explain the basis for these conclusions in more detail.

First I will discuss radiation and shielding.

Present naval reactor shielding meets all existing civilian radiation standards and recommendations, and in addition has the following built-in factors of conservatism:

Present AEC radiation standards, based on recommendations by the National Committee on Radiation Protection and Measurement, permit up to 15 rem in any one year, so long as a person's accumulated dose does not exceed 5 times his age beyond 18 years. To insure always meeting this latter requirement we design our shielding for 5 rem per year.

In our designs we make certain conservative assumptions as to how long a man might stay, on the average, at various locations, and what the average power level of the reactor will be.

We also design the shielding so that the highest radiation level in any compartment will not exceed specifications, and this means that the average radiation levels in each compartment are considerably lower than this.

There are many other factors which we cannot predict precisely but which help reduce radiation. We do not count on any of these in our shielding design. This includes such things as the shielding effect of various equipment, contents of tanks, etc. which may not always be present.

These factors give us considerable conservatism for the average crew member under average conditions. Our records show that the average person in the engineering department of a naval nuclear-powered ship has been receiving about one-half rem per year.

However, the shielding must be designed for the worst case, not the average case. The highest doses received by any person aboard each nuclear ship thus far have been about 1 or 2 rem per year. In addition, there are other factors which will tend to increase the radiation received by personnel in the future. For example, the *Nautilus* and the *Seawolf* first operated about 1,000 full power hours per year; but current operations of nuclear ships are about double that figure, and may increase still further.

In addition to the normal operating doses, allowance must be made for radiation received during maintenance. We must assume that as the ships get older the number of hours spent on maintenance will increase.

We must also assume that the radiation levels encountered in reactor plant maintenance will increase as more reactor operating hours are accumulated.

These factors indicate that although radiation doses received by naval personnel to date have been low, they may increase, and a further reduction in permissible radiation levels would require added shielding. Any additional shielding sufficient to effect a significant decrease in radiation levels throughout the ship would result in serious weight increases. In many cases shield weights could not be so increased without direct impairment of military characteristics.

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In addition to the question of weight, the problem of monitoring radiation levels even lower than those now maintained would be difficult. Present permissible levels for neutrons are already below practical detection limits and dependence must be placed on gamma monitoring, supplemented by occasional laborious counting of microscopic neutron tracks in special nuclear emulsions. Even the present permissible gamma levels are so low that they present a difficult monitoring problem.

Next I will discuss radioactivity in the ship's atmosphere.

Present permissible levels for radioactivity in air are also so low that they are near the limit of detectability of available radiation monitoring equipment. If these permissible levels were to be reduced any further, detection and monitoring could become a serious burden, since every fluctuation in normal background radiation would have to be assumed to be significant. We are already at the point where wristwatches must be sealed up in soldered cans during any submergence of more than a few days because radon from the watch dials would otherwise build up in the ship's atmosphere to greater than present permissible levels. This has actually been observed experimentally, and because of this we have prohibited use of radium on nuclear submarines for the usual purposes of luminous dials and switches. In the few cases where stock items containing radium were inadvertently brought aboard, their presence was easily detected by the ship's monitoring equipment. This is indicative of how low the radiation levels are that we are currently maintaining.

Another aspect of the permissible air activity problem involves leakage of water from the reactor system. The water normally contains radioactive impurities at or below current permissible drinking water levels. Leakage of this water into the air normally creates no hazard. However, if permissible airborne radioactivity levels were decreased, this situation could then be defined as "intolerable" or "not permissible." Not only minor leaks, but routine operations such as sampling, venting, draining, and minor maintenance could lead to fluctuations in background radioactivity. Decreasing permissible airborne radioactivity levels might require that during such fluctuations, if detectors could be built to detect reliably such low levels, all personnel would have to wear respirators. This is not a safe, desirable, or effective way to work. This point is particularly important in a military craft where survival may depend on the crew operating at maximum effectiveness.

Now let me cover disposal of radioactive wastes.

Present Navy instructions, worked out in cooperation with the AEC and with the U.S. Public Health Service and cognizant local public health authorities, permit water from nuclear-powered naval ships to be discharged into harbors when it contains radioactivity less than 100 times the drinking water tolerances defined in National Bureau of Standards handbooks. Reactor cooling water in our ships normally runs, at full power, at or near drinking water tolerance for iron 59, somewhat less for tungsten 187, and considerably less for all other isotopes. Operating instructions to the ships state that radioactivity levels 10 times higher than normal indicate undesirable plant chemistry which should be investigated and corrected. This level has never been reached in any of our ships.

During 1958 the *Nautilus* and the *Skate* together discharged radioactive water into New London Harbor a total of 84 times. Each time, the quantity of water discharged and its radioactivity were measured and recorded; at no time was the permissible radioactivity limit exceeded. The records show that a total volume of 7,500 gallons containing a total radioactivity of only 0.4 curies was discharged. Stringent monitoring of the water and air in the immediate vicinity of these discharges has never disclosed an increase in environmental radioactivity attributable to these discharges or to any other aspects of the operation of nuclear-powered ships. These surveys are maintained by the Public Health Department of the State of Connecticut in cooperation with the U.S. Public Health Service, the Navy, and the Electric Boat Division. Similar surveys are being carried out at all other shipyards building nuclear-powered naval ships and at Shippingport.

Reduction of the limits on waste disposal might require the ships to have waste disposal systems for handling and treating wastes. These would increase space and weight requirements. As with shielding, such weight and space increases could impair military characteristics of the ships.

The radiochemistry of the pressurized water reactor, or PWR, at Shippingport is similar to that of the naval reactors. The Duquesne Light Co. and the AEC voluntarily applied for a waste disposal permit from the State of Pennsylvania for the PWR. This permit allows the disposal of 0.5 curies per year of mixed radioisotopes into the Ohio River, plus 3,600 curies of tritium. Because of its low energy, the tritium is difficult to detect and presents little biological hazard. By actual measurement, the PWR in 1958 dumped only 0.035 curies of mixed radioisotopes into the river, plus 50 curies of tritium. As with the naval reactors, no effect on the radioactivity of the environment has been detected.

Finally I will draw some comparisons.

It should be borne in mind that under present regulations and operating procedures naval reactors and PWR discharge quantities of radioactivity which are small compared to natural environmental variations and trivial compared with other existing sources of man-made radioactivity. A few examples may be useful:

First let's take wristwatches: As I have stated, the radon from ordinary wristwatches produces more airborne activity than is currently permissible aboard ship.

Next let's take cosmic radiation: The ships' monitoring equipment in engineering spaces and living quarters shows no detectable increase when the reactor is started up and brought to power. Yet these same detectors show a twofold or threefold decrease in the background level when the cosmic radiation aboard is decreased by the ship submerging.

Then consider fallout and natural background variations: The environmental monitoring programs at shipyards and at Shippingport cannot detect the radioactivity discharged to the environment by our reactor plants, yet they show seasonable variations in natural radioactivity and easily pinpoint each major nuclear weapons test by the United States, United Kingdom, or the U.S.S.R.

Now look at waste discharge from other reactors: The 0.4 curies per year discharged from *Nautilus* and *Skate* together and the 0.035 curies per year of mixed activity plus 50 curies per year of tritium at

The Shippingport Station present a striking contrast with the millions of curies per year of metallic radioisotopes discharged by Hanford into the Columbia River, or even with the approximately 1 million curies of argon 41 discharged into the atmosphere annually by the Brookhaven reactor. These figures include only radioactivity produced by activation of the reactor coolant; fuel-processing wastes are not included.

Finally, I should like to mention for comparison, weapons fallout: The number of curies of fission products produced by 1 kiloton of fission weapon detonation is about equal to the number of curies of radioactivity discharged by Hanford each year. Since fission products are more harmful than the same number of curies of the activation products discharged at Hanford, it actually takes less than a kiloton of fission weapon detonation to equal the total contribution of radioactive hazard from Hanford. Of course the radioactivity from weapons testing is widely dispersed compared with that discharged from Hanford or any other stationary reactor. I am comparing only total contribution of radioactivity to the earth's atmosphere and oceans.

To further illustrate these comparisons I have a little table here that shows the equivalent quantities of water which would be contaminated up to the maximum permissible concentrations (MPC's) listed in Bureau of Standards handbooks by waste disposal operations and fallout:

Reactor:	Equivalent amount of water contaminated to MPC per day (average for 1958)
(a) <i>Skate</i> and <i>Nautilus</i> (total radioactivity dumped into New London Harbor).	About 10 gallons each.
(b) Shippingport Station (including tritium).	About 3,000 gallons.
(c) Hanford reactor coolant (into river; excludes fuel-processing wastes).	About 1 billion gallons.
(d) A 1 kiloton fission weapon detonation.	Over 1 trillion gallons per detonation.

I recognize the pitfalls of quantitative comparisons between dissimilar situations, but I believe the contrast is valid.

The conclusions then are these:

Current standards and procedures regarding radiation and radioactivity on naval nuclear-powered ships and at the Shippingport Station provide adequate and reasonable protection for operating personnel and for the public.

The total amount of radioactivity released to the environment by naval reactors and by the Shippingport Station is trivial, based on environmental measurements and on comparisons with other accepted sources of radioactivity.

Any further reduction in permissible levels of radiation or radioactivity would create a difficult monitoring and control requirement, complicate operating procedures, increase costs of equipment and records, and increase weight and size of naval ships.

If further reductions in permissible levels of radiation or radioactivity are enacted, the Navy would have to consider taking exception to them for naval application, based on military necessity and on demonstrated adequacy of present criteria on naval reactor plants.

For these reason, the Navy would probably be unwilling to accept more restrictive radiation standards, and would have to consider con-

tinuing with present practice on the grounds of military necessity and experience to date.

If more stringent radiation standards were to be applied to civilian reactors, the resulting expense and regulatory complexity could well be a decisive factor in stifling the timely development of atomic energy.

I believe the public should be aware of these facts I have given you. We have kept the local and U.S. Public Health agencies fully informed of what we are doing. We work closely with these agencies. I feel that we have a definite responsibility to do so.

Representative VAN ZANDT. Have you had any criticism from these agencies?

Admiral RICKOVER. No, sir. We have explained to them what we are doing, and these public health agencies have always been interested and cooperated well with us.

Representative VAN ZANDT. The water that has been dumped into the harbor—what will happen to it?

Admiral RICKOVER. The water has such a low radioactivity that when it is discharged into the harbor it cannot be detected even right next to the ship. The discharged water merely becomes mixed with the harbor water and flows out to sea.

Senator JACKSON. Would it be possible to dump it only at sea, there would be no question? Is it more convenient to discharge it in the harbor than at sea?

Admiral RICKOVER. In many cases it is not just a matter of convenience; it is necessary to discharge into the harbor. The reactor plant must discharge some water when it is being warmed during startup; this takes place while the ship is in the harbor. To hold this water until the ship is far at sea would require extra tanks and considerable equipment that would all add significantly to space and weight requirements. The radioactivity of the water is so low that we are permitted to discharge it directly into the harbor and it is so low that it cannot even be detected there.

Senator JACKSON. You mentioned 10 gallons of waste water from the ships, Admiral; why can't this be taken out to sea?

Admiral RICKOVER. The 10 gallons is an equivalent quantity of water at drinking water tolerance, Senator. By this I mean that if you put all the curies of radioactivity discharged by the *Nautilus* and the *Skate* on an average day into a 10-gallon pail of pure water, the pail of water would still meet lifetime drinking water tolerances. The volume of the water discharged by the ships actually averaged about 15 or 20 gallons per day, but its radioactivity was lower than drinking tolerance. Of course, a ship will usually go for weeks or even months without dumping any water into a harbor; but when it does some maintenance or has a startup in a harbor, it has to dump as much as several hundred gallons at one time. On a large surface ship this could amount to several thousand gallons at one time. To hold up thousands of gallons for discharge at sea would take more space and weight in the ships than we can afford.

Senator AIKEN. How would the danger of radioactivity from the aircraft carrier compare with the danger of the radioactivity from a submarine?

Admiral RICKOVER. The problem is basically the same. The radiation and shielding criteria are the same. As I said before, I personally go over the shielding design and other aspects of the design

volving radiation or safety. I review it and approve it myself. I consider it my responsibility. I can assure you that the carrier will not present any different or any worse radioactivity problems than the submarine. I also look at the personnel records and the training. We check up and see that the crews are adequately trained.

Senator AIKEN. These facts that you have given us are not classified, are they Admiral? I definitely would like to see them in the record if they are not.

Admiral RICKOVER. No, sir. In the Shippingport and naval reactors programs such information has always been handled on an unclassified basis and has been widely disseminated to appropriate Public Health authorities, to Congress and to the general public. I can give you some examples to illustrate this.

First, all information on the PWR reactor at Shippingport is categorically unclassified, including information on the discharge of radioactivity.

The Duquesne Light Co. of Pittsburgh, Pa. which operates the Shippingport Station, and Westinghouse, who designed the reactor plant, publish periodic unclassified reports, available to the public, which include the latest data on radioactivity in the PWR coolant and on release of radioactivity to the environment. In addition, Duquesne and Westinghouse report quarterly to the State of Pennsylvania in accordance with the provisions of a Pennsylvania waste disposal permit which Duquesne voluntarily applied for. These reports include data on waste disposal and also results of a continuing survey of radioactivity in the environment near Shippingport and also at the AEC's Bettis Plant which is operated for the AEC by Westinghouse.

The AEC voluntarily initiated an environmental radioactivity survey at Shippingport in cooperation with the U.S. Public Health Service more than a year prior to PWR operation. I also arranged with the U.S. Public Health Service to station a Public Health officer at the Pittsburgh Naval Reactors Operations Office of the AEC at the Bettis Plant to follow developments at Shippingport.

Then, as you may know, entire reactor safeguards report on PWR—15 separate reports—is unclassified and has been given wide distribution.

In addition, detailed reports on radioactive waste handling at PWR, at Bettis and at the Knolls Atomic Power Laboratory (KAPL) which designs naval reactors and is operated for the AEC by the General Electric Co. were prepared especially for the Joint Committee's hearings on waste disposal this February. These were detailed technical reports; no data or information were withheld.

Senator AIKEN. What has been your policy on this sort of information regarding the naval reactors?

Admiral RICKOVER. In September 1957, I arranged with the U.S. Public Health Service to have a meeting of all interested Public Health officials and scientists at National, regional, State, and local levels. We gave them all of the information available at that time on radioactivity associated with operation of nuclear powered naval ships and their land prototypes. An all-day discussion of these data took place and copies of our technical report summarizing the information were then given to Public Health officials by the U.S. Public Health Service.

I have also arranged with the appropriate local public health authorities, through the U.S. Public Health Service, to conduct continuing cooperative radioactive surveys at each location where nuclear powered naval vessels are being built.

A detailed technical report was prepared by my people and submitted to your committee in connection with this year's waste disposal hearings.

Representative HOLIFIELD. I wish that you would supply a copy of that report for the record of this meeting; I remember it provides a detailed explanation of your current Navy waste disposal instructions and criteria, and the technical data which they are based on.

(The report referred to is attached as an appendix to this record, p. 47.)

Admiral RICKOVER. In addition, every effort has been made to acquaint all pertinent responsible public health and medical authorities with our data and program in this area and to solicit their comments. Representatives from the AEC's Division of Biology and Medicine, the Advisory Committee on Reactor Safeguards, the National Committee on Radiation Protection and Measurement, the Navy's Bureau of Medicine and Surgery, the AEC's Division of Reactor Development and the AEC's Division of Licensing and Regulation, as well as individual scientists and engineers, have been kept fully informed. We have also held detailed discussions on our data and plans with prominent and responsible scientists and officials in the fields of meteorology and oceanography. For example, we have supplied all of our information on waste disposal to the National Academy of Sciences Committee on Oceanography which is currently publishing a report on waste disposal from ships.

Senator ANDERSON. I am pleased that you have not withheld any of this information, Admiral. I just got a study of fallout that Los Alamos finished in 1956 and cleared 2 days afterward and it was just cleared by the AEC recently.

Admiral RICKOVER. We do feel our responsibility for the public. If the public, or your committee, thinks we are not carrying out our responsibility, I hope you will say so. I have always tried to put myself in your place in determining what we should do. I never want your committee to think that I do not feel this responsibility. We have to be able to certify that there is no danger.

Senator ANDERSON. What you have said is that the public need not worry about submarines?

Admiral RICKOVER. They need not worry about nuclear submarines as long as we keep on watching them as we have. It is very dangerous to be negligent where radiation is involved. Everyone must be aware of it and act accordingly. There are a considerable number of people who are incapable of making a distinction between ordinary death or injury and injury by radioactivity. You have to think many years in the future. Radioactivity may inflict greater injury on our posterity than on ourselves. We are responsible for future generations too.

Senator ANDERSON. Admiral, on behalf of the committee, I wish to say that this trip and this meeting have given us an excellent picture of the important work you are doing. We have a strong feeling of

pride for this nuclear navy, and a great deal of confidence in your work. We are highly pleased to have this opportunity to meet with Captain Behrens and the fine officers and crew of this submarine.

Representative HOLIFIELD. I would like to say on my behalf and on behalf of my colleagues in the House, that we join Senators Anderson, Jackson, and Aiken in a feeling of pride and confidence in the operations and development of these nuclear submarines and we extend on behalf of the Members of the House on the Joint Committee to the Admiral and Captain Behrens our sincerest thanks and congratulations.

Mr. RAMEY. What is the status of the natural circulation reactor? Are you any closer to getting any money? What is your situation in getting money or authorization for it?

Admiral RICKOVER. We are in exactly the same status we have been for a long time—on dead center. I told your committee on March 23 if we didn't get funds for it this fiscal year we would lose a lot of time. As far as I know, nothing has been done. So, unless the Joint Congressional Committee acts, nothing will be done.

Senator JACKSON. How much is needed to initiate it?

Admiral RICKOVER. The total cost for the land prototypes will be \$18½ million. We need authorization for it in fiscal year 1960. We need authority to obligate \$6 million and to spend \$2 million.

Senator JACKSON. Which year?

Admiral RICKOVER. This current fiscal year—the one you are working on now, fiscal year 1960.

Senator ANDERSON. Why do you think the natural circulation system should be developed? What are its advantages?

Admiral RICKOVER. The basic consideration is simply that it is simpler. It is more reliable. There are fewer parts. The more parts and machinery you have, the more difficulties you have. With such a reactor we will be able to eliminate all the primary coolant pumps and check valves, and all the electrical supplies and controls that go with them. This also makes the plant more efficient and quieter. This added reliability is particularly necessary because we expect to use these submarines under the ice. We want to make them as reliable as possible.

Representative VAN ZANDT. What does the Director of Reactor Development think about this?

Admiral RICKOVER. Dr. Libby asked him to appoint a board to look into the natural circulation reactor. He convened this Board and then recommended to Dr. Libby that we go ahead. But the Commission still took it out of the budget. Year after year the General Advisory Committee to the AEC meets and accuses me of not being venturesome enough. Recently another committee set up by one of the offices in the Department of Defense said I wasn't venturesome enough. Yet whenever I want to do something I can't get support. What does one do in a situation such as this? It is completely illogical and contradictory.

(Discussion off the record.)

Representative VAN ZANDT. Has the Department of Defense set a military requirement for the natural circulation reactor?

Admiral RICKOVER. Yes, sir.

Representative VAN ZANDT. Will you put the letter into the record.
Admiral RICKOVER. Yes, sir.
(The letter referred to follows:)

ASSISTANT SECRETARY OF DEFENSE,
Washington, D.C., September 3, 1958.

Mr. JOHN A. McCONE,
*Chairman, U.S. Atomic Energy Commission,
Washington, D.C.*

DEAR MR. McCONE: Recent studies indicate that it is feasible to develop a pressurized water reactor plant for submarine application in which the reactor coolant would be circulated by natural convection, eliminating the need for the large coolant pumps, coolant check valves and associated electrical power equipment required in current designs. Successful development of a natural circulation reactor could result in substantial improvement in simplicity, reliability and inherent safety of naval pressurized water reactor plants. These potential improvements are highly desirable, particularly for nuclear submarines which may operate in Arctic regions.

It is therefore requested that the Atomic Energy Commission undertake the early development and test of a natural circulation pressurized water reactor plant of (classified) shaft horsepower for submarine application.

Your cooperation with the Department of the Navy in the development of this plant will be greatly appreciated. Detailed guidance in connection with the development will be furnished through the Naval Reactor Branch of the Bureau of Ships.

Sincerely,

HERBERT B. LOFER,
Assistant to the Secretary of Defense (Atomic Energy).

Senator ANDERSON. What about the Shippingport reactor?

Admiral RICKOVER. We designed that reactor for 60,000 kilowatts of electricity. When we started working on it we hoped that we might get more power. Accordingly, there was installed at Shippingport a generating capacity of 100,000 kilowatts. About a year ago we started to design the second core for the reactor. As the development of the core and its fuel elements progressed, it became apparent that we might be able to get as much as 150,000 kilowatts out of the core. Your committee and the AEC authorized us to develop the Shippingport plant, and the cost to the Government and to the Duquesne Light Co. has been about \$120 million.

Now by spending another \$20 million we can increase the plant generating capacity to 2½ times the original rating of 60,000 kilowatts. It is also possible that when we get to the third core for PWR we may get still more power. I therefore would like to put in an additional turbogenerator of 75,000 kilowatts capacity, to bring the total capacity to 175,000 kilowatts and permit us to take full advantage of the potential of the Shippingport plant. However, before we can proceed with this, the necessary funds have to be appropriated. Of the \$20 million needed approximately \$15 million is for the increase in generating capacity and \$5 million for modifications to the reactor plant.

Incidentally, the difference in cost between a 50,000-kilowatt and a 75,000-kilowatt generator is small, so that it is worthwhile to put in the larger size generator to be sure that we can test the plant to its maximum power capability. I have discussed with the chairman of the Duquesne Light Co. the possibility of Duquesne furnishing the \$15 million for the generator expansion, and he is currently studying this. It will take about 3½ years to install this generating equipment, and so if I do not get the money and authority to proceed with this modification this fiscal year, the plant will not be ready

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to the full capacity of the new reactor core, and the project will be delayed considerably. Actually all I need to spend in fiscal year 1960 is about \$2 million.

I have been asked: Instead of increasing the generating capacity at Shippingport, why not install a condenser to get rid of the excess steam generated by a 150,000 kilowatt core? While this is technically feasible, I believe that the waste of such large amounts of energy would be unwise and unjustifiable. It would be a waste of our most valuable material resource just to burn up uranium and dump the steam into a condenser. The Nation can make good use of all the electric power it can get.

Another suggestion we have had is to not increase the Shippingport generating capacity but to install a second core of only 100,000 kilowatt capacity instead of 150,000 kilowatts. If we did this, we would never really find out if the Shippingport reactor plant is capable of putting out any more than 100,000 kilowatts. The whole reason for designing and building the Shippingport plant in the first place, and the intent of Congress in approving it, was to advance our reactor technology so that people both here and abroad can benefit. Also, the design of a 100,000-kilowatt core is technologically easier than a 150,000-kilowatt core, so we would not be faced with solving difficult problems which we must face and solve if we are to make real advances in this reactor business, advances which are necessary if we are ever to make competitive atomic power.

As I have said before, if I don't get some money and authority this fiscal year the project will be delayed considerably.

Representative HOLIFIELD. Are you requesting \$5 million to do the alterations or are you asking for the full \$20 million?

Admiral RICKOVER. You could provide in the legislation for the entire amount if industry doesn't furnish any.

Senator ANDERSON. They have to come up with the money, or forget it.

Admiral RICKOVER. Would you want to spend more later and have a delay, too?

Senator ANDERSON. We will be going into partnership with a public utility. You will get into a whole lot of objections on that. It is a good deal for us, but it is also a good deal for Duquesne.

Representative HOLIFIELD. We could make it "providing Duquesne puts up \$15 million."

Senator ANDERSON. If it is put that way, you might get some support for it. You know the Comptroller has written a letter about that plant up there.

Senator JACKSON. How long before Duquesne will let you know?

Admiral RICKOVER. Probably a couple of months. They have to figure what power they are going to need in that area in the future. It is a large expenditure for them. They are now paying us 8 mills per kilowatt-hour, which is about what their oldest plants cost them.

Senator AIKEN. What are we getting out of it?

Admiral RICKOVER. Two and one-half times the power from the same basic reactor plant. If we don't do it now, it will cost much more later. The whole industry both here and abroad is depending on the PWR information and what we are doing to advance the reactor art.

Representative HOLIFIELD. The \$20 million you speak of would consist of \$5 million for the change in reactor plant to adapt it to new generator equipment, and the generator machinery would be around \$15 million. That would not take into consideration the cost of the reactor core?

Admiral RICKOVER. We have separate money for the development of the core. We are going ahead with the research and development. But I can assure you you will make more progress for less money by going ahead now with the 175,000-kilowatt modification.

Representative HOLIFIELD. I think it might be well to call a representative of the company before the committee and ask him.

Admiral RICKOVER. I am meeting with Mr. Philip Fleger, chairman of the board of the Duquesne Light Co., Monday, to discuss this matter with him.

Representative HOLIFIELD. It might be proper to ask AEC Chairman McCone to take it up with Mr. Fleger.

Admiral RICKOVER. Last Tuesday Mr. McCone spoke to the Edison Electric Institute in New Orleans and told them that the second PWR core is estimated to produce 150,000 kilowatts of electricity and that the third core might even exceed that. The point of issue is that we definitely want to have sufficient generating capacity in time to exploit this potential. I hope you will authorize it in this year's bill.

Senator JACKSON. In other words, you are suggesting that we write into the bill \$5 million, contingent upon Duquesne coming up with \$15 million. I would be in favor of that.

Admiral RICKOVER. Yes, sir; but, in order not to delay the project, you could provide in the legislation for the total amount, in the event industry does not furnish it.

Senator ANDERSON. Captain Wilkinson, we are happy you are here with us. Would you care to comment on the operations of our nuclear-powered ships?

STATEMENT OF CAPT. E. P. WILKINSON, UNITED STATES NAVY

Captain WILKINSON. Having had the honor of taking you and other members of your committee on your first nuclear submarine ride 4 years ago, it is a great pleasure to be with you again on this trip. The *Nautilus* was the culmination of a major scientific effort under the inspired leadership of the admiral and was made possible by your support. Most of my Navy career has been spent at sea. How a ship performs at sea means a lot to me. It has to be reliable; it has to run far and fast. The *Nautilus* ran and ran. I could count on her. In the 4 years since she was commissioned, a lot has happened. We have in the *Skipjack* a submarine that is entirely different. It is easier to get at her machinery for maintenance, so that people working at sea in case of necessity can fix it and keep it going for a long period of time. I know that this can't be done cheaply. The things that count—such as reliability, speed, maneuverability—they mean much to me.

It is fabulous that so much has been done in these 4 years.

Captain Behrens and his crew are to be congratulated on their handling of this new model that is so important to the security of our country.

Senator PASTORE. As you build new ones you make improvements and you have to build and try them out.

Admiral RICKOVER. It is more than that, sir. A lot of programs that are presented to your committee are just paper studies, and you never can tell what will come of a paper study, if anything.

A few weeks ago there was an article in one of the Sunday newspaper supplements stating that a man had invented the *Nautilus* in 1946. Well, Jules Verne did it long before that, and Buck Rogers was using an atomic bomb in the comics in 1930. A mere idea and a little paperwork is not enough. There is hardly a single idea that is new. What really counts is to take an idea, fight for the authority to do it, establish the organization, find and train the necessary scientists and engineers, justify to Congress the large sums of money involved, worry over and solve the thousands of technical difficulties. Well, about \$200 million and 8 years after the 1946 "idea," and with the devoted efforts of many, many hundreds of scientists and engineers, and the active participation of many hundreds of companies, we finally had the *Nautilus*.

Ideas and paper studies alone do not solve anything. You run into no trouble until the instant you start the designing and development and the manufacture of the new items. Actually, it would have made no differences if Jules Vernes had never written about the *Nautilus*. No matter what new thing comes out, there will always be thousands of people to say that they were the first ones to have the idea.

Senator PASTORE. I asked you earlier whether or not the *Skipjack* made the *Nautilus* obsolete. Let's assume that the Russians had a *Nautilus* and we had one. Then they get a *Skipjack*. Would our *Nautilus* then be obsolete? In other words, it is not obsolete if you compare it with a conventional submarine.

Admiral RICKOVER. Right, sir; the *Skipjack* can make it pretty tough for the *Nautilus*.

Representative VAN ZANDT. In your new submarines, will you get any more speed out of them?

Admiral RICKOVER. I can't answer that right now. If we redesign it, we may. Higher speed usually means more displacement, more machinery. You always hope for higher speed. Speed is important, because it may make the difference between catching up with a ship and sinking him or just watching him pull away. You can't sink him if you can't catch him.

Representative VAN ZANDT. On the high seas in rough weather, surface ships have to slow down. The *Skipjack* does not.

Admiral RICKOVER. You have been on surface ships and you know that in a rough sea you can't maintain a high speed. I was on a battleship once that could only make 8 knots in a heavy sea, even though we were using close to full power.

Representative HOLIFIELD. How much could she make in a calm sea?

Admiral RICKOVER. Twenty-one knots. I think the *Skipjack* might set a record in a winter crossing of the Atlantic.

During the war we learned from hard experience that surface ships have to slow down in heavy seas. We had cases of the flight decks of aircraft carriers being damaged by the seas when too high a speed was attempted.

Before I close my testimony, Mr. Chairman, I would like to thank the Westinghouse people at the Bettis plant for the outstanding job they did in the design of the *Skipjack* powerplant. And I want to thank Electric Boat and Mr. Shugg for the very fine job they have done. They have designed and turned out these fine ships. The Navy's Board of Inspection and Survey has just completed its inspection of the *Skipjack* and I understand they found it in as fine a state of readiness for war as any new ship they have inspected.

Senator ANDERSON. Mr. Shugg, any comments?

STATEMENT OF CARLTON SHUGG, GENERAL MANAGER, ELECTRIC BOAT DIVISION, GENERAL DYNAMICS CORP.

Mr. SHUGG. I would like to say for the several thousand Electric Boat employees that this is more than just a job for them. They are interested in these ships personally—they are devoted to this new nuclear submarine program and its development and many of them work overtime to get the job done correctly.

Senator JACKSON. It is a real privilege to have Mr. Shugg aboard. I have known him for many years. He was operating Hanford for the AEC at the time the Soviets exploded their first atomic bomb. I think it is fortunate that he is in this field. He is a distinguished graduate of the Naval Academy—graduated third in his class, or was it first?

Mr. SHUGG. Second.

Representative VAN ZANDT. How many subcontractors were there for these submarines?

Admiral RICKOVER. About 500 or 600 I believe. A sizable portion of these are small business firms. Some of our statistics on this are reported in a July 1955 report of the Senate Small Business Committee. The Small Business Committee stated in this report that we had approached 90 percent of the small-business potential. Our record since then has been just as good.

Senator ANDERSON. Thank you Admiral Rickover. And thank you, Captain Behrens, for having us aboard to see the *Skipjack* and to be present when the records were broken. I hope you will tell your men how much the members of this committee appreciate it.

Representative HOLIFIELD. I would like to suggest that we prepare an appropriate news release for the subcommittee that is assembled here and also a message of congratulations to the people that build these fine submarines.

Senator ANDERSON. I will have one prepared.

(The news release referred to follows:)

JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES

[Apr. 12, 1959, for immediate release]

Two new performance records of the USS submarine *Skipjack* were announced today by Senator Clinton P. Anderson, chairman of the Joint Committee on Atomic Energy upon his return from an overnight trip on the submarine with six other committee members and Vice Adm. H. G. Rickover, USN.

Senator Anderson stated:

"While underway and submerged, the Joint Committee held an official committee meeting, during which time the *Skipjack* was going faster and deeper than any known submarine in history. For security reasons, I can only say that we were deeper than 400 feet and moving faster than 20 knots. In 1955 some of us

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also travelled on the *Nautilus* and we were impressed today by the many technical advances and substantial increases in performance that have been achieved in *Skipjack*, including speed, maneuverability, and endurance."

In addition to Chairman Anderson, the following committee members were aboard: Senator John O. Pastore (R.I.), Henry M. Jackson (Wash.), George D. Aiken (Vt.), and Congressmen Chet Holifield (Calif.), James E. Van Zandt (Pa.), and Jack Westland (Wash.).

During the recordbreaking trip, the committee members and staff were given a thorough tour of the new submarine, and participated in high speed maneuvers.

At the underwater hearing held in *Skipjack's* wardroom, Admiral Rickover gave a presentation on the accomplishments of the *Skipjack* and new developments in the naval reactors program. In response to questions, the Admiral explained the safety features of the reactor design and operation of the *Skipjack*.

The committee members stated that the Electric Boat Co. and other participating industrial companies deserved congratulations for a job well done.

Senator Anderson, on behalf of the congressional committee, thanked Commander William W. Behrens, Jr., USN, the Commanding Officer of the *Skipjack*, for the hospitality extended by him, his officers and crew, and for the expert way they put *Skipjack* through its paces.

In closing, Senator Anderson said:

"We are impressed with the tremendous advancements that have been made in the 4 short years that have transpired since the first atomic submarine went to sea."

"The country and all our citizens can be proud of Admiral Rickover and his fine team for achieving for the United States technological leadership in the field of nuclear ship propulsion. The committee, on behalf of the Congress, will recognize these accomplishments at its forthcoming public ceremony, Wednesday, April 15, 1959, when we will present to Admiral Rickover the special Congressional Medal authorized by Congress last year."

The committee and Admiral Rickover were accompanied by Capt. E. P. Wilkinson, USN, Commander Submarine Division 102; Carleton Shugg, vice president, General Dynamics Corp., Electric Boat Division; and James T. Ramey, Executive Director of the Joint Committee Staff.

(The hearing adjourned at 9:43 p.m.)

NAVAL REACTOR PROGRAM AND ADMIRAL RICKOVER AWARD

WEDNESDAY, APRIL 15, 1959

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON ATOMIC ENERGY,
Washington, D.C.

The Joint Committee on Atomic Energy met, pursuant to call, at 2:30 p.m., in room G-308, New Senate Office Building, Washington, D.C., Hon. Clinton P. Anderson (chairman) presiding.

Committee members present: Senators Clinton P. Anderson (presiding), John O. Pastore, Albert Gore, Henry M. Jackson, Bourke B. Hickenlooper, George D. Aiken, and Wallace F. Bennett; Representatives Carl T. Durham, Chet Holifield, Melvin Price, Wayne N. Aspinall, James E. Van Zandt, William H. Bates, and Jack Westland.

Other Members of Congress present: Hon. Lyndon B. Johnson, majority leader, U.S. Senate; Hon. Everett M. Dirksen, minority leader, U.S. Senate; Hon. Herbert C. Bonner, chairman, Merchant Marine and Fisheries Committee, House of Representatives; Hon. Carl Vinson, chairman, Armed Services Committee, House of Representatives; and Hon. Clarence Cannon, chairman, Appropriations Committee, House of Representatives.

Representatives of the Atomic Energy Commission present: Hon. John A. McCone, Chairman; and Vice Adm. Hyman G. Rickover, Chief, Naval Reactors Branch.

Committee staff members present: James T. Ramey, executive director; John T. Conway, assistant director; David R. Toll, staff counsel; Thomas J. Foley and George E. Murphy, Jr., professional staff members; Edward J. Bauser, technical adviser, Joint Committee on Atomic Energy.

STATEMENT OF HON. CLINTON P. ANDERSON (NEW MEXICO), CHAIRMAN, JOINT COMMITTEE ON ATOMIC ENERGY

Chairman ANDERSON. Because of the pressures on the Members of the House and Senate I think we will proceed, although some of our distinguished guests will be arriving a little later.

I do want to explain, ladies and gentlemen, that this is a beautiful room and I regret very much that we had to upset its beauty by arrangement with the Architect of the Capitol to permit these television stands to be erected. There are galleries with equipment for taking pictures which could be utilized. However, since this is the first time this room has been tested this way it was felt these stands would serve much better. Also, a special lens is in reality required from the far booth and they were not available. They will be available in 3 or 4 days. Therefore we paid the price that all people pay

who are trying something for the first time—some little flaw develops. I am as sorry about it as I can be. The fault is that we didn't have a chance previously to become familiar with all of the circumstances surrounding its use.

I appreciate very much the many friends of our distinguished guest of honor who are here today, particularly those who wear the proud uniform of the U.S. Navy. We are extremely proud of our distinguished guest and extremely proud of the people who have come here today to pay him honor. May I say also that it is a matter of great personal joy to me to have on the platform the very able and distinguished Chairman of the Atomic Energy Commission, Hon. John McCone. Would you rise and take a bow, please? [Applause.]

This illustrates the working of pure democracy. We fixed another place for him, put the card in it, and then wouldn't let him sit there. That is as much choice as people have in this world.

I am happy that the officials of the Westinghouse Co., where a great deal of Admiral Rickover's work has been done, are here, and I express my appreciation to Mr. Mark Cresap and the others who have come here also to honor our distinguished guest.

The Joint Committee on Atomic Energy is honored to have with us today those distinguished Americans to whom Congress has entrusted its leadership. We meet on behalf of the Congress to present a special gold medal to Vice Adm. Hyman G. Rickover.

Last year, in the 85th Congress, a joint resolution was enacted unanimously authorizing the Chairman of the Joint Committee on Atomic Energy to confer this medal on Admiral Rickover.

The text of the resolution is in your program and I shall read only a few words from it.

*Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That in recognition of the achievements of Rear Admiral Hyman George Rickover, United States Navy, in successfully directing the development and construction of the world's first nuclear-powered ships and the first large-scale nuclear power reactor devoted exclusively to production of electricity, the Chairman of the Joint Committee on Atomic Energy, on behalf of the Congress, is authorized to present to Admiral Hyman George Rickover, United States Navy, an appropriate gold medal. * * **

Since 1947 Admiral Rickover has been primarily responsible for the application of atomic energy and nuclear power to the propulsion of naval vessels, and in the annals of modern science and technology there have been few efforts more successful than his.

He has contributed immeasurably to the defense of our Nation and concurrently demonstrated the peaceful intentions of the United States in atomic energy. He directed the development and construction of the Shippingport Atomic Power Station—the first full-scale peaceful atomic plant in the United States.

Within the Navy Admiral Rickover made possible a new strategic weapons system of paramount importance in the missile age—the first ballistic missile submarine.

His attack submarines promise the control of the seas in event of war.

The voyage of the *Nautilus* and the *Skate* under the North Pole—and this bottle which Admiral Rickover brought along with him is not a special elixir for throats of individuals who may be speaking here but is water from the North Pole. It ought to be parceled out drop by drop I am sure, but I want you to see that it is very similar to the

when you get at the South Pole if you have been there. (Laughter.) The trip of these ships under the North Pole contributed immeasurably to the prestige of the United States following events like the Soviet sputnik. Members of the Joint Committee on Atomic Energy have just returned from a voyage on the *Skipjack* during which we set two records: we went to a record depth and then traveled at a speed greater than any submarine ever attained.

May I just say to you that the task of trying to preside at a meeting of the Joint Committee at that depth is no small task because these silly individuals keep commenting on that fact that we are giving the deepest thought to our problems and so forth that anybody could ever give.

Anyhow, because of Admiral Rickover our science is richer—our Nation is stronger.

Over the years it has been the custom of the Joint Committee to have Admiral Rickover meet with us for an annual report on the naval reactors program. It occurred to us that it would be fitting and in keeping with the workaday atmosphere of his naval reactors program if we heard today from the admiral on his work with submarines and at Shippingport.

I am, therefore, going to let him go part way through his report and then we are going to break in because some of the Members of Congress have some additional responsibilities for which they must leave. Then we will return to his report. This is also in the best tradition of the Joint Committee on Atomic Energy which has to sometimes jump from subject to subject.

Admiral Rickover, it is a tremendous honor and pleasure to present you to this fine audience and to give you an opportunity to comment on the reactor program.

In the tradition that we have developed we bring Admiral Rickover in and he doesn't prepare an address. We ask him a question and let him freewheel. This will be no different from the ordinary.

Admiral Rickover, how many submarines, ships, and powerplants have been built or are under construction or authorized? This would be commonly known as the James Van Zandt question. Jimmy Van Zandt, who is a good captain of the Naval Reserve—and whom I found to be an excellent navigator of the *Skipjack*—generally starts with this question, so we will start with it today.

**STATEMENT OF VICE ADMIRAL HYMAN G. RICKOVER, CHIEF,
NAVAL REACTORS BRANCH, ATOMIC ENERGY COMMISSION**

Admiral Rickover. Thank you, Senator Anderson. Congress has authorized a total of 33 nuclear-powered submarines. Of the 33, 5 are presently in operation and the others are either under construction or shortly will be under construction. Twenty-two of the submarines are attack submarines. Nine will be capable of carrying the Polaris-type missile. One, the largest submarine in the world, the *Triton*, will be a radar picket submarine which will be fast enough to operate with a task force; the last one is a submarine which will carry Regulus guided missiles.

In addition to the submarine program, Congress has also authorized a nuclear-powered aircraft carrier which is being built by the Newport News Shipbuilding & Dry Dock Co. at Newport News, Va. Congress

has also authorized a nuclear-powered guided missile cruiser and a nuclear-powered fleet destroyer; both are being built by the Bethlehem Shipbuilding Co. at Quincy, Mass.

The naval reactors program is carried out by a group of 120 engineers and scientists at my Washington headquarters who supervise the work of the scientists and engineers of our three nuclear laboratories. These are the Bettis Laboratory at Pittsburgh, Pa., which is operated for the Atomic Energy Commission by the Westinghouse Electric Corp.; the Knolls Atomic Power Laboratory at Schenectady, N.Y., operated for the Atomic Energy Commission by the General Electric Co.; and the Windsor Laboratory at Windsor, Conn., which is owned and operated by Combustion Engineering. At these laboratories there are about 2,000 scientists and engineers together with the supporting people, who work in the naval program. There are, of course, many other additional scientists and engineers who work for the subcontractors who are designing equipment for our program.

We have designed and built five land prototypes for the various types of nuclear-powered ships we are building. These land prototypes are located at the Atomic Energy Commission's Nuclear Reactor Testing Station at Idaho Falls, Idaho; at West Milton, N.Y.; and at Windsor, Conn. At these places the first model of each nuclear plant is tested to determine whether it is suitable. We also conduct many nuclear and engineering experiments in these plants. The total cost of the naval nuclear program to date is about \$800 million. This figure includes the cost of building all of the laboratories, of building the five land prototypes, the cost of all the research and development from the beginning of our program, and even the cost of the propulsion plants of the first two nuclear submarines, the *Nautilus* and the *Seawolf*. We are currently spending on research and development about \$100 million a year, of which 85 percent is supplied by the Atomic Energy Commission, and 15 percent by the Navy.

I believe that the members of the Joint Committee and many in the audience are aware of the tremendous benefits that can be derived from having nuclear power in a submarine. World War II submarines, which operated in the Pacific and did such a valiant job for our Navy and our country were only able to make about 10 miles an hour for only 1 hour, after which they were no longer able to operate submerged because the storage batteries were exhausted. In fact, hardly any submarines ever used more than half their storage battery capacity because they had to reserve battery capacity to permit escape in the event they were attacked by the Japanese.

Nuclear-powered submarines, on the contrary, can travel almost indefinitely at far higher speeds than the conventional submarines. The conventional submarines simply are not capable of making any such high speed. In fact, even today the most modern nonnuclear submarines can only make about 18 knots for half an hour. The *Nautilus* and all our other nuclear submarines can make 20 knots and more. The 20-knot figure was stated by President Truman when he laid the keel for the *Nautilus* in 1952, and we have not been authorized to disclose a higher figure since that time. I hope that the Republican administration will permit us to give a new figure. A conventional aircraft carrier can go about 5,000 miles continuously at full power; the nuclear-powered carrier will be able to steam at full power for about 90,000 miles. The conventionally powered fleet

destroyer can go about 2,000 miles at full power; the nuclear-powered destroyer will be able to go about 150,000 miles.

Representative DURHAM. Admiral, I suppose that since we have had a Van Zandt question we should also ask what we call the Mel Price question because Mel has done such an outstanding job in the Research and Development Subcommittee. What new developments, such as the *Skate* going under the North Pole, have occurred in the past year?

Admiral RICKOVER. The most important development from a technical standpoint is the considerable increase in the life of the nuclear cores which has greatly extended the cruising range of our nuclear-powered ships. This is due to the fact that we have learned how to design and build the nuclear cores in such a way that they will last for much longer periods of time. The increased life is obtained with practically no increase in cost because the major part of the core cost is the fabrication. We can now get cores that last two or three times as long as the first one. We thereby cut the cost proportionately. The tremendous advantage of being able to operate a naval vessel in wartime for indefinite periods of time without having to return for refueling is obvious.

Another advancement has been our ability to use computing machines to help us design nuclear cores. We spend several million dollars a year developing and using new computing machine methods. For example, a calculation which used to require 3 months and many physicists can now be done in less than a day. We just would not be able to develop our advanced reactor cores without these machines and the techniques we have developed for using them.

Another event that has happened is that two new submarine building yards have demonstrated their ability to construct nuclear-powered submarines. These are the Mare Island (California) Naval Shipyard and the Portsmouth (New Hampshire) Naval Shipyard. We have also arranged for additional commercial shipyards to engage in building nuclear-powered submarines. The Ingalls Shipbuilding Co. at Pascagoula, Miss.; the Newport News Shipbuilding & Dry Dock Co. at Newport News, Va.; and the New York Shipbuilding Co. at Camden, N.J. So you see we have considerably expanded our facilities from the early days when the Electric Boat Division at Groton, Conn., the builder of the *Nautilus*, the *Seawolf*, the *Skate*, the *Skipjack*, and the *Triton*, was the only commercial yard building nuclear-powered submarines.

Another item that may be of interest is the industrial strength we have developed to build the many items of equipment needed for our nuclear-powered ships. As you may know, the facilities for building airplanes and missiles are somewhere about 98 percent owned by the U.S. Government. I decided, in establishing the manufacturing capacity to supply us with our nuclear components, that it should be 100 percent industry owned, and that not one dollar of Government money would be used to build these facilities.

Thus, we have now established at least three sources of supply for every item we use, and so we are able to buy the components for our nuclear plants on a competitive lump-sum basis. And these components are being made in facilities that are wholly owned by the companies themselves. In fact, we do not even give these companies

the benefit of a certificate of necessity, which permits a fast amortization of the facilities. This lump-sum competitive purchase of applies to all the nuclear and machinery parts, including even the reactor cores.

There have been operational developments in the past year too, Mr. Durham. To illustrate this, I would like to give you some of the records that have been established.

The *Nautilus*, on her first nuclear core, steamed more than 62,000 miles. A conventional submarine would have used about 2 million gallons of oil in going this distance. And this oil would have required a line of tank cars more than 1.5 miles long. On her present second core, the *Nautilus* has already steamed more than 80,000 miles, and still has energy left in the core. We are now designing nuclear cores that should enable ships to operate for an entire war without refueling.

The *Nautilus* last year steamed nonstop from Honolulu to England, a distance of more than 8,000 miles, during which time she traveled 1,830 miles under the polar ice cap. The *Skate* a few days later went under the North Pole from the other direction, east to west, and then made the shortest circuit around the earth that has ever been made. She went around the earth in 1 hour. She was only 1 mile from the pole, but it is still the record. I suppose some day an airplane will just spin around the pole and so make it in even shorter time; nevertheless, today the *Skate* holds the record for circumnavigation of the globe.

To give you an idea of what a nuclear powerplant can do, in 1956 I had the plant of the *Nautilus* land-based prototype at Idaho Falls, Idaho, operated for 66 days and nights continuously at full power. The distance a submarine would have gone during that period at that power is twice around the world. For conventional ships, the requirement for acceptance by the Navy is that the plant be able to operate for only 4 hours at full power; but we ran that propulsion plant for 66 days and nights continuously at full power. Last year the *Seawolf* stayed completely submerged, on a military exercise for 60 days. She traveled 13,000 miles during that time; she was completely independent of the earth's atmosphere.

Just a few days ago, the *Skate* again steamed under the North Pole. This time she was under the polar ice for 3,000 miles continuously; she demonstrated that we can operate our submarines at will in the Arctic. This also means that when we have developed submarines that can carry Polaris ballistic missiles, these submarines can remain undetected in the dark polar seas, hidden from an enemy. If an enemy dared to attack the United States; even if he were successful in destroying the United States, he will know that he himself would inevitably be destroyed.

Representative DURHAM. How thick was the ice?

Admiral RICKOVER. The ice in the polar region varies with the time of the year. It varies from about 30 feet to 40 feet to nothing in some places. The *Skate* carries equipment on board by which she can tell roughly where the ice is not too thick to break through. She was able to "punch" her way through the ice 10 times on this recent polar voyage.

Another most significant record was set by the *Sargo*. She left the Mare Island Navy Yard in January of this year and steamed nonstop for 19,000 miles in the Pacific. She returned to port about 2½ months

later. Of this 19,000 miles, 18,880 were fully submerged, and only 120 miles were on the surface.

That brings out another important fact about our nuclear submarines. They travel nearly all of their time fully submerged—at the present time about 85 percent. They can go much faster submerged than on the surface because their hulls are designed for submerged operations, and they do not have to worry about weather or rough seas. For example, the *Skipjack*, which is our fastest submarine, can travel about 10 knots faster submerged than on the surface.

Some of the very fine officers who have piloted these ships are in the audience. I am more proud of what these young men have done than I am of what we have done with atomic power. With officers such as these and their highly devoted crews, there is nothing our country cannot do. They are the finest men in the finest military organization in the world. When people of their caliber are exposed to the challenge and opportunity of our nuclear power program, the results go beyond all expectations. Not only do we get these outstanding operating crews, but individual officers and sailors go on to do an outstanding job in other parts of the Navy as well.

For example, about 20 times as many sailors are selected, proportionately, as officer candidates from our nuclear power program than from the entire Navy. One out of every six sailors who has been in the nuclear power program has already been selected for officer programs. Of course, these men represent a loss to the nuclear power program, and an additional training burden to us, but the Navy as a whole benefits immeasurably.

Chairman ANDERSON. Admiral, if you will let us break in, we will introduce a couple of other people and come right back to you.

I am very happy that some of my old associates from the House of Representatives are here today. I appreciate it tremendously. When I went into the House in 1941 next to me was a young Congressman from North Carolina. I want to ask Herbert Bonner to stand up. Congressman Bonner. [Applause.]

At that time everyone conceded the greatest expert on naval affairs in the Congress of the United States was Carl Vinson of Georgia. Carl. [Applause.]

He is just a few months behind Sam Rayburn in his record for longevity as a Member of the House and he is certainly one of its finest Members.

Everyone who tries to get an appropriation from the House Appropriations Committee knows what an easy time he has with Clarence Cannon. [Applause.]

I want to say to him that it was my great honor to serve under him when I was in the House of Representatives and he is truly one of our great public officials.

I see a great many Senators in the audience. I hope I will see a good proportion of them. There is Senator Javits of New York. Would you rise please? [Applause.]

I saw Senator Prescott Bush a minute ago. Is he still in the audience? Where is John Taber?

John, we should have you right up here. You were supposed to be up here. [Applause.]

I am happy to bear eloquent testimony to the fact that John T. Ober is one of the truly fine people in the House of Representatives if I dared take time on the program I could give you a sample out of my own life.

Strom Thurmond, would you rise please? [Applause.]

Are there other Members of the Senate or House here?

Senator Fulbright is way back there. I don't know why the chairman of the Foreign Relations Committee went that far back into the audience, but apparently he has things on his mind.

Congressman Rabaut of Michigan. Mr. Congressman, will you stand up? [Applause.]

Congressman Anderson of Montana. [Applause.]

Senator Saltonstall. [Applause.]

Congressman Boland of Massachusetts is here. I am going to ask him to stand up. [Applause.]

May I say that all of us—some 46 Senators who have served in the House of Representatives—are as proud as we can be to be known as Sam Rayburn's boys. It is a matter of tremendous regret to me that the Speaker of the House of Representatives, beloved on both sides of the aisle, found it impossible to be here today.

The Speaker sent me this note.

I regret very much that because of the situation on the floor of the House at the present time, I will be unable to be present for the ceremonies in connection with the conferring of the special Congressional Medal on Admiral Rickover. Please convey to him my very best wishes.

I trust that his outstanding abilities may continue to be used for the benefit of the welfare of the people of the United States and for the world.

With every good wish, I am

Sincerely yours,

SAM RAYBURN.

Senator Kuchel, you were supposed to do some reading. [Applause.]

He got back there and so, as is customary, he loses the floor. I will read then a little note which the Vice President of the United States sent over.

It is a genuine honor for me to be able to extend my congratulations to Vice Adm. Hyman G. Rickover in connection with the special tribute being paid him today.

No man could be more deserving than Admiral Rickover of the special Congressional Gold Medal being presented to him on this occasion. His vision, skill, and tenacity in successfully directing the development and construction of the world's first nuclear-powered submarines has added immeasurably to our military strength. And his contribution in the development of the world's first large-scale nuclear-power reactor devoted exclusively to production of electricity opens new vistas for progress for the United States and the world in the years ahead.

I regret that I am unable to be personally present at the ceremony today and I hope, through this message, I can convey in small measure the great debt of gratitude every American owes to him for the unique service he has given our Nation.

RICHARD NIXON.

[Applause.]

May I just say that I know the Vice President planned to be here but there are some matters arising today which made it impossible for him to be here in person. I appreciate his sending this message along as I do the action of the Speaker.

Because of a situation in the Senate, which is in session, I am going to break the program just a little bit and present to you a very fine team. As everyone knows, the Senate has been extremely fortu-

nate over the past few years in having a majority leader and a minority leader who were able to work together and who were able to preserve that great feeling of comradeship that we like to have in the Senate of the United States.

First of all it will be my pleasure to present to you the dynamic leader of the majority in the Senate of the United States whose vision, whose courage, and whose drive are bringing great rewards to the American people, the Honorable Lyndon Johnson of Texas. [Applause.]

**STATEMENT OF HON. LYNDON B. JOHNSON (TEXAS), THE
MAJORITY LEADER IN THE SENATE OF THE UNITED STATES**

Senator JOHNSON. Mr. Chairman, my colleagues in the Congress, Admiral Rickover, and my fellow Americans, Congress is made up of a very proud group of men and women. We take pride in our work, in its results, and in many achievements. But there is nothing in which we take more pride than we do in the work of the Joint Committee on Atomic Energy. That committee is presently headed by my friend, the junior Senator from New Mexico, Mr. Anderson. He is the kind of legislator that every State ought to have at least one of—experienced in the executive branch of the Government, a graduate of the Appropriations Committee of the House of Representatives where they spend the money, and of the Ways and Means Committee where they raise the money.

He came to the Senate and in a very short time the late Vice President Alben W. Barkley assigned him to the Joint Committee on Atomic Energy. I don't think I exaggerate when I say I believe this committee, under the leadership of Clinton Anderson and Carl Durham, has the complete confidence of the Members of the U.S. Senate.

I am very proud that along about the time of my birthday last year, Clint Anderson came to me in a hurry and said that he had a little resolution that didn't cost much money but would bring great results to this Nation which he wanted passed by unanimous consent. Before I had a chance to call it up I found that he was going to pass it by unanimous consent because he had practically every Member of the Senate as sponsor of it.

That is the reason we are here today. We meet here to honor a man and to honor an achievement—to honor an uncommon man and an uncommon achievement. I heard Clinton Anderson introduce my delightful and wise and talented friend from Georgia, under whom I served 12 years, as the outstanding "expert on naval affairs." Clint, I am going to correct you and I want you to accept an amendment. I am going to strike the word "naval," and substitute "military"—because one of the outstanding experts in this country on our armed services is Carl Vinson.

Now, notwithstanding the provisions that Uncle Carl has made for the armed services throughout the years—and he has been a zealot, he has been a perfecter, he has been a defender, he has been an aggressor, he has attempted to see that they had more than some of them wanted and to take away some that people didn't want to give—nevertheless when it came to launching this uncommon man on this uncommon venture, we had to renovate a restroom to provide him with an office. We hadn't made a provision for that in our services.

However, as a result of his dynamic personality, as a result of his outstanding leadership, as a result of his ability to command me and respect, today we occupy a position of leadership in at least one field that would not be ours except for Admiral Rickover.

So we meet here today to honor you and as a result of the resolution initiated by this great committee, Admiral, I think we should say to the rest of the world that you are our secret weapon. You are a symbol of the "can do" man. There are plenty of us who can find 15 reasons why something that ought to be done, can't be done, but there are very few of us who can cut through red tape, slash through the "can't do" folks and get on with the job. You have done that. You have brought pride to the Navy. You have been an inspiration and a stimulating example to every young man in this country.

I asked a friend of mine this morning over a cup of coffee what he thought I ought to say this afternoon. He said, "Not very much but I think you might say that I want to send my boy to the Naval Academy because Admiral Rickover has demonstrated what a scientist with education and determination can do for the world. I think that is what I am going to ask my boy to do." I don't think there is a finer tribute could be paid to you than for the fathers of the land and the sons of the land to want to follow in your footsteps.

It is a great privilege to be here with you. I express the gratitude of a grateful Nation for the many successful jobs that you have done that will help us to preserve peace not only for this Nation, but for freedom loving people everywhere. [Applause.]

Chairman ANDERSON. Now it is my privilege to present the other part of the Senate leadership team. He is a man who, like Senator Johnson, had his early training in the House of Representatives, who early established a fine reputation there and who as a Member of the U.S. Senate has quickly risen to a position of prominence and leadership in that body, the Honorable Everett Dirksen, minority leader of the U.S. Senate. [Applause.]

STATEMENT OF HON. EVERETT M. DIRKSEN (ILLINOIS), THE MINORITY LEADER IN THE SENATE OF THE UNITED STATES

Senator DIRKSEN. My friend and chairman, Senator Anderson, our very distinguished guest, Admiral Rickover, my friends, associates, and colleagues. I suppose, Admiral, if I were thinking in terms of any other kind of an award that might be bestowed upon you today, we might ask the Navy to set up a new rank or a new classification and just call it subnik and confer it upon you, sir. That probably would go a long way.

But I am delighted to be here today to pay testimony and to congratulate you and to think in terms of a slightly larger implication of this ceremony. It is rather easy to classify and to recognize those impellent forces that carry men on to action. Probably at the head of the list we would set self-preservation because it is the deepest and most enduring thing in the human life. Next to that we might set acquisition of property because in all of us there is a pardonable desire to acquire a little something in this mundane journey.

Then we might set reputation; not merely the reputation that ensues from a blameless life, but rather the reputation that ensues from achievement and recognition that causes men, like fuel to the

first to strive for it and in the doing they enrich not only themselves but enrich their own country and mankind. Probably it might be referred to as a vanity, but if it is, it is one that is the most pardonable vanity and it is the most justifiable vanity that I know.

And so, Admiral, today as we do testimony to you, and as we congratulate you on extraordinary achievement, I like to think that this great Republic has not yet gotten so ponderous, has not yet gotten so bureaucratic, has not yet gotten so impersonal that we cannot express our gratitude and appreciation for those who through fidelity and dedication to service and devotion have enriched the country and have enriched their fellow man. I hope, therefore, that people will take account of this day as a testimony to the fact that there is recognition, and in proportion, as we tap one of the great and impelling powers that has carried mankind along the march of progress for so long.

And so I am delighted, Admiral Rickover, to have a small part in this ceremony; first to congratulate you, second to pay my respects and finally to utter the earnest hope that it will be something of a reminder to all people—men and women, young and old, rich and poor—that there is still an expressible gratitude within the capability of this country.

I congratulate you, sir. [Applause.]

Chairman ANDERSON. Weren't those two fine statements from these fine Senate leaders? They have to leave us now. They have to return before this program is over. Let's give them a hand as they go back to their jobs. [Applause.]

I have been waiting for the arrival of a particular person so I could make two introductions. Now I would like to ask Secretary Gates of the Navy and the Chief of Naval Operations, Adm. Arleigh Burke, to please stand for a moment. [Applause.]

Thank you both very much for being here to honor this naval officer.

We are going back to the questions for a few minutes. Then we will come back to the introduction of the members of the Joint Committee and the business of the afternoon, at which, after all, we have not yet arrived.

Admiral, would you tell us a little bit about the future of Shippingport? It is a great nuclear powerplant. What about its future plans? Can you furnish us for the record a history of the project since its inception?

(The history referred to is contained in the appendix, p. 59.)

STATEMENT OF VICE ADMIRAL HYMAN G. RICKOVER—Resumed

Admiral RICKOVER. The Shippingport project was authorized by Congress so that the United States could learn about the real problems of atomic power by actually building and operating this first large-scale central station atomic powerplant.

We broke ground for that plant in September 1954, and on December 2, 1957, it first started operating. We designed, developed and constructed that plant in just about the same time it takes to build a conventional central station plant. To date, the Shippingport plant has generated more than 280 million kilowatt-hours of electric power. It is running right at this minute at its rated output of 60,000 kilowatts.

The plant was designed by the Bettis Laboratory at Pittsburgh, Pa., which is operated for the Atomic Energy Commission by the Westinghouse Electric Corp. It is being operated by the Duquesne Light Co., and it is furnishing electric power to the city of Pittsburgh.

The reactor core of that plant has already lasted longer than we expected it would. For example, we expected that the "seed" part of the core—that is a technical term—would only last for 3,000 full power hours. It has already run more than 4,400 full power hours and we expect it will last as high as 6,000. Similarly, the remaining portion of the core, the "blanket," we expect will run for twice what we anticipated.

In order to continue with progress we must design new reactor cores; so about a year ago, after obtaining approval from the Atomic Energy Commission and getting the research and development funds from the Congress, we started to design a new core. Recently, after considerable design work, we found that we could design that core to generate about 150,000 kilowatts of electrical power instead of the 60,000 which the plant is currently generating. I have asked the Atomic Energy Commission for funds to make the necessary alterations to increase the generating capacity of the plant to permit utilizing the full 150,000 kilowatts.

At Shippingport we run a school where we train operators from U.S. utilities and from those in foreign countries in the operation of central station atomic plants. Since Shippingport is the only one in the United States—in fact the only one in the world—which was designed for the sole purpose of producing atomic power, this school should prove to be very valuable for other atomic powerplant operators.

In designing and building the Shippingport plant, we used the same system we are using for developing our naval plants.

The naval program is conducted by a combined Atomic Energy Commission, Navy, congressional, and industrial team. The joining of a civilian and a military organization, together with congressional interest and help, and industrial know-how affords us the opportunity to work fast—which is inherent in a totalitarian state—while at the same time retaining the advantages of a democracy. The control of money for our program is still retained by the elected representatives of the people and the congressional committees provide us with counsel and supervise us. This meeting today is a living example that the Congress, who represent our people, can call a public servant to account for what he does. This, of course, the people in a totalitarian state cannot do.

At Shippingport we have learned many lessons. The Shippingport project led the way in developing uranium oxide for use in large scale reactors. Uranium oxide is a brownish powdery material which we use for fuel instead of metallic uranium. Nearly all other designers of large scale reactors in the United States have now adopted uranium oxide. The European countries, as well, have adopted it. The various units such as the pumps, the pressure vessel, the pressurizer, the reactor control, the reactor control drive mechanisms, and a thousand other items which we developed at Shippingport are also being copied by other reactor designers. We are proud of the compliment of being copied both here and abroad. That, of course, is one of the main reasons for the Shippingport project.

We have learned so much from the Shippingport project—and from the development of naval reactors too—I wish I had time to tell you more about it.

Chairman ANDERSON. Could you give us a list to insert in the record?

Admiral RICKOVER. Yes, sir. I would be glad to.

(The material referred to will be found in the appendix, p. 71).

Admiral RICKOVER. It is frequently said that the electricity from the Shippingport reactor is expensive. It is necessarily so. In 1854, when electric power was first being discussed in this country, scientists and engineers said that it would never be practicable because they proved it would cost about \$2 a kilowatt-hour. The Shippingport station is in somewhat the same position for atomic power as electricity from coal was about a hundred years ago. True, our costs are high, but it must be borne in mind that we are operating this plant primarily to develop scientific and technical information and not merely for the sake of producing electricity.

STATEMENT OF HON. CLINTON P. ANDERSON—Resumed

Chairman ANDERSON. I see out in the audience Congressman Yates from the home district of our distinguished guest. Would you stand up please? [Applause.]

The program calls for comments by members of the Joint Committee and my comments will be in connection with something entirely different, but I do want to present the members of the Joint Committee who are here. Will you each stand please?

Mr. Westland of Washington. [Applause.]

Mr. Aspinall of Colorado. [Applause.]

Mr. Bates of Massachusetts. [Applause.]

Mr. Hosmer of California. [Applause.]

Mr. Van Zandt of Pennsylvania. [Applause.]

Mr. Holifield of California. [Applause.]

Senator Pastore of Rhode Island. [Applause.]

Senator Hickenlooper of Iowa. [Applause.]

Senator Gore of Tennessee. [Applause.]

Senator Aiken of Vermont. [Applause.]

Senator Jackson of Washington. [Applause.]

Senator Bennett of Utah. [Applause.]

I am their spokesman in this next matter. There is a resolution of the Joint Committee on Atomic Energy, which is in your program, but I shall read the text of the resolution and then present to Admiral Rickover the original text with the signatures of all the members of the Joint Committee.

Whereas Vice Adm. Hyman George Rickover, U.S. Navy, has served his country faithfully and with great honor as a naval officer; and

Whereas as a result of his unstinting drive, organizational ability, and technical leadership, the United States produced the world's first nuclear-powered ships; and

Whereas Admiral Rickover has dedicated his efforts and creative ability to the furtherance of the U.S. efforts to continue its nuclear technological lead in the world today; and

Whereas the advances in reactor technology made under the direction of Admiral Rickover have resulted in the development and construction of the first full-scale nuclear powerplant in the United States; and

Whereas Admiral Rickover for many years, in testimony before the Joint Committee on Atomic Energy, has willingly given the committee the benefit of his knowledge and advice and thus greatly assisted the committee in fulfilling its responsibilities; and

Whereas in recognition of the achievements of Admiral Rickover and his team in the field of military and peaceful uses of atomic energy, the Congress of the United States has awarded to him a special gold medal: Now, therefore, be it

Resolved, That the members of the Joint Committee on Atomic Energy do hereby express their appreciation of the great accomplishments of Admiral Rickover and his assistance to the Joint Committee over the years; and be it further

Resolved, That the members of the Joint Committee on Atomic Energy do hereby convey to Admiral Rickover their heartfelt congratulations on the occasion of the award to him this day of the Congressional Gold Medal.

Admiral Rickover, it is a joy to present this to you on behalf of the Joint Committee on Atomic Energy. [Applause.]

While the press photographers are getting a picture I am going to say to you that the next report from a Member of Congress will come from the vice chairman of the committee who is alternately the chairman of the committee and who, in my opinion, is one of the truly fine Members of the Congress of the United States and certainly one of the finest men we could possibly have on the Joint Committee, Carl Durham of North Carolina. [Applause.]

**STATEMENT OF HON. CARL T. DURHAM (NORTH CAROLINA),
VICE CHAIRMAN, JOINT COMMITTEE ON ATOMIC ENERGY**

Representative DURHAM. Thank you very much, Mr. Chairman, Admiral Rickover, and distinguished guests. It is certainly a very great occasion for me this afternoon. I might say, Admiral, that the sun shines brighter today than it did in 1946, 1947, and 1948, those struggling days in first initiating your idea and other ideas that came from the laboratories. Although it has been said many times, I would also like to say in connection with this occasion that no great man accomplishes very much without the loyal support of his wife and associates. It gives me a great deal of pleasure this afternoon to look back in the audience and see the faces of Mr. Simpson, the General Manager, and others from Bettis Laboratory who have made up, I believe, one of the greatest teams of scientific personnel ever put together anywhere in the world. Those of you who have not visited there and have not looked at it should certainly do so.

Admiral, on behalf of my colleagues on the Joint Committee and also speaking for myself personally, I want you to know how greatly we appreciate what you and your excellent team have done for the United States and the free people of the world.

Under your personal direction, the Naval Reactors Branch of the Atomic Energy Commission, and the Navy Bureau of Ships have succeeded in obtaining for the United States world leadership in nuclear ship propulsion which, today, cannot be challenged anywhere in the world. The five U.S. nuclear submarines currently at sea and the many more nuclear submarines and surface ships under construction and planned serve as testimony to your early foresight, dedicated devotion, and determined effort.

I would like to say at this point also that I, as a member of this Joint Committee, want to thank every member of the Appropriations Committee of the House for the way in which they have backed this program without hesitation.

Your outstanding accomplishments in the naval program alone are sufficient to induce a grateful Nation to honor you which we are attempting to do here this day. In addition, however, your countrymen are indebted to you and to your team for the fact that the United States of America has today in operation the first full-scale nuclear powerplant devoted exclusively to the production of electricity at Shippingport, Pa.

We on the Joint Committee through long and close association know the tremendous obstacles and difficulties you had to overcome to achieve these accomplishments for the United States.

We on the Joint Committee are honored today to join with our colleagues in the U.S. Congress and, on behalf of a grateful Nation, to thank you and your team for what you have done with the hope that you will be able to continue in the years to come in your important work. [Applause.]

Chairman ANDERSON. I have two telegrams which I desire to read. One is from Albany, N.Y., addressed to Vice Adm. Hyman G. Rickover:

New York State shares in the pride and satisfaction that I know you and all of your friends must feel today. This recognition by Congress of your pioneering achievements in atomic energy is certainly most appropriate and well deserved. It is especially gratifying to New Yorkers who are privileged to have some of your most important work carried on within our borders. Congratulations.

NELSON A. ROCKEFELLER.

[Applause.]

Then there is a wire from Schenectady.

Congratulations, from the city of Schenectady, on gold medal, a most appropriate honor in view of your important role in development nuclear power ships. This is a tribute well earned.

MAYOR KENNETH S. SHELDON.

What a bad Chairman I am. I notified Senator Hickenlooper that I would appreciate it if he would move down here and he said, "Am I supposed to say anything?" I had forgotten to notify him, but that isn't necessary because Senator Hickenlooper is one of the real pioneers in the work of the Joint Committee, a long time ago its chairman and steadily one of the finest members that we have, regular in his attendance and devoted to his work.

I am happy indeed to present to you the distinguished senior Senator from Iowa, Senator Hickenlooper.

**STATEMENT OF HON. BOURKE B. HICKENLOOPER (IOWA), A
MEMBER OF THE JOINT COMMITTEE ON ATOMIC ENERGY**

Senator HICKENLOOPER. Thank you, Senator Anderson. Congressman Durham, my colleagues, Admiral Rickover, and guests, this is indeed a significant milestone in the development of science in the United States and in the national defense. Those of us who have been in this atomic energy business since its inception have seen some fantastic and, from the standpoint of a few years ago, unbelievable developments.

This accomplishment, for which we are honoring Admiral Rickover today, is one of the great series of accomplishments of America. We started out almost 200 years ago and we made the breakthrough on political accomplishments in which we established the greatest exper-

iment in human living that the world had ever seen. Then getting down to the practical we established the clipper ships—and that was quite an accomplishment for those days. We came along and did a lot of other things. We dug the Panama Canal. Then skipping to the modern age we developed the ability to produce fission of the atom so that useful power in quantities could be released. Now we have succeeded in pioneering in that great field of almost unexplored portions of the earth, the undersea regions, by the successful building of atomic submarines which are true submarines and whose true element is under the surface of the water rather than on it.

We have not always honored sufficiently those who have spearheaded these developments in the past, but today we are honoring most deservedly and most enthusiastically Admiral Rickover whose courage, drive, foresight, and determination have done more perhaps than that of any other one man to develop this breakthrough in a new area, not only for industrial and peacetime uses but for the military in the defense of our country.

I have known Admiral Rickover for a great many years, I have watched him and his activities and I assure you that he is a dedicated American. He is a great American. He has done a tremendous job for his country and perhaps in the long run, the job for the world will overshadow the benefits to his country.

Admiral Rickover, I am honored indeed to participate here today in this ceremony in which you receive this medal from the Congress of the United States, but I am more honored in having been able over the years to participate with you in some small way through committee activities and otherwise in the development and fruition of this great new step forward in atomic progress.

Thank you. [Applause.]

Chairman ANDERSON. Thank you and now the final speaker before the presentation.

I am going to introduce to you the man to whom we all have to turn when a Navy problem comes up within the committee; a man who has had experience with the Navy, who is a naval captain and who knows what the Navy is supposed to do and never lets the joint committee forget. If there is anyone in a Navy uniform who wants to know who is the staunchest Navy defender in Congress, I will say it is the next speaker, one of the most lovable, likeable and friendly members of our committee, whom we are all privileged to call our friend, Jim Van Zandt. [Applause.]

**STATEMENT OF HON. JAMES E. VAN ZANDT (PENNSYLVANIA),
A MEMBER OF THE JOINT COMMITTEE ON ATOMIC ENERGY**

Representative VAN ZANDT. Senator Anderson, Admiral Rickover, my colleagues, ladies and gentlemen, this is a happy occasion for the Members of the minority on the House side. We have worked with the majority on both sides of this committee to make possible this unique event here today, an event when we honor not only a distinguished naval officer, but a distinguished American who through his perseverance and his insistence has given to his country an item of national security of which we are most proud.

If you will pardon a personal reference to the Admiral, I would like to mention that when I joined the Joint Committee immediately

after my separation from the Navy back in 1946, I was told there was a fellow in the Navy Department, by the name of Rickover who was very much interested in the development of a nuclear-powered submarine. Having been a sailor in the Navy when they had coal ships and knowing the problems we have when we take on fuel oil today, I asked about this nuclear power in ships and was given a complete rundown. It was a matter of a year or more until I met Admiral Rickover and said to him, "What can I do?" He said, "Just keep quiet and get reelected." That was the beginning of a long period of friendship I have enjoyed with the Admiral. He has made many friends and he has made many enemies, but he has had one objective and that is the development of nuclear power not alone for the submarine, but for the other types of craft so necessary to the Navy.

While we honor him today I would like to take the privilege of paying honor to others. We have here today Arleigh Burke, Chief of Naval Operations, who has stood up and fought for the program. I see Admiral Mumma who heads the Bureau of Ships who stood up in the same way and supported Admiral Rickover as did the Secretary of the Navy from my own State of Pennsylvania, Tom Gates.

As I look around I see some of those devoted officers of the Navy and civilians with whom Admiral Rickover has surrounded himself and in whom exists an esprit de corps the like of which I have never found in my some 40 years of experience in the Navy. Also here today is Captain Wilkinson who commanded the Nautilus, Commander Calvert, Captain Laning. I am sorry Commander Anderson is not here and Commander Behrens who is commissioning today the USS *Skipjack* at New London. All of these officers have played a part. So today while we honor Admiral Rickover we also honor those naval officers and likewise the enlisted men of the Navy who have made possible this program and who will take these submarines, these carriers, cruisers and destroyers to sea and fight for America and in so doing give the American people the security to which we are entitled.

I congratulate you, Admiral Rickover again on behalf of the minority Members of the House side of the committee. [Applause.]

STATEMENT OF HON. CLINTON P. ANDERSON—Resumed

Chairman ANDERSON. Just privately he did a pretty good job of speaking for all of us. Now that he has done that, I think there are three captains here who ought to stand up:

Captain Wilkinson, the first nuclear submarine commander, now commander of a nuclear squadron. Will you stand up, Captain? [Applause]

Commander Calvert of the *Skate*. [Applause.]

Commander Brooks of the *Sargo*. [Applause.]

Captain Laning, former commander of the *Seawolf*. [Applause.]

John (Chairman McCone), would you come up here and help me?

I asked Mr. McCone to come over. This is not a part of the program, but he has been so helpful in the work that Admiral Rickover has done and is doing, that I did not want this ceremony to go on without the Chairman of the Atomic Energy Commission.

On instructions of the Congress of the United States, in behalf of the American people, with their gratitude and appreciation, it is my privilege today to present to you that recognition which a democracy can give to its deserving citizens.

Different countries have different ways of rewarding distinguished and meritorious achievements. In Great Britain a man who was personally responsible for giving his country a position of world leadership in submarine warfare might well be elevated to knighthood; in Belgium such a man might receive the Order of the Crown. Holland might bestow on him the Order of the Lion and Sweden the Order of the Polar Star. France could give him the Legion of Honor or Greece the Order of the Redeemer.

But this United States is not a country of heraldry. Our high awards, such as the Congressional Medal of Honor, are usually reserved for valor on the battlefield. For this reason, the Congress of the United States, beginning with the birth of our Nation in 1776, has ordered gold medals struck to honor the Nation's outstanding citizens. The first gold medal bestowed by congressional resolution was given to General Washington in 1776. The medal honored him in connection with the siege of Boston.

Since that time the Congress has ordered gold medals bestowed on a long list of distinguished citizens: Cornelius Vanderbilt, Cyrus Field, the Wright Brothers, Thomas Edison, Charles Lindbergh, General George Marshall, General John Pershing, General Billy Mitchell, and the famed Army Surgeon General Walter Reed. The most recent recipients were Vice President Alben Barkley in 1949 and Dr. Jonas Salk in 1958.

Incidentally we ran a special research project to find out how many admirals before you had been presented with gold medals by act of Congress and the research wasn't extensive enough so I don't guarantee it, but as far as I have been able to determine you are the third U.S. Navy admiral to be so honored. The other two were the famed Polar explorer, Richard Byrd, and the man who made such a contribution to World War II, Fleet Adm. Ernest J. King. That, I am sure, is illustrious company but no better than you deserve. A gold medal was presented to John Paul Jones, but he was never an admiral in the Navy of this country. He was an admiral in the Russian Navy. Silver and bronze medals have been presented to other naval heroes, among them Admiral Perry and Admiral Dewey.

I have no further wish to test your patience. On behalf of the people of America, I hand you this symbol of your success, a medal of achievement from the Congress of the United States, with the hope that it will remind you of your great services to the country, our great devotion to what you have done and the long years you have been associated with the Navy of the United States.

I congratulate you in behalf of the Congress of the United States. [Applause.]

Admiral RICKOVER. Senator Anderson, Mr. Durham and other distinguished members of the Committee and the Congress, ladies and gentlemen; there are times when one is too deeply moved to express his feelings. How can I put into words my gratitude, as I stand before you—the busy leaders of our great country who have taken time out from your heavy responsibilities—to honor me. It is not



FACE OF THE MEDAL



BACK OF THE MEDAL

enough that I thank you from the bottom of my heart. I speak not only for myself but for all the devoted and hardworking members of the naval reactors group when I pledge that we shall continue our work with renewed enthusiasm and strength. We shall let nothing deter us from building a nuclear Navy in the shortest possible time.

My colleagues and I know—and I am confident it will become known to everyone—that without the Committee's active help on countless occasions, and the continuous support of the Congress, we should not now have a single nuclear ship.

For your never-failing understanding, your friendship, and your kindness in awarding me this medal, I thank you. [Applause.]

Chairman ANDERSON. On behalf of the Congress and the Joint Committee on Atomic Energy may I thank each one of you for being kind enough to be here this afternoon and to say I know Admiral Rickover well enough to know that if just one or two of you—or maybe all of you—want to shake his hand, this is a good occasion to do it.

Thank you very much.

(Whereupon at 3:45 p.m. the meeting was adjourned.)

APPENDIX

APPENDIX 1

RADIOACTIVE WASTE DISPOSAL FROM U.S. NAVAL NUCLEAR-POWERED SHIPS

(Date: January 1959; prepared by T. J. Iltis and M. E. Miles, Nuclear Propulsion Divisions, Bureau of Ships, Department of the Navy)

(Approved by: H. G. Rickover, vice admiral, USN, Assistant Chief of Bureau for Nuclear Propulsion)

I. SUMMARY

The purpose of this report is to: (1) describe the sources and nature of radioactive wastes from U.S. naval nuclear-powered ships, (2) outline and discuss the established waste disposal procedures used for these ships, and (3) summarize the measurements made to detect any effect of wastes discharged by the first ships on the radioactivity of their harbor environs.

The basic criterion adopted for disposal of radioactive waste from U.S. naval nuclear-powered ships is that disposal should not increase the average concentrations of radionuclides in the surrounding environment by more than one-tenth of the maximum permissible concentrations for continuous exposure listed in National Bureau of Standards Handbook 52. Actual data from the operating ships shows that the radioactivity of their wastes is consistently low and has had no detectable effect on the radioactivity of their environment.

II. INTRODUCTION

A. General description of U.S. naval nuclear powerplants

All nuclear-propelled U.S. naval ships now planned, in construction, or in operation are powered by pressurized water reactors. In these reactors, pressurized water circulating through the reactor core picks up the heat of the nuclear reaction. The reactor coolant passes through heat exchangers which transfer the heat to water in a steam system. The steam system water is converted to steam and is then used as the source of power for the propulsion plant as well as for the auxiliary machinery.

B. Principal sources of radioactive waste

The principal source of radioactive waste from all nuclear-powered naval ships is the reactor coolant water which contains small quantities of activated impurities. The largest amounts of reactor coolant water are discharged when this water expands as a result of bringing the reactor plant up to operating temperature. This normally happens a few times per month on each ship and the quantity of coolant water discharged on each heat-up averages about 500 gallons. The nature of the radioactivity in the coolant water and the procedures established for its disposal are described in detail in the main body of this report (sec. III).

There are other sources of radioactive waste derived from the operation of naval nuclear powerplants which require only infrequent waste disposal considerations. These include disposal of (a) the ion exchange resin that is used to purify the coolant water of the reactor plant, (b) reactor shield water, (c) solid wastes from maintenance operations, and (d) special wastes from laundry or decontamination operations. The nature and procedures for handling these wastes from infrequent operations are discussed in section IV of this report.

Aside from the above-mentioned sources of radioactive waste, it should be noted that the direct radiation emanating from the hull of any nuclear-powered naval ship is designed to be insufficient to cause any detectable activation of the sea water.

C. Fission products

In addition to activated impurities, the reactor cooling water may contain trace amounts of fission products. These come from minute quantities of uranium impurity in the reactor structural materials. The large quantities of fission products that are produced by the fission process of the reactor are retained where they are born: metallurgically bound within the fuel alloy. They cannot get out of the fuel elements unless by a very remote possibility the reactor itself were to melt down. The plant is protected against this possibility by its inherent safety characteristics and by a "fail-safe" protection system, although the possibility of such an accident cannot be completely eliminated. If the ship were sunk, it is expected that the reactor core could remain submerged in sea water for decades without release of fission products, since the zirconium protective cladding on the fuel elements corrodes only a few millionths of an inch per year. The steam system is entirely separate from the reactor system, and a failure in the steam system would not endanger the reactor nor release fission products or activated impurities.

D. Environmental effects

In order to confirm the adequacy of waste disposal procedures for naval nuclear-powered ships, surveys are being conducted of the radioactivity in the environment around ports where nuclear ships are being built and operated. These surveys cover periods both before and after commencement of operation of the reactors. A description of these surveys and some results obtained to date are discussed in section V of this report.

III. REACTOR COOLANT WASTE

A. Nature of reactor coolant

In order to establish waste disposal procedures, the radioactive nuclides in the reactor coolant must be identified. The radioactive isotopes of most concern result from activation of the small amounts of corrosion and wear products of plant surfaces and from activation of small amounts of impurities in the coolant water. All nuclides normally present in significant amounts in the reactor coolant of operating naval reactors and prototypes have been identified and their concentrations determined. These determinations are performed during initial operations of the reactors, and at intervals thereafter coolant samples are analyzed for the long-lived (greater than several days half life) nuclides. These analyses have shown that the concentrations of radioactive nuclides in reactor coolant a few minutes after sampling for naval nuclear propulsion plants are approximately as shown in table I. The table shows for comparison the tolerances used for dumping reactor coolant in restricted waters, to be discussed in section III B of this paper. Significant increases in coolant activity would be indications of reactor plant malfunction; therefore, continued reactor operation with the concentration of any nuclide above dumping tolerance is not expected and would not normally be permitted.

TABLE I.—Concentrations of radionuclides in reactor coolant

Measure activities of coolant in microcuries per cubic centimeter

Nuclide	Half life	Maximum	Average	Dumping tolerance in $\mu\text{c/cc}$
Mn ⁵⁶	2.5 hours.....	9.3×10^{-2}	2.2×10^{-2}	15.
Co ⁶⁰	5.2 years.....	2.5×10^{-2}	5.7×10^{-3}	2.
Fe ⁵⁹	45 days.....	2.8×10^{-3}	1.5×10^{-4}	1×10^{-2} .
Ni ⁶⁵	2.56 hours.....	1.3×10^{-3}	1.6×10^{-4}	1.9.
Cr ⁵¹	27 days.....	5.5×10^{-3}	1.0×10^{-3}	50.
Na ²⁴	15 hours.....	2.0×10^{-2}	8.0×10^{-3}	3×10^{-1} .
Cu ⁶⁴	12.8 hours.....	9.1×10^{-3}	1.5×10^{-3}	8.
Ta ¹⁸²	112 days.....	5.6×10^{-2}	7.3×10^{-3}	10.
P ³²	1.87 hours.....	6.8×10^{-2}	1.2×10^{-2}	90.
W ¹⁸⁷	24 hours.....	9.0×10^{-3}	3.3×10^{-4}	9×10^{-2} .
Gross activity measured 15 minutes after sampling.....	1.5×10^{-1}	5.0×10^{-2}	3.0.
Gross activity measured 120 hours after sampling.....	3.6×10^{-2}	3.1×10^{-3}	1×10^{-1} .

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Complete results of the nuclide identification program performed on *Nautilus* and the coolant water are shown in appendix B. Detailed analyses of *Nautilus* reactor coolant were made every 1 to 2 months during the operation of the first core and at less frequent intervals for the second core. No new nuclides appeared in these analyses. The gross 15-minute activity has remained below a normal operating limit of 0.3 microcuries per cubic centimeter ($\mu\text{c/cc}$). Similar results have been obtained for the *Skate* and other naval reactors already operating. Nevertheless, initial and periodic checks on the activity of the nuclides present in the reactor coolant of each new ship will continue to be made to detect changes that may affect plant operation or waste disposal procedures.

Fission products occur in very small concentrations in reactor coolant because of uranium impurity in core structural materials. The concentrations of fission products in reactor coolant from this source are shown in table II, along with their tolerances for waste disposal. (The very short-lived fission products are not shown in the table since their tolerances are relatively high.) Since a rise in fission product concentrations would indicate a fuel element defect that might lead to further plant operational or maintenance difficulties, continued operation of a naval reactor with fission products concentrations above waste disposal limits would not normally be permitted.

TABLE II.—Concentrations of fission products in reactor coolant

Nuclide	Half life	Concentration, $\mu\text{c/cc}$	Dumping tolerance, $\mu\text{c/cc}$
Total iodine.....	Variable.....	5×10^{-4}	To be conservative 1×10^{-3} is normally used.
I^{131}	8 days.....	1×10^{-5}	3×10^{-5} .
Total strontium.....	Variable.....	5×10^{-4}	To be conservative 1×10^{-4} is normally used.
Sr^{90}	28 years.....	5×10^{-5}	8×10^{-5} .
Sr^{90}	54 days.....	5×10^{-6}	7×10^{-5} .
Ba^{140}	13 days.....	1×10^{-6}	2×10^{-5} .
Ce^{144}	285 days.....	1×10^{-7}	4.0.
Cs^{137}	30 years.....	1×10^{-8}	1.5×10^{-1} .

Two other radionuclides that may be present in reactor coolant but produce no waste disposal problems are argon-41 and tritium. Argon, present as a constituent in small quantities of air dissolved in reactor coolant, becomes activated as argon-41 and may reach concentrations up to 0.7 $\mu\text{c/cc}$. Argon-41 has a short half-life (1.9 hours); it is gaseous and thus it will mostly escape to the atmosphere upon discharge. It is not an ingestion hazard, and calculations have shown that if all the argon-41 in the coolant were released as a cloud, persons exposed to the cloud would receive only a negligible external radiation dose. Since argon-41 is no waste disposal problem, it will not be further discussed in this report.

In some of the reactors the primary coolant water is treated with a few parts per million of lithium hydroxide to raise the pH (alkalinity) of the coolant and thereby reduce corrosion of the system materials. The lithium will undergo a neutron reaction in the reactor core and form small amounts of tritium in the coolant. Experience with the PWR plant at Shippingport, Pa., which uses this same lithium hydroxide treatment, has shown that the tritium activity in primary coolant will consistently remain below 0.3 $\mu\text{c/cc}$. This concentration of tritium activity is far less than dumping tolerance of 7 $\mu\text{c/cc}$ established for tritium and thus it does not constitute a waste disposal problem.

B. Criteria and procedures for disposal of reactor coolant

The basic criterion adopted for disposal of coolant is that disposal should not increase the average concentrations of radionuclides in the surrounding environment by more than one-tenth of the maximum permissible concentrations for continuous exposure listed in National Bureau of Standards (NBS) Handbook 52. Application of this criterion has led to the waste disposal instruction for use by all U.S. naval nuclear-powered ships, included as appendix A to this report. This instruction was reviewed and concurred in by the U.S. Public Health Service, the Bureau of Medicine and Surgery of the Navy, the Reactor Development and Biology and Medicine Divisions of the AEC, and the Atomic Energy Applications Division of the Office of the Chief of Naval Operations. The instruction states that for discharge in port, reactor coolant gross activity must be less than 3 $\mu\text{c/cc}$ and the fission product iodine¹³¹ must be below 10^{-3} $\mu\text{c/cc}$. For discharge in the open sea, the instruction specifies no restriction because the quantities of waste

are small, the activities are normally well below the above dumping tolerances and the dilution obtained in the open sea is very much greater than in port.

The development of simple shipboard control procedures from the basic criterion stated above is discussed below in summary and then in detail:

1. A dilution factor is first determined by considering the frequency and quantities of coolant that are discharged and the dilution factors that are available in harbor waters. It has been established that in these waters a dumping tolerance of 100 times the NBS Handbook 52 tolerance for any specific nuclide is conservative.

2. By equally scaling up the activities of all the individual nuclides until the first nuclide reaches its dumping tolerance, it is determined that when the gross coolant activity is $3 \mu\text{c/cc}$ all nuclides are below their respective dumping tolerances. This gross activity then becomes the shipboard limit for disposal of reactor coolant during operation.

3. A similar scaleup is performed for the coolant after reactor shutdown. This condition is different from the operating condition above since all short-lived nuclides in the reactor coolant have decayed. The gross activity limit becomes $0.1 \mu\text{c/cc}$ for this case.

4. For the unexpected condition where fission product concentrations might become significant, the fission product that is closest to dumping tolerance is determined. A shipboard radiochemical procedure is established for determination of this nuclide. Experience on all naval ships to date indicates that this worst nuclide is iodine¹³¹ with a dumping tolerance of $3 \times 10^{-3} \mu\text{c/cc}$.

Each of the above steps is explained in more detail as follows:

1. *Dilution factor and definition of dumping tolerance.*—Because coolant is normally discharged in small quantities (average less than 500 gallons per discharge) it has been assumed that the discharged water will almost immediately be diluted in the harbor water by a factor of at least 1,000.¹ This assumption has been checked by actual measurements of activity in the water alongside the *Nautilus* while the ship was discharging reactor coolant at the Electric Boat Division dock in Groton, Conn. These measurements showed that when the ship was discharging water at about $2 \times 10^{-2} \mu\text{c/cc}$ the harbor water alongside the ship remained at background level of about $2 \times 10^{-7} \mu\text{c/cc}$, representing a dilution factor of at least 100,000.

To be conservative, a dilution factor of only 1,000 has been assumed. With this factor, dumping tolerances in the Navy instruction (appendix A) are set at 100 times the maximum permissible concentrations for continuous exposure listed in NBS Handbook 52. This will insure that disposal will meet the basic criterion of not increasing the average concentrations of radionuclides in the environmental water by more than one-tenth of the NBS Handbook 52 concentrations. The dumping tolerances in this report and in appendix A then are defined as 100 times the concentrations listed in NBS Handbook 52.

2. *Gross activity limit during reactor operation.*—As noted previously a complete analysis of all the significant radionuclides in the reactor coolant is made for each naval ship. (See table I and appendix B.) If these concentrations of nuclides in the reactor coolant are scaled up for a gross coolant activity of $3 \mu\text{c/cc}$, one may observe (see table III) that the concentrations of all nuclides are below dumping tolerance. On this basis, a shipboard procedure is used to verify that gross activity is below $3 \mu\text{c/cc}$. This procedure is easy to perform by ship personnel and provides ready control for coolant waste disposal purposes. In actual experience the gross activity is nearly always below $0.3 \mu\text{c/cc}$. Significant increases of coolant activity above this level would be indications of plant malfunction and continued reactor operation would normally not be permitted. Hence the normal limit imposed for reactor operating reasons is one-tenth the waste disposal limit of $3 \mu\text{c/cc}$.

¹ A volume of water equal to the displacement of the ship would be more than enough to accomplish this dilution.

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TABLE III.—Comparison of nuclide activities with dumping tolerance (all activities in $\mu\text{c/cc}$)

Nuclide	Column A, nuclide activity from table I scaled up to gross activity = $3 \mu\text{c/cc}$	Column B, dumping tolerance (100 times Handbook 52)	Ratio, column A/ column B
Mn ⁵⁶	1.3	15.0	0.09
Co ⁶⁰	3.6×10^{-4}	2.0	.002
Fe ⁵⁹	9.0×10^{-3}	1.0×10^{-2}	.90
Ni ⁶⁵	9.6×10^{-3}	19.0	.0005
Cr ⁵¹	6.0×10^{-4}	50.0	.00001
Na ²⁴	4.8×10^{-3}	8.0×10^{-1}	.006
Cu ⁶⁴	9.0×10^{-4}	8.0	.0001
Ta ¹⁸²	4.3×10^{-1}	10.0	.04
F ¹⁸	7.2×10^{-1}	90.0	.008
W ¹⁸⁷	1.9×10^{-2}	9.0×10^{-2}	.21

3. *Gross activity limit after reactor shutdown.*—Within several days after reactor shutdown there are no longer significant quantities of short-lived nuclides; the coolant activity is now largely composed of long-lived isotopes such as iron 59 and cobalt 60. A different gross activity limit is needed for waste disposal after shutdown, since if the water has a gross activity as high as $3 \mu\text{c/cc}$, some of these nuclides could be above their dumping tolerances. Examination of table I and appendix B shows that iron 59 has concentrations closest to dumping tolerance and that its highest concentration in the coolant more than 48 hours after shutdown is less than 10 percent of the gross activity. On this basis, if the gross activity is less than $0.1 \mu\text{c/cc}$ 48 hours or more after shutdown, all nuclides including iron 59 will be below dumping tolerances. Table IV illustrates this point. On the basis of these data the instruction to ships, appendix A, uses the limit of $0.1 \mu\text{c/cc}$ for times beyond 48 hours after reactor shutdown.

TABLE IV.—Reactor coolant activity 48 hours after shutdown (scaled up to a gross activity of $0.1 \mu\text{c/cc}$ assuming the most adverse Fe⁵⁹ concentrations)

Nuclide	Half life	Measured coolant activity ($\mu\text{c/cc}$)	Dumping tolerance ($\mu\text{c/cc}$)
Fe ⁵⁹	45 days	1×10^{-2}	1×10^{-2}
Co ⁶⁰	5.2 years	1.2×10^{-2}	2
Cr ⁵¹	27 days	2.6×10^{-3}	50
Na ²⁴	15 hours	3.2×10^{-3}	8×10^{-1}
Cu ⁶⁴	12.8 hours	1.5×10^{-2}	8.0
Ta ¹⁸²	112 days	2.6×10^{-2}	10
W ¹⁸⁷	24 hours	1.5×10^{-3}	9×10^{-2}
Gross activity		1.0×10^{-1}	1×10^{-1}

4. *Fission products.*—Analysis of the fission product concentrations in the coolant (shown in table II) shows that iodine 131 comes the closest to its dumping tolerance. The relative amounts of all these fission products has remained consistent on all naval reactor plants operated to date. For shipboard control of coolant waste disposal then, a radiochemical analysis for iodine is performed daily to determine that iodine 131 concentration is below $10^{-3} \mu\text{c/cc}$. This will insure that all other fission products are below their respective dumping tolerances.

IV. WASTES FROM INFREQUENT OPERATIONS

Reactor plant operations also produce other radioactive wastes that require less frequent disposal than reactor coolant. This section discusses these wastes which include ion exchange resin, reactor shield water, solid wastes from maintenance operations, and special wastes from laundry or decontamination operations.

A. *Ion exchange resin*

The reactor coolant is continuously being filtered and purified by passing a small bypass flow through an ion exchange resin. This resin becomes exhausted and is

replaced approximately every 6 months. Table V shows the radioactivity associated with the spent resin. Short lived nuclides are not included since the activities present shortly after reactor shutdown are insignificant compared to the long-lived nuclides shown.

TABLE V.—Radioactivity of spent ion exchange resin¹

Nuclide	Half life	Maximum activity ¹ curies
Co ⁶⁰	5.2 years.....	10.0
Co ⁵⁸	71 days.....	.5
Fe ⁵⁹	45 days.....	.5
Cr ⁵¹	27 days.....	.3
Mn ⁵⁴	300 days.....	.2
Hf ¹⁷⁶	70 days.....	1.0
Total.....		12.5

¹ Maximum radioactivity expected based on measurements from operating plants.

If resin replacement is necessary in port, the resin is dumped to a disposable catch tank. The catch tank is subsequently sealed and buried by land or sea in accordance with approved procedures.

Resin discharge at sea can take account of the great dilution available in the ocean. When dumped overboard the resin will sink and as it sinks the radioactive ions on the resin are rapidly replaced by ions of the sea water. Thus, within a few minutes the radioactivity has transferred from the resin to the sea water in the wake of the ship where it will readily disperse. Assuming conservatively that the wake is no longer than the path of the ship itself, the distributed activity from the resin results in a sea water gross concentration in the ship's wake of less than 10^{-3} $\mu\text{c/cc}$. Even at this concentration all nuclides are below NBS Handbook 52 permissible concentrations. In addition, subsequent action of wind, wave, and current will rapidly decrease these concentrations. On this basis the Navy instruction appendix A, allows resin disposal in the ocean. However, in order to avoid any possibility of having such discharges increase the radioactivity to which people are exposed, restrictions stated in appendix A are placed on ship location with respect to land, to other ships, and to fishing areas during resin discharge.

B. Reactor shield water

Some attenuation of the radiation emanating from the reactor core is accomplished by using water in a shield tank around the reactor. This shield water will seldom if ever be dumped during the life of a ship. Two-tenths percent potassium chromate is used in this water as a corrosion inhibitor to protect the steel surfaces inside the tank. Neutron activation of the potassium chromate and impurities in the shield water produce small concentrations of radionuclides as shown in table VI. Since the concentrations are well below dumping tolerance, no waste disposal restrictions for radioactivity are necessary as disposing of shield tank water.

TABLE VI.—Radionuclides in shield tank water

Nuclide	Maximum observed activity, $\mu\text{c/cc}$	Dumping tolerance, $\mu\text{c/cc}$
K ⁴²	0.2.....	1.
Cr ⁵¹	0.5.....	5.
Fe ⁵⁹	1×10^{-4}	1×10^{-2} .

C. Solid wastes

Solid radioactive wastes from nuclear ships result primarily from maintenance operations. Such materials include metal scrap, pieces of insulation, rags, sheet plastic, and paper. These solid wastes are given by the ships to shore or tender facilities for subsequent packaging and burial in accordance with approved procedures.

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1. Decontamination and laundry wastes

Other operations associated with reactor plants require disposal of radioactive liquids. Decontamination of radioactive tools and equipment and laundering of radioactive anticontamination clothing may be performed on some ships. Discharge of resulting liquids is permitted by appendix A in harbors if no nuclide concentrations exceed dumping tolerance. To insure that this criterion is met, the radioactive decontamination and laundry wastes from the ships are held up for monitoring and treatment by ion exchange if necessary.

It should be noted that all of the above wastes from infrequent operations, with the exception of shield water, derive their contamination from radioactivity produced in the reactor coolant water. They will therefore contain the same radionuclides as the reactor coolant.

V. ENVIRONMENTAL EFFECTS

In order to verify the adequacy of the ship waste disposal procedures of appendix A, surveys are being conducted of the radioactivity in the environment around ports where nuclear ships are being built and operated. These surveys cover periods both before and after commencement of operation of the reactors. The surveys are being made in cooperation with the U.S. Public Health Service and are being conducted by State and local public health organizations and the shipyards. Included in the surveys are measurements of the radioactivity of water and atmospheric fallout, and sometimes marine organisms, fish, shellfish, mud, and vegetation.

The greatest amount of experience with these surveys to date has been obtained in the New London, Conn., area where the U.S.S. *Nautilus* has operated for 4 years and the U.S.S. *Skate* has operated 1 year. The waste disposal records of these ships are shown in tables VII and VIII. They are presented for later comparison with environmental survey results, and they may be summarized as follows:

Average gallons dumped in New London Harbor per month----	625.
Average number of discharges per month-----	7.
Average number of gallons dumped in a single discharge-----	90.
Maximum 15-minute activity at any single discharge-----	2.0×10^{-1} $\mu\text{c/cc}$.
Average 15-minute activity of water dumped-----	2.0×10^{-2} $\mu\text{c/cc}$.
Average 120-hour activity of water dumped-----	4.5×10^{-3} $\mu\text{c/cc}$.

In addition to the above data from *Nautilus* and *Skate* on disposal at New London, a review of coolant activity on all operating ships indicates the activity of the reactor coolant water is always low, averaging 2.5×10^{-2} $\mu\text{c/cc}$, and never reaches the normal limit of 0.3 $\mu\text{c/cc}$. Moreover, the logs indicate that at no time has water of an activity greater than 0.3 $\mu\text{c/cc}$ been disposed of in harbor or at sea.

TABLE VII.—U.S.S. "Skate" reactor coolant discharged in New London Harbor

Date	Gallons	Average 15 minute activity
December 1957-----	485	1.75×10^{-1}
January 1958-----	844	1.47×10^{-1}
February 1958-----	120	1.43×10^{-1}
March 1958-----		
April 1958-----	130	$.90 \times 10^{-1}$
May 1958-----		
June 1958-----		
July 1958-----	806	$.83 \times 10^{-1}$
August 1958-----		
September 1958-----		
October 1958-----	578	$.15 \times 10^{-1}$
November 1958-----	316	$.83 \times 10^{-1}$
December 1958-----	328	$.34 \times 10^{-1}$

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TABLE VIII.—USS "Nautilus" reactor coolant discharged in New London Harbor

Date	Gallons	Average 15 minute activity	Date	Gallons	Average 15 minute activity
March 1955.....	255	1.26×10^{-2}	February 1957.....	354	2.00×10^{-2}
April 1955.....	300	$.23 \times 10^{-2}$	March 1957.....		
May 1955.....	1,357	2.11×10^{-2}	April 1957.....	800	$.70 \times 10^{-2}$
June 1955.....	148	$.65 \times 10^{-2}$	May 1957.....	880	$.67 \times 10^{-2}$
July 1955.....	998	2.41×10^{-2}	June 1957.....		
August 1955.....			July 1957.....		
September 1955.....			August 1957.....	800	3.36×10^{-2}
October 1955.....	366	$.30 \times 10^{-2}$	September 1957.....		
November 1955.....	1,444	1.29×10^{-2}	October 1957.....		
December 1955.....	417	1.91×10^{-2}	November 1957.....		
January 1956.....			December 1957.....		
February 1956.....	2,268	1.78×10^{-2}	January 1958.....		
March 1956.....	1,128	2.97×10^{-2}	February 1958.....	2,380	$.90 \times 10^{-2}$
April 1956.....			March 1958.....	1,378	3.06×10^{-2}
May 1956.....	2,236	1.41×10^{-2}	April 1958.....	1,608	2.76×10^{-2}
June 1956.....	612	$.89 \times 10^{-2}$	May 1958.....		
July 1956.....			June 1958.....		
August 1956.....			July 1958.....		
September 1956.....			August 1958.....		
October 1956.....			September 1958.....	1,256	1.56×10^{-2}
November 1956.....			October 1958.....	540	1.41×10^{-2}
December 1956.....			November 1958.....	1,428	4.56×10^{-2}
January 1957.....	340	1.00×10^{-2}	December 1958.....	696	3.01×10^{-2}

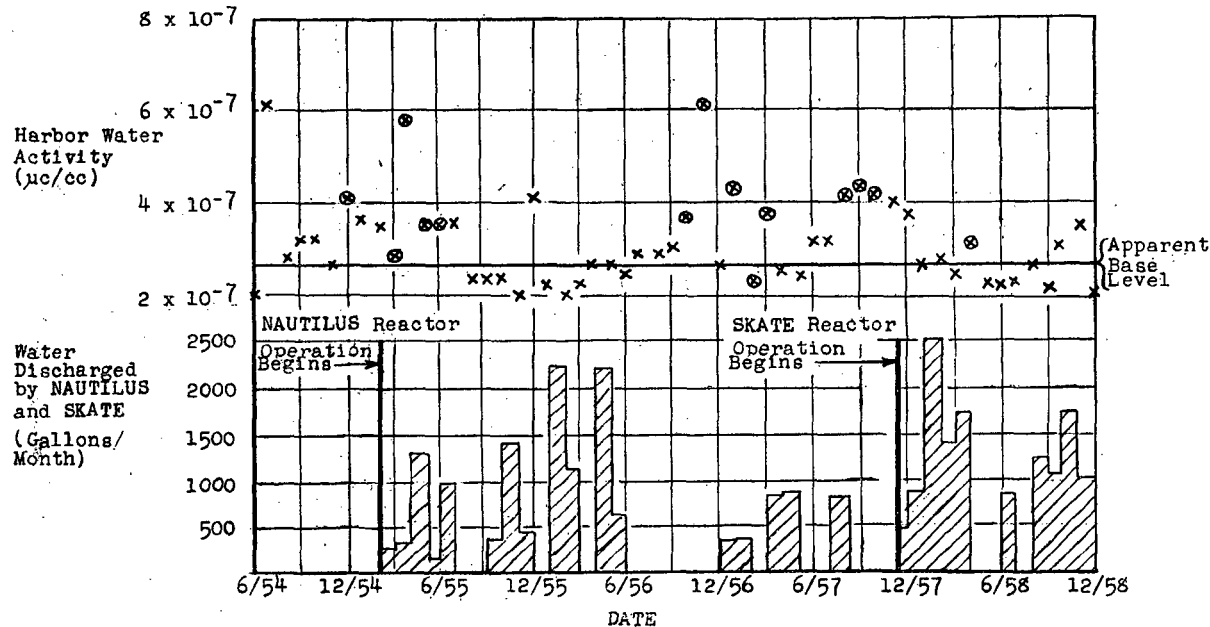
As noted above, a program was initiated before *Nautilus* began operation to survey periodically the activity of the New London Harbor environs. This survey was carried out by the Connecticut Department of Health, the Connecticut Water Commission, and the Electric Boat Division. An analysis of the effects of discharging of the reactor plant wastes on the activity of the Thames River can be made by considering the discharges presented in table VII and VIII together with the pre- and post-operational survey data obtained by the Electric Boat Division. Figure 1 presents the record of the *Nautilus* and *Skate* discharges at or near the Electric Boat dock together with the results of the operational surveys of water activities in the immediate area of the dock. The data show that the post-operation survey measurements all fall well within the range of the preoperational measurements even during period of maximum discharge from the ships. The data further indicates that the only increases in the activity of the river water samples bear no relation to the operation of nuclear submarines, but occurred during periods when nuclear weapons fallout was detected in rain and snow samples.

Examination of the additional survey data taken by the Connecticut Department of Health and the State Water Commission reveals that nearly all points surveyed both pre- and post-operational, showed activity below the minimum detectable limit. Some scattered pre- and post-operational data points show activities ranging up to twice the minimum detectable activity. These points bear no correlation with *Nautilus* discharges or with location respective to the Electric Boat dock where the *Nautilus* discharges were centered.

One must conclude from this survey data that the controlled disposal of radioactive wastes from the *Nautilus* and *Skate* has had no detectable effect on the radioactivity of the environment. The surveys will continue as more ships go into operation at New London and other ports to detect any possible effects of the naval ships on environmental radioactivity. Surveys are now underway at Portsmouth Naval Shipyard, N.H.; Mare Island Naval Shipyard, Calif.; and Bethlehem Steel Shipbuilding Division, Quincy, Mass. Additional surveys will soon be initiated at Newport News Shipbuilding & Drydock Co., Virginia, and Ingalls Shipbuilding Corp., Pascagoula, Miss.

FIGURE 1

Activity of Water in New London Harbor Near Electric Boat Division



x Normal survey. Each point represents the maximum of about 60 measurements per month

⊗ Survey point coincides with above-background fallout from nuclear weapons

APPENDIX A

BUSHIPS INSTRUCTION 9890.5

From: Chief, Bureau of Ships.

To: Distribution list.

Subject: Disposal of radioactive effluents from U.S. naval nuclear-powered ships.

Enclosure: (1) Maximum permissible concentrations of radioisotopes in effluents for discharge within 12 miles from shore.

1. *Purpose.*—To establish procedures and limits for the disposal of radioactive effluents from U.S. naval nuclear-powered ships.

2. *Cancellation.*—This instruction cancels and supersedes the following:

(a) BuShips ltr SSN-571(590) ser 590-1808 dtd May 31, 1955.

(b) BuShips ltr Ser. 1500G-660 dtd September 26, 1957.

3. *Scope.*—This instruction applies, during construction or operation, to all U.S. naval nuclear-powered ships equipped with pressurized water reactor plants.

4. *Reactor coolant sampling.*—The following analyses are performed using shipboard-type Geiger-Mueller counting equipment for reactor plant operational control, and to obtain information for disposal of reactor coolant:

(a) A sample of reactor coolant is taken at least once daily and measured for short-lived activity at 15 ± 2 minutes after sampling. At least once a week the same 15-minute sample is allowed to decay for 120 ± 6 hours and measured again for long-lived activity.

(b) The concentrations of fission products in the reactor coolant water are determined by analyses performed daily for iodine activity and monthly for strontium activity.

5. *Procedures for disposal of reactor coolant water.*—

(a) When the ship is more than 12 miles from shore, reactor coolant water and other effluents containing reactor coolant as the only radioactive contaminant may be discharged directly overboard without restriction.

(b) Reactor coolant water and other effluents containing reactor coolant as the only radioactive contaminant may be discharged directly overboard within 12 miles from shore, or at dockside, provided—

(1) the daily iodine analysis and monthly strontium analysis indicate that concentrations of fission products are less than 10^{-3} microcuries per milliliter ($\mu\text{c}/\text{ml}$) of iodine 131 and less than 10^{-4} $\mu\text{c}/\text{ml}$ of strontium 90;

(2) when the reactor is in operation or has been shut down for less than 48 hours, the daily measurement of gross degassed activity, 15 minutes after sampling, does not exceed 3 $\mu\text{c}/\text{ml}$;

(3) when the reactor has been shut down for 48 hours or more, the daily measurement of gross degassed activity, 15 minutes after sampling, does not exceed 0.1 cc/ml.

(c) If the conditions in paragraph 5 b above are not met, reactor coolant water should not be discharged overboard within 12 miles from shore. Under these conditions reactor coolant water may be discharged to a dockside retention tank for disposal by a shore facility.

6. *Procedures for disposal of spent demineralizer resin.*—

(a) At sea, spent demineralizer resin may be discharged overboard when the ship is more than 12 miles from shore, provided—

(1) the ship has headway on,

(2) other ships are not within 3 miles, and

(3) the ship is not in known fishing areas.

(b) Except as provided above, spent demineralizer resin should not be discharged overboard. At dockside, resin may be discharged to a retention tank for disposal by a shore facility.

7. *Procedures for disposal of other radioactive effluents.*—

(a) When the ship is more than 12 miles from shore, radioactive effluents derived from other propulsion plant fluid systems, shipboard decontamination, and laundry may be discharged directly overboard without restriction.

(b) For discharge directly overboard within 12 miles from shore or at dockside, the radioactivity of liquid effluent derived from propulsion plant fluid systems, shipboard decontamination, and laundry must be less than the values listed in enclosure (1).

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8 Records.—

Records shall be maintained of the measurements of paragraph 4 as well as type of discharge, total quantity, time, and location of discharged radioactive effluents.

(b) After the first 6 months of operation, the records obtained in accordance with the preceding requirement should be submitted to the Bureau of Ships for review.

9. *Effective date.*—This instruction is effective upon receipt.

H. G. RICKOVER,

Assistant Chief of Bureau for Nuclear Propulsion.

Distribution list:

- 29W SSN (only 571, 578).
- L1 Navshipyds (only PTSMH, Mare).
- L3 Supships-Insord (only Groton, Quincy, NPTNWS, Pascagoula).
- L3O Subase.
- 29W PCO Swordfish.
- 29W PCO Sargo.
- 24G Comsublant
- 24G Comsubpac.
- 21 Cinclantflt.
- 21 Cincpacflt.
- BSTR, Pittsburgh (5).
- BSTR, Schenectady (5).
- ABSTR, Windsor (3).
- A3 CNO (OP36).
- A5 Burned.
- USAEC, Division of Biology and Medicine.
- USAEC, Advisory Committee on Reactor Safeguards.
- USAEC, Division of Reactor Development.
- USAEC, Division of Licensing and Regulation.
- Military Liaison Committee, USAEC.
- U.S. Public Health Service, Division of Sanitary Engineering Services.

[Enclosure 1]

Maximum permissible concentrations of radioisotopes in effluents for discharge within 12 miles from shore

(Derived from National Bureau of Standards Handbook 52)

Isotope	Concentration (μc/ml)	Isotope	Concentration (μc/ml)
Unidentified beta or gamma emitters or any undetermined mixtures of beta or gamma emitters.	1×10 ⁻³	Unidentified alpha emitters or any undetermined mixtures of alpha emitters.	1×10 ⁻³
Ba ¹⁴⁰ +La ¹⁴⁰	2×10 ⁻¹	Na ²⁴	3×10 ⁻¹
Cu ⁶⁴	3×10 ⁻¹	Nb ⁹³	4×10 ⁻¹
Cd ¹⁰⁹ +Ag ¹⁰⁹	7	Ni ⁵⁹	
Ce ¹⁴⁴ +Pr ¹⁴⁴	4	Po ²¹⁰	3×10 ⁻³
Ci ¹⁰⁴	2×10 ⁻¹	Pu ²³⁹	1.5×10 ⁻⁴
Co ⁶⁰	2	Ra ²²⁶ +1 dr.	4×10 ⁻⁶
Cr ⁵¹	50	Rb ⁸⁶	3×10 ⁻¹
Cs ¹³⁷ +Ba ¹³⁷	1×10 ⁻¹	Rn ²²² +dr.	2×10 ⁻⁴
Cu ⁶⁴	8	Ru ¹⁰⁶ +Rh ¹⁰⁶	10
F ¹⁸	90	Sr ⁸⁹	7×10 ⁻³
Fe ⁵⁵	4×10 ⁻¹	Sr ⁹⁰ +Y ⁹⁰	8×10 ⁻³
Fe ⁵⁹	1×10 ⁻³	Th-natural	5×10 ⁻³
H ³ (HTO or T ₂ O)	7	U-natural	7×10 ⁻³
I ¹³¹	1×10 ⁻³	Xe ¹³³	4×10 ⁻¹
K ⁴²	1	Xe ¹³⁵	1×10 ⁻¹
Mn ⁵⁶	15	Y ⁹¹	20
Mo ⁹⁹	1400	Zn ⁶⁵	6

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APPENDIX B

Summary of radionuclide analyses on "Nautilus" and "Skate" reactor core

PT. 1. USS "NAUTILUS" (ALL ACTIVITIES IN $\mu\text{C/CC}$)

Dumping tolerance	15 min. gross 3.0	120 hr gross	Mn ⁵⁴ 15	Co ⁶⁰ 2	Fe ⁵⁹ 1×10 ⁻²	Ni ⁶³ 1.9	Cr ⁵¹ 50
DATE							
May 1955	1.4×10 ⁻¹	4.9×10 ⁻⁴	9.3×10 ⁻²	8.1×10 ⁻³	2.6×10 ⁻⁵		1.2×10 ⁻³
June 1955	8.2×10 ⁻²	8.9×10 ⁻³	2.0×10 ⁻²	2.7×10 ⁻³	8.9×10 ⁻⁴	1.8×10 ⁻⁴	
July 1955	8.2×10 ⁻²	3.0×10 ⁻³	1.3×10 ⁻²	9.1×10 ⁻⁴	3.6×10 ⁻⁴	5.5×10 ⁻⁴	1.0×10 ⁻⁴
August 1955	2.2×10 ⁻¹	3.3×10 ⁻³	1.0×10 ⁻²	1.2×10 ⁻³	5.3×10 ⁻⁴	8.9×10 ⁻⁴	2.8×10 ⁻³
October 1955	1.5×10 ⁻¹	1.0×10 ⁻²	7.3×10 ⁻³	2.5×10 ⁻²	2.8×10 ⁻³	5.0×10 ⁻⁴	3.4×10 ⁻³
November	4.5×10 ⁻²	1.4×10 ⁻³	9.8×10 ⁻³	6.1×10 ⁻⁴	1.1×10 ⁻⁴	9.3×10 ⁻⁵	1.6×10 ⁻³
December 1955	1.3×10 ⁻¹	3.3×10 ⁻³	3.4×10 ⁻²	9.9×10 ⁻³	1.5×10 ⁻³	1.3×10 ⁻³	6.5×10 ⁻⁴
February 1956	8.1×10 ⁻²	1.2×10 ⁻³	9.2×10 ⁻³	5.6×10 ⁻⁴	7.4×10 ⁻⁵	3.8×10 ⁻⁴	2.4×10 ⁻³
April 1956	1.3×10 ⁻¹	3.6×10 ⁻²	6.4×10 ⁻²	1.6×10 ⁻³	2.2×10 ⁻⁴	1.5×10 ⁻³	9.1×10 ⁻³
June 1956	7.0×10 ⁻²	9.0×10 ⁻⁴	1.3×10 ⁻²	1.4×10 ⁻⁴	4.1×10 ⁻⁵	2.3×10 ⁻⁴	5.9×10 ⁻³
July 1956	4.7×10 ⁻²	4.4×10 ⁻⁴	4.5×10 ⁻³	3.8×10 ⁻³	2.0×10 ⁻⁵	2.6×10 ⁻⁴	5.9×10 ⁻³
August 1956	1.5×10 ⁻¹	4.8×10 ⁻³	7.0×10 ⁻³	8.3×10 ⁻³	1.7×10 ⁻³	1.2×10 ⁻³	1.3×10 ⁻³
October 1956	4.6×10 ⁻²	2.5×10 ⁻³	1.1×10 ⁻²	1.2×10 ⁻³	1.6×10 ⁻⁴	5.0×10 ⁻⁵	1.4×10 ⁻³
December 1956	5.1×10 ⁻²	1.2×10 ⁻³	1.8×10 ⁻³	6.5×10 ⁻⁴	9.0×10 ⁻⁵	2.8×10 ⁻⁴	8.8×10 ⁻³
February 1957	5.8×10 ⁻²	1.4×10 ⁻³		5.8×10 ⁻⁴	5.1×10 ⁻⁵		3.0×10 ⁻³
March 1958	2.3×10 ⁻¹			4.5×10 ⁻⁴	4.8×10 ⁻⁶		8.2×10 ⁻³
August 1958				2.1×10 ⁻⁴	1.7×10 ⁻⁵		4.3×10 ⁻³

Dumping tolerance	Na ²⁴ 3×10 ⁻¹	Cu ⁶⁴ 8	Ta ¹⁸² 10	F ¹⁸ 90	W ¹⁸⁷ 9×10 ⁻²
DATE					
May 1955	2.0×10 ⁻⁴	2.9×10 ⁻⁴			4.7×10 ⁻³
June 1955	1.0×10 ⁻⁴	3.4×10 ⁻⁴	5.2×10 ⁻⁵	5.5×10 ⁻³	3.6×10 ⁻³
July 1955	2.0×10 ⁻⁴	6.8×10 ⁻⁴	1.4×10 ⁻³	2.6×10 ⁻²	1.3×10 ⁻⁴
August 1955	2.1×10 ⁻⁴	1.8×10 ⁻³	6.8×10 ⁻³		1.1×10 ⁻³
October 1955	5.0×10 ⁻⁴	2.1×10 ⁻³	2.9×10 ⁻²	6.8×10 ⁻²	1.3×10 ⁻³
November 1955	5.4×10 ⁻⁵	1.9×10 ⁻⁴	1.2×10 ⁻³	8.2×10 ⁻³	1.4×10 ⁻³
December 1955	6.2×10 ⁻⁴	1.4×10 ⁻³	1.7×10 ⁻²	1.5×10 ⁻²	9.5×10 ⁻⁴
February 1956	2.5×10 ⁻⁴	1.4×10 ⁻⁴	1.8×10 ⁻⁴	2.7×10 ⁻²	1.5×10 ⁻⁴
April 1956	4.1×10 ⁻⁴	3.0×10 ⁻³	4.5×10 ⁻³	6.8×10 ⁻³	7.7×10 ⁻⁴
June 1956	4.8×10 ⁻⁵	7.9×10 ⁻⁵	5.7×10 ⁻⁵	1.9×10 ⁻²	1.8×10 ⁻⁵
July 1956	4.9×10 ⁻⁵	3.5×10 ⁻⁵	7.6×10 ⁻⁵	8.6×10 ⁻³	1.8×10 ⁻⁴
August 1956	2.7×10 ⁻⁴	4.7×10 ⁻³	2.2×10 ⁻³	3.0×10 ⁻²	9.0×10 ⁻³
October 1956	1.1×10 ⁻⁴	1.0×10 ⁻⁴	1.8×10 ⁻⁵	5.1×10 ⁻³	1.3×10 ⁻³
December 1956	1.0×10 ⁻⁴	9.3×10 ⁻⁵	6.7×10 ⁻⁶	2.0×10 ⁻²	3.0×10 ⁻⁴
February 1957		1.1×10 ⁻⁴	3.0×10 ⁻⁵		
March 1958					1.5×10 ⁻³
August 1958					4.1×10 ⁻³

PT. 2. U.S.S. "SKATE" (ALL ACTIVITIES IN $\mu\text{C/CC}$)

	15 min- utes gross	120 hours gross	Cr ⁵¹	Fe ⁵⁹	Co ⁵⁸	Co ⁶⁰	Mn ⁵⁴	Zr-Hf	W ¹⁸⁷
Dumping tolerance	3.0		50	1.0×10 ⁻²	2	2.0	1.3×10 ⁻¹	4×10 ⁻¹	9.0×10 ⁻³
1957									
October	1.7×10 ⁻²	1.1×10 ⁻⁴	2.5×10 ⁻⁶	1.7×10 ⁻⁷	1.4×10 ⁻⁷	1.0×10 ⁻⁷	1.6×10 ⁻⁶		1.8×10 ⁻³
November	1.1×10 ⁻²	7.5×10 ⁻⁴	4.5×10 ⁻⁷	2.4×10 ⁻⁶	3.6×10 ⁻⁶	2.2×10 ⁻⁶	2.5×10 ⁻⁵	1.2×10 ⁻⁷	2.3×10 ⁻³
1958									
January	2.3×10 ⁻²	1.7×10 ⁻⁴	2.7×10 ⁻⁵	2.4×10 ⁻⁵	3.2×10 ⁻⁵	3.6×10 ⁻⁵	3.6×10 ⁻⁵	6.4×10 ⁻⁷	3.1×10 ⁻³
February	1.7×10 ⁻²	2.3×10 ⁻⁴	7.3×10 ⁻⁷	4.6×10 ⁻⁶	7.0×10 ⁻⁶	4.9×10 ⁻⁶	3.7×10 ⁻⁵	3.8×10 ⁻⁵	2.1×10 ⁻³
March	3.2×10 ⁻²	2.3×10 ⁻⁴	1.5×10 ⁻⁵	1.3×10 ⁻⁵	2.4×10 ⁻⁵	1.7×10 ⁻⁵	5.1×10 ⁻⁵	2.8×10 ⁻⁷	2.9×10 ⁻³
May	8.0×10 ⁻³	9.3×10 ⁻⁴	3.0×10 ⁻⁵	3.1×10 ⁻⁵	7.6×10 ⁻⁵	1.1×10 ⁻⁴	6.5×10 ⁻⁵	3.6×10 ⁻⁶	2.1×10 ⁻³

APPENDIX 2

EAF HISTORY OF THE PRESSURIZED WATER REACTOR (PWR) AT SHIPPING-
PORT, PA. PREPARED BY THE NAVAL REACTORS BRANCH, AEC

On April 22, 1953, the National Security Council, the President approved the elimination of the large ship reactor project from the defense program. This project, known as the CVR, was instituted on the basis of a military requirement set up by the Joint Chiefs of Staff. That requirement stated that the CVR was to be a shore-based prototype of a single shaft for a large naval vessel such as an aircraft carrier, and to be used, after completion, to produce power and plutonium.

The decision to cancel the CVR project was influenced by the views of R. M. Kyes, Deputy Secretary of Defense, and Robert LeBaron, Assistant Secretary of Defense for Atomic Matters. H. G. Rickover, then captain, USN, in a memorandum dated May 15, 1953, to Gordon Dean, Chairman, Atomic Energy Commission, reported these views as brought out in a conference held among R. M. Kyes, R. LeBaron, Assistant Secretary of the Navy for Air J. F. Floberg, and himself, on April 30, 1953. In this conference it was stated by R. LeBaron that private industry was ready to undertake this development. It was further indicated by R. LeBaron that the time scale as currently planned for the CVR would require an inordinately long period of time and that such a time scale was too great to make it worth while to continue with the project. He indicated that with private industry doing the work the plant could be developed and installed in an aircraft carrier much more quickly, probably by 1956. It was further indicated that the technical approach being taken to the CVR project might be wrong and that reactors of the type installed in the submarine prototype plant in Idaho or a similar type could be used in the CVR plant. H. G. Rickover suggested that since there was doubt that industry would undertake the job and that since he felt that the technical approach being followed was the right one, the decision to terminate the CVR should be held up for 4 to 6 weeks so that an opportunity could be afforded to clear up these points. R. M. Kyes would not agree to this and terminated the meeting with the statement that the decision to cancel the CVR stood.

As a result of the April 22, 1953, action of the President, H. D. Smyth, Acting Chairman of the Atomic Energy Commission, following a suggestion of Commissioner Thomas E. Murray, addressed a letter dated April 29, 1953, to the President. This letter referred to the President's decision that "The early development of nuclear power by the United States is a prerequisite to our maintaining our lead in the atomic field." To achieve this early development, we recommend that segments of the large ship and aircraft programs, essential to the development of civilian power, be continued vigorously even though the NSC has determined that these programs should "be eliminated as not required from the viewpoint of national security." The reason for our recommendation is the long recognized fact that these programs bear a vital relationship to the development of reactor technology leading to civilian power.

"It is true that the primary purpose of the large ship reactor program was to meet a high priority military requirement of the Joint Chiefs of Staff. We have depended on the program, however, as providing a principal basis for the ultimate construction of civilian powerplants. We are convinced that the pressurized light-water reactor, which is the heart of the planned large ship propulsion unit, offers a promising avenue of approach which must be pursued vigorously if the Nation is to get on with the job of attaining civilian power * * *.

"The Commission's recommended power policy recognizes the importance of utilizing the resources of private industry to the greatest extent possible. One of the main reasons the Commission is urging a change in the 1946 law is to obtain such industrial participation. However, it may well require a long period before the legal obstacles to privately financed work in this field are removed. In the meantime, the civilian power program would be marking time. We are convinced that even after statutory obstacles are removed, private industry will not assume a major part of the expensive, long-term development work that must precede the attainment of civilian power. This is the unanimous opinion of the Commission and is based upon its assessment of the state of the technology, its many contacts with industry, and investigations made during the last 2 years by private groups.

"It is, therefore, the unanimous recommendation of the Commission that the pressurized light-water program and research, such as that on fluid fuel reactors, be continued.

"Although we believe that private interests will not take the initiative and construct experimental power reactors, it is the opinion of the Commission that some private financial assistance may be obtained in connection with the design and construction by AEC of a civilian version of the proposed Navy reactor."

On May 5, 1953, at a meeting of Atomic Energy Commissioners Smyth, Murray, and Zuckert and General Manager Boyer, the Commission asked for a report from Dr. L. R. Hafstad, Director of Reactor Development, and H. G. Rickover, based upon the following ground rule: "The Commission asked authority to proceed on the study of a pressurized light-water reactor along the same central idea as the CVR to the point of constructing such a reactor with an electrical power output of 50,000 kilowatts and with an overall cost of approximately \$100 million."

On May 6, 1953, the President confirmed his earlier action to eliminate, as not required from the viewpoint of national security, the existing program for the large ship reactor. The President, however, adopted the recommendation of the Atomic Energy Commission that the pressurized light-water program and related research be continued, pending the availability of private financing, in the interests of nuclear power development. It was estimated that carrying the full program to completion would cost the Government approximately \$100 million unless private financing should become available before completion.

On May 13, 1953, in response to the May 5, 1953, request of the Commission, H. G. Rickover furnished to M. W. Boyer a plan of action for handling the light-water power reactor. In part, Rickover recommended as follows:

"Centralized control by Government—to insure carrying through of specified direction of the project and to fulfill Government responsibility for expenditure of funds.

"Firm decisions—to assure rapid progress and the avoidance of protracted studies.

"Close coordination between manufacturer and user—to insure a successful end product.

"Concentration upon the most difficult problems first—these govern the time scale."

H. G. Rickover further continued:

"As a basic premise, the slightly enriched light-water cooled and moderated reactor concept will be adhered to as has been planned for CVR in order to make maximum use of the study and development which has already gone into this project; this will permit the earliest possible construction. This principle will involve close administrative and technical coordination by the Government, of the industrial effort of Bettis, and of other organizations working on the problem."

On May 12, 1953, a revised budget estimate was furnished the Bureau of the Budget which included \$4,200,000 for beginning research and development and \$5 million for commencing construction of a PWR. On May 14, however, the funds for beginning construction of PWR in fiscal year 1954 were deleted from the 1954 budget estimates by the Bureau of the Budget.

On May 20, 1953, W. Sterling Cole, chairman, Joint Committee on Atomic Energy, Congress of the United States, wrote to the Honorable John Phillips, chairman, Independent Offices Subcommittee of House Appropriations Committee, in part, as follows:

"I would like to call your attention to a matter of great concern to me and my colleagues on the Joint Committee on Atomic Energy. * * *

"It is possible that the relations of the United States with every other country in the world could be seriously damaged if Russia were to build an atomic powerplant for peacetime use ahead of us. The possibility that Russia might demonstrate her 'peaceful' intentions in the field of atomic energy while we are still concentrating on atomic weapons could be a major blow to our position in the world. It could even disrupt the continued operations of our own weapon plants by stimulating friendly countries to cut off the vital uranium they now sell us—cut it off to avoid the charge at home that they are selling their atomic power birthright for American dollars.

"Needless to say, loss of American prestige as the leader in the field of atomic energy development might also result if Great Britain or other friendly foreign countries achieve commercial atomic power before we do. There have been announcements in Great Britain, France, Canada, Norway, and Australia, that competent teams of scientists and engineers are hard at work preparing to build atomic powerplants. There is little question but that they will succeed and do so

thin a few years. Yet in the United States, where we are spending billions of dollars every year on atomic energy, there is not a single atomic powerplant of commercial size under construction or even scheduled for construction in the next 18 months. * * *

"The first atomic power project began under the Manhattan Engineer District in 1946 at Oak Ridge. It failed a year later because of the inadequacy of the existing scientific and technical data. The second atomic power project ran its course from 1948 through early 1950 at the Knolls Laboratory in Schenectady, N.Y. * * * It was canceled before construction began in part because of the excessive cost in prospect for this design. * * * The third effort, in 1951-52, consisted of getting four groups of private companies to study the prospects for privately financed projects. All four groups expressed interest, but none offered to put up more than token money at this stage of development.

* * *
"Finally, Navy plans for an atomic powerplant prototype for an aircraft carrier were reviewed by the National Security Council and the Department of Defense and were eliminated as too long-term for the current budget. The so-called CVR aircraft carrier project happens to coincide with many aspects of commercial atomic power development. It was the last-ditch stand from which the Commission hoped to draw the design and operating experience for stimulating private commercial atomic power development.

"Cancellation of the aircraft carrier reactor resulted in a letter appeal from the Commission to the President and a special appearance before the Joint Committee. As a result, a completely civilian version of the aircraft carrier reactor was put back in the fiscal 1954 budget now before the Congress. This plant would produce 250,000 kilowatts of electric power. But the budget now before you contains only \$4,200,000 for continuation of research and development and nothing for construction.

* * *
"I would therefore like to recommend most earnestly that you give consideration to adding \$12 million to the plant and equipment part of the Atomic Energy Commission fiscal 1954 budget for the start of construction of at least one atomic powerplant designed to produce commercial electric power. This is the amount the Commission has stated to the Joint Committee would be the amount of which construction could be certain to start this coming year * * *.

"In 1946, the 79th Congress declared it to be 'the policy of the people of the United States that * * * the development and utilization of atomic energy shall * * * be directed toward improving the public welfare, increasing the standard of living, strengthening free competition in private enterprise, and promoting world peace.' It is vital that we get on with peacetime atomic power.

"Scientists and engineers the world over have declared commercial atomic power possible now. We must be about the business of building at least one plant as a demonstration to American industry and to the world that it is possible, economic, and truly practical."

In addition to the Rickover plan of May 13, 1953, and as a further consequence of the May 5, 1953, request of the Commission, an alternate plan was submitted to L. R. Hafstad by S. McLain of the Production Reactors Branch, AEC. Under this plan it was assumed that the objective of the new PWR program would be to construct and operate a reactor by 1959 which would produce industrially significant blocks of electric power as cheaply as the best currently available technology would permit, and which would show conclusively actual cost and the technical areas of high cost in which further savings might be made, looking toward ultimate economic power. It was further recommended that system analyses of both pressurized light- and heavy-water reactors should be reviewed with target date of January 1, 1954, for the decision concerning the reactor to be constructed. Under this plan it was felt that the organization which would be evolved to carry forward the program should include elements reflecting the point of view of the utility companies and their engineering associates, the point of view and experience of manufacturers of equipment, and contributions from AEC laboratories such as Argonne National Laboratory.

On May 22, 1953, H. G. Rickover and S. McLain met in the office of M. W. Boyer, General Manager. Boyer opened the meeting by reading a memorandum written by Commissioner Murray in which the latter indicated that he desired no commitments as to the organization or contractual aspects of the proposed light-water pressurized reactor program until his return to Washington about June 2, 1953. Boyer then stated that in his opinion the philosophy must be

adopted of definitely deciding to build a reactor and not to do studies and investigations beyond a limited point.

It was also agreed that the fuel element was the most difficult and important item and should be given highest priority and precedence. Subsequently, at this meeting McLain and Rickover met to arrange the basis for work which they would jointly do in the next few days. It was agreed that neither would go to Westinghouse or to Argonne or to any other contractor during this period or ask them to make any studies.

On June 16, 1953, the Commission met in executive session and approved a pressurized water reactor program for the development and construction of a pressurized light-water reactor plant. At this meeting the Commission further noted that Westinghouse would be continued as the principal prime contractor responsible for this development and also noted that in the interest of continuity and early completion, responsibility for this project within the Division of Reactor Development would be assigned to the Naval Reactors Branch. This action was in accordance with the plan earlier submitted by H.G. Rickover.

During the month of June 1953 the independent offices appropriation bill was being considered by the House of Representatives. On June 9, 1953, the Commission pointed out in a letter to the chairman of the Independent Offices Subcommittee of House Appropriations Committee that no provision was made in the 1954 budget for beginning construction of a civilian power reactor. It was stated that if \$7 million was provided, essential work for initiating construction of such a reactor could be undertaken in fiscal year 1954. This proposal received congressional support, and the independent offices appropriation bill as finally signed by the President in July 1953 contained language as follows:

"Provided further, That in addition to funds allocated for research and development for a reactor which will advance technology toward both ship propulsion and the generation of industrial power and for design of such atomic power reactor, the Commission may expend from funds provided under this head such sum as may be necessary, not to exceed \$7,000,000, for the beginning of construction of such reactor, without regard to any other provision of this Act."

On July 8, 1953, W. Sterling Cole, chairman, JCAE, in a letter to Lewis L. Strauss, Chairman, AEC, stated, in part, as follows:

"It now appears likely that the provision in your fiscal 1954 appropriation relating to the start of construction of atomic powerplants will be approved by the Congress. This provision, as you know, will permit the Commission to spend up to \$7 million from appropriate construction funds for the start of construction of atomic powerplants which will be able to contribute to the technology needed for further development of practical and economic civilian powerplants.

"As is indicated in the attached copy of my letter of May 20, to Mr. John Phillips, chairman of the House Independent Offices Appropriation Subcommittee, this provision will establish a program initiated by the Congress. This is in contrast to those programs recommended by the executive branch and approved by the Congress. In this sense, it is being imposed on the Commission outside of the recommendations submitted to the Congress by the President with his fiscal 1954 budget message.

"The Joint Committee has a more than usual interest, therefore, in just how this program is carried out. Any advantage which it has been hoped might be gained from a demonstration of the interest of the United States in peaceful application of atomic energy might, for example, be impaired if administration of the program results in too heavy emphasis on the Navy aspects of the objectives. Such impairment might result from Navy direction, extensive Navy specifications, and the inevitable 'leaked' new articles referring to aircraft carrier reactor prototypes.

"It appears to be the intent of the Congress to provide a substantial advance in technology to the future benefit of both civilian and Navy applications of atomic power. In setting up the administrative framework for carrying out the provision, therefore, care must be exercised to avoid any commitment to reactor systems based on any particular civilian or Navy specifications such as pressures, power ratings, or other features which might prevent the systems from ever allowing extrapolations with regard to the economics of the power generated.

"It would be very much appreciated, therefore, if you would arrange to inform the committee in some detail of the specific administrative and organizational plan by which you propose to effectuate this provision for construction of atomic powerplants.

"I believe that this proposed administrative structure should be submitted for the perusal of the Joint Committee before it is put into effect. I am aware of the

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fact as of this date it is not yet certain whether the final provision will be stated in terms of one reactor or more than one, but in either event the committee will still want to know how the Commission plans to administer the program. In order that this review of the proposed plan will in no way delay execution of the provision, it would be helpful if your plan could be available for our examination before the recess of Congress."

In its meeting on July 9, 1953, the Atomic Energy Commission reaffirmed its action taken at the executive session on June 16, 1953, approving the program and assignment for the development and construction of a pressurized light-water reactor plant. The July 8, 1953, letter from W. Sterling Cole quoted above was available to the Commission at this meeting.

On the same date, L. R. Hafstad, Director of Reactor Development, dispatched a teletype to A. Tammaro, Manager, Chicago Operations Office, AEC, with a copy to Lawton D. Geiger, Manager, Pittsburgh area office, AEC. The text of this teletype was as follows:

"The AEC has authorized reorientation of the CVR program. The new objective has been set as a pressurized light-water reactor powerplant, with the basic reactor design of the old CVR program, primarily for the purpose of the generation of civilian electrical power, but secondarily for possible use in a naval application should a future requirement for this type develop. This program is designated 'PWR' (pressurized water reactor).

"The general features of this reactor are expected to be—

"(a) Generation of at least 60,000 kilowatts of useful electric energy.

"(b) Use of light-water cooled and moderated, slightly enriched uranium type of reactor.

"(c) Six hundred pounds per square inch saturated or higher steam conditions.

"(d) Fuel element life as long as possible between chemical reprocessings (initial goal in excess of 3,000 MWD/T).

"(e) Refueling with minimum shutdown period.

"(f) Simplified reactor control system.

"(g) Central station type turbine and electrical generating equipment.

"(h) Conventional central station steam, electric, and other auxiliary systems.

"(i) Commercial standards of equipment.

"(j) Use of concrete for shielding.

"(k) Minimum possible construction cost of the plant.

"(l) Minimum possible operating cost of the plant consistent with the above requirements.

"All work will be terminated on items in the former CVR program aimed specifically at ship design and testing directed solely at meeting specific Navy requirements. Orderly closeout and the preparation of terminal reports for this work is authorized.

"Westinghouse will be continued as the principal prime contractor responsible for this development. Responsibility for this project within the Division of Reactor Development has been assigned to the Naval Reactor Branch, who will discuss the detailed program with you and your staff and with the contractor.

"No public announcement is presently planned regarding this program reorientation. Any relations with interested public utilities will be handled by the Commission in Washington for the time being."

The technical features outlined in the teletype above were conceived by the Naval Reactors Branch. These were transmitted to Westinghouse through Lawton D. Geiger, manager, Pittsburgh area office, AEC, for guidance in developing the design of the plant.

On August 5, 1953, Chairman Strauss replied to the July 8 letter of W. Sterling Cole, chairman, JCAE, as follows:

"This is in response to your letter of July 8 regarding the pressurized light-water reactor.

"In all recent planning for construction of a central station atomic powerplant we have worked on one principal assumption, that the United States should start construction of a power reactor now—rather than continue research and development looking to the 'last word' in an economical power reactor. Because large-scale engineering and operational experience are essential for rapid technological development, we believe that only by moving into the construction phase can we fulfill the requirement of the President which recently held that the early development of nuclear power by the United States is a prerequisite to maintaining our lead in the atomic field. And your most effective assistance on

obtaining construction funds for a power reactor in the 1954 House indent offices appropriation bill demonstrates your complete agreement on this e.

"Acting on this assumption, AEC recommended to the President on April 29 that a pressurized light-water reactor (PWR) be constructed. Construction of such a reactor can be started this fiscal year because of past development work on the recently canceled project for the Navy. Fortunately, as you pointed out in your letter to Mr. Phillips dated May 20, attached to your letter to the Commission of July 8, 'The so-called CVR aircraft carrier project happens to coincide with many aspects of commercial atomic power development.' We are convinced that substantial delays would result if an attempt were made to develop some other reactor system for this first civilian powerplant.

"Moreover, the need for early completion of this power reactor has led us to conclude that the PWR project should be continued in its present contractual and organizational framework, namely, with Westinghouse as the prime contractor and the Reactor Development Division, Naval Reactors Branch, as the responsible Government supervising agency. It is our judgment that much time and momentum would be lost by turning over this project to a new contractor or a different unit for governmental control.

"Although the appropriation act contains a general authorization to the Commission to build a reactor that will advance both civilian central station power technology and naval propulsion technology, you may rest assured that this reactor will be as you described it in your letter to Mr. Phillips of May 20—a completely civilian version.' No compromise or hybridization is planned or needed because of this congressional language. In view of the withdrawal of military support for the CVR, no naval engineering will be introduced into this design if it would cause any delay or increase the cost or affect the economical functioning of this reactor for its primary purpose as a central station powerplant. However, in our opinion, in the design and building of the PWR, useful technology having application to naval propulsion reactors will inevitably be developed.

"We also believe that the PWR project will be a focus of interest and activity for private enterprise and that its actual construction will stimulate offers for private support both in the supplying of components and in the overall development and operation of the resulting nuclear powerplant.

"You stated in your above-mentioned letter to Mr. Phillips: 'I do not know whether the first civilian powerplant will produce power at less cost than conventional plants.' Nor does the Commission, and it should be understood that in proceeding with this program the Commission is making no representation that the PWR will produce power at competitive costs.

"I trust that this outline of our planning will make clear to you that in executing the PWR program, there will be no subordination of the primary civilian power objective to military considerations."

On October 22, 1953, Commissioner Thomas E. Murray, in a speech before the electric companies public information program in Chicago, Ill., officially announced the start of the PWR program. He said, in part, as follows:

"I am very glad to be able to tell you officially today that the Commission has embarked on a program to construct a full-scale power reactor. It will produce a minimum of 60,000 kilowatts of electrical energy with good possibilities of much higher output. We hope to have it in operation in 3 to 4 years. This is America's answer—its significant peacetime answer—to recent Soviet atomic weapons tests. It should show the world that even in this gravest phase of arming for defense America's eyes are still on a peaceful future.

"You should know that there has been much talk and perhaps guarded criticisms among some scientists and some industrial groups of the choice of the particular reactor design that we have selected for our first large-scale reactor. I might hazard a guess that part of this attack was generated by the fact that the design chosen was inherited from a naval project. Be that as it may, let me assure you that it was not selected at random but is one of several studied for some time and approved by the entire reactor fraternity—and in addition that this particular reactor was much further along than any of the alternate systems.

* * * * *

"Supervision of the project has been delegated to our Reactor Development Division. The Director of this Division, Dr. Lawrence R. Hafstad, has assigned the immediate responsibility for the job to Rear Adm. H. G. Rickover, the Navy reactor expert. Some of our friendly critics have been reported as being somewhat concerned about the psychological effect of a Navy man in charge of this first industrial reactor construction. Let me tell you that this choice was based solely on the admiral's unique experience and accomplishments in building propulsion

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pow actors for the Commission and for the Navy. We have assured ourselves that only Navy aspect which the admiral will bring to this work is his title."

On November 2, 1953, the manager of the Chicago Operations Office, AEC, established a Contract Board for the selection of an architect-engineer for the PWR project. As of November 23, 1953, the Contract Board had reviewed the qualifications of over 80 firms and had reduced the list of firms considered qualified to 8. In the latter part of November and in early December members of the Contract Board visited each of these eight firms and in late December recommended the names of three to the manager, Chicago Operations Office, AEC.

Action on final selection of an architect-engineer was held in abeyance in view of the Commission's action of December 7, 1953, in renewing its invitation to private industry to submit proposals for the investment of risk capital in the PWR project. In this invitation the Commission said that it encouraged further evidence of industry's interest in private investment for the purpose of obtaining firsthand experience with the new technology involved in building and operating a large-scale reactor designed specifically for power-producing purposes. A deadline for submission of proposals by companies or organizations interested in participating was established as February 15, 1954.

On December 15, 1953, Chairman Strauss of the AEC responded to an earlier letter of the chairman, Joint Committee on Atomic Energy and set forth the manner in which the Commission had selected the principal contractor for the development of the PWR reactor and how the Commission had determined the type of reactor to be constructed. Admiral Strauss' letter is quoted in part as follows:

"In my letter to you of August 5, 1953, I stated the basis on which the pressurized water reactor program rests: 'That the United States should start construction of a power reactor * * * rather than continue research and development looking to the 'last word' in an economical power reactor.'

"In selecting the type of power reactor to construct, the Commission considered that the pressurized light-water reactor represented the type of power reactor on which the most work had been done. This technology had been advanced through the submarine thermal reactor development, construction, and operation and through the work on the large ship reactor. The Commission, after fully considering the technical merit of the project, unanimously decided to proceed with the light-water cooled type of reactor which had demonstrated through the successful operation of the submarine thermal reactor mark I its ability to produce large quantities of useful power for protracted periods of time.

"In selecting the contractor to be responsible for the development, design, and construction of the reactor itself and for the development of the primary coolant system no ordinary selection process was possible. The selection was made on the basis of the work completed by Westinghouse, and experience of the company in the light-water reactor field, and the qualification of the Bettis Laboratory staff to carry out the project.

"I am hopeful that the above information on the reasons for the Commission's selection of Westinghouse and the pressurized light-water reactor is helpful to you. The basis of both actions was of course our strong desire, which I know is shared by your committee, to get on with the development of atomic power by construction of a large-scale experimental nuclear powerplant of the type which seemed to provide the best assurance of successful operation."

In anticipation of the receipts of proposals from industry, on January 29, 1954, L. R. Hafstad appointed a board under the chairmanship of A. Tammaro, manager, Chicago Operations Office, for evaluation of any PWR participation proposals which might be received. In addition to this board, another board was appointed to evaluate various Commission-owned facilities with the end in view of locating PWR at one of these in the event that satisfactory proposals from industry were not forthcoming. A. Tammaro was also designated chairman of this latter board.

In early February the board for evaluation of Commission-owned facilities visited sites at Oak Ridge, Tenn.; Portsmouth, Ohio; Paducah, Ky.; and Savannah River. A report was submitted to the Director of Reactor Development listing these sites in order of preference in the event that it was determined that the PWR should be constructed at one of these.

By February 15, 1954, nine broad-scale proposals for participation by industry in the PWR project had been received. On February 19, 1954, the Evaluation Board recommended to L. R. Hafstad that certain of these be eliminated from further consideration and that the Board proceed to hold discussions in the field with officials of those which remained.

Accordingly, on March 2, 1954, a subcommittee of the Evaluation Board headed by H. G. Rickover began visits to organizations in Pennsylvania, South Carolina, Louisiana, New York, and New England. The final proposals received detailed evaluation by the entire Board in Washington and a recommendation was submitted to the General Manager.

On March 11, 1954, the Commission authorized the General Manager to enter into discussions with the Duquesne Light Co. of Pittsburgh, Pa., as a basis for detailed contract negotiations. The Commission further approved the location of the PWR on land owned by the Duquesne Light Co. at Shippingport, Pa., a small town on the Ohio River approximately 25 miles west of Pittsburgh. The approval of the site location was the result of a preliminary opinion on the suitability of the site made by C. Rogers McCullough, Chairman, Advisory Committee on Reactor Safeguards, and two other members of the Committee on March 9, 1954. A portion of this letter is quoted below:

"DEAR MR. NICHOLS: Mr. A. Tammamro, as Chairman of the Board of Evaluation of PWR Participation, has asked for a preliminary opinion on the suitability of the site proposed by Duquesne Power & Light Co. at Shippingport, Pa., from the point of view of hazards. It is my opinion in consultation with two members of the Advisory Committee on Reactor Safeguards that this site is suitable provided that the reactor system is so designed that containment of radioactive material can be guaranteed beyond reasonable doubt. It is a general view, based on preliminary information, that this is a reasonable requirement and one that can be attained. This rigid requirement rests upon the fact that the Ohio River, below the site in question, is one of the most heavily used sources of domestic and industrial water in the United States.

"It is my understanding the PWR will be a reactor installation only and no chemical separation will take place at this site.

"These conclusions are consistent with the preliminary information given a subgroup of the Advisory Committee on Reactor Safeguards on January 22, 1954 * * *"

On March 14, 1954, the Commission released to the press the information that negotiations were underway with the Duquesne Light Co. A portion of this release is quoted below:

"Lewis L. Strauss, Chairman of the Atomic Energy Commission, announced today that a proposal submitted for participation by the Duquesne Light Co. of Pittsburgh, Pa., in the construction and operation of the Nation's first full-scale central station nuclear powerplant is the most favorable to the Government and that the AEC is negotiating a formal agreement with the company. The Duquesne Co. submitted one of nine major proposals to the Commission.

"Under the Duquesne proposal the company would—

"1. Furnish a site for the entire project and build and operate a new electric generating plant at no cost to the Government.

"2. Operate the reactor part of the plant and bear the labor costs thus entailed.

"3. Assume \$5 million of the cost of research, development, and construction of the reactor portion of the plant.

"4. Pay the Commission at the rate of 48.3 cents per million B.t.u.'s of steam used in the turbines for the first year; the rate increasing annually until it reaches 60.3 cents in the fifth year.

"5. Waive any reimbursement by the Government of costs incident to termination of the contract.

"The Chairman estimated that, including revenues from the sale of steam generated by the reactor, the company's proposal would reduce by an estimated \$30 million the expenditures the Government would have to make during the period of construction and 5 years of operations if it undertook the full cost of the project.

"The proposed plant site is on land presently owned by the company in the Greater Pittsburgh area. The reactor design will incorporate safety features developed through 10 years of experience with reactor operation.

"The Westinghouse Electric Corp. has a contract with AEC to develop, design, and construct the reactor portion of the plant. The reactor is expected to generate sufficient heat to produce a minimum of 60,000 kilowatts of saleable electricity in addition to meeting the electricity requirements of the plant itself. The actual sufficient heat to produce a minimum of 60,000 kilowatts of saleable electricity in capacity of the reactor may turn out to be somewhat greater than the minimum of 60,000 kilowatts design and foreseeing this possibility the company would design its generating plant with some reserve capacity.

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"It is not expected that this first plant will produce electric power at costs comparable with power from conventional fuels. The project has been undertaken in order to gain more design and technological experiences than could be obtained otherwise, such as from a smaller plant, and to provide firm cost estimates for the future."

On March 18, 1954, A. Tammaro, manager, Chicago Operations Office, and Philip A. Fleger, chairman of the board, Duquesne Light Co., signed a memorandum of understanding which would serve as the basis of more detailed contract negotiations to follow. The definitive contract was signed on November 3, 1954.

Details of the contract between the Atomic Energy Commission and the Duquesne Light Co. are available elsewhere. One extract, however, will be quoted in order to demonstrate the reasons for which the PWR was built.

"It is anticipated by the parties that the information to be gained by the construction and operation of the pressurized water reactor will probably permit a major advance toward realization of civilian nuclear power and that such information is expected to lead to further technical advances in subsequent power reactors. It is recognized that this first full-scale nuclear powerplant will be of a developmental nature and will be operated with the primary objective of gaining information and advancing reactor technology rather than with an objective of furnishing dependable power and maintaining a high load factor. The parties expect to make every effort to demonstrate the practicability of nuclear central station power and to make the cost of such power as low as possible. Based on present technological knowledge, it is unlikely that power from this first nuclear central station will be competitive in cost with power from conventional plants."

During the months of February and March 1954, the Subcommittee on Research and Development of the Joint Committee on Atomic Energy, Congress of the United States, held a series of meetings to review and evaluate the 5-year reactor development program proposed by the Atomic Energy Commission. With respect to the PWR, it was the consensus of the testimony that as a demonstration of the serious intent of the United States to develop peacetime uses of atomic energy for both ourselves and our allies, and as a tool to help gain operating experience on a full-scale plant, the continuation of construction of one large-scale plant such as the pressurized water reactor was important. On March 12, 1954, a meeting was held between representatives of the Joint Committee and the Atomic Energy Commission in order to insure that both the committee and the Commission were in agreement on continuation of the project, that they appreciated its limitations, and had a clear conception of what it could be expected to accomplish. At that meeting, the Commission gave a detailed presentation of the purpose of, and the prospects for, the pressurized water reactor. Strong assurances were given to the committee that every effort would be made to incorporate into the pressurized water reactor all promising ideas which would help make it more economic and would not unduly delay its completion.

In April 1954, as a result of the recommendation of the Contract Board, which had convened the previous November, the General Manager approved the selection of the Stone & Webster Engineering Corp. to perform the architect-engineering services associated with the design of the nuclear portion of the PWR project. It was specified that the work to be done by Stone & Webster would be accomplished under subcontract to the Westinghouse Electric Corp. The subcontract as finally negotiated provided for the reimbursement of actual cost from Government funds and the payment to Stone & Webster of a fee of \$1 for the services rendered.

On April 19, 1954, an organizational meeting was held in Pittsburgh among representatives of the Naval Reactors Branch and the Pittsburgh area office, AEC, and of the Duquesne Light Co. At that meeting, at which H. G. Rickover was senior Government representative and P. A. Fleger, chairman of the board, was senior representative of the Duquesne Light Co., the division between the Atomic Energy Commission and the Duquesne Light Co. of design and financial responsibility for the components, systems, and facilities of the PWR plant was established. This division of responsibility was subsequently made a part of the definitive contract between the Commission and the Duquesne Light Co.

In implementation of another agreement made at the meeting of April 19, on April 27, 1954, Commission and Bettis representatives began a series of 20 lectures to the Duquesne Light Co. These lectures were designed to acquaint Duquesne personnel with the organization and relationships which existed between the Commission and its prime contractor Westinghouse and, in addition, to inform them of the status of design and development on the PWR project.

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In turn, Duquesne Light Co. representatives later gave a series of five lectures. Commission representatives to acquaint them with utility company problems. On September 6, 1954, the official groundbreaking for the PWR took place at Shippingport, Pa. At this ceremony President Eisenhower, in Denver, Colo., placed a wand containing a source of neutrons close to a fission detector. The resulting current, flowing through wires across the country, started up an unmanned bulldozer which performed the first excavation at the Shippingport site. In addition to the President, who spoke on television, speakers at the site included the Honorable W. Sterling Cole, chairman, Joint Committee on Atomic Energy, Congress of the United States; Adm. Lewis L. Strauss, Chairman, Atomic Energy Commission; Gwilym A. Price, president, Westinghouse Electric Corp.; and Philip A. Flegler, chairman of the board, Duquesne Light Co.

The last major subcontractor on the PWR project whose selection involved the use of a contractor selection board, was the Dravo Corp. of Pittsburgh, Pa. This organization performed the installation work on the nuclear portion of the plant under subcontract to Westinghouse. The subcontract, which was forwarded by Westinghouse to the Commission for approval on October 11, 1955, provided for reimbursement of actual costs incurred and for the payment to Dravo of a fee of \$1 for services rendered.

Actual construction at Shippingport began in May 1955, and the plant achieved full power in December 1957. Details of the design, development, and construction which took place during this period are contained in a book entitled "The Shippingport Water Reactor," published by the U.S. Atomic Energy Commission for the 1958 Geneva Conference on Peaceful Uses of Atomic Energy. However, because of the complexity of the job and the number of contractors and subcontractors concerned with the work, the following remarks will be made concerning the administration of the project.

As stated earlier, responsibility for the PWR project within the Division of Reactor Development, AEC, was assigned by the Commission to H. G. Rickover of the Naval Reactors Branch. The Naval Reactors Branch gave technical approval of all nuclear plant parameters, performance requirements, and details of design and development upon recommendation by Bettis. The Chicago Operations Office, AEC, approved the design of nuclear plant facilities, structures, and equipment outside the primary system provided they met or were compatible with parameters and performance requirements previously approved by the Naval Reactors Branch.

In each of the major participating organizations, a PWR project officer or project manager was appointed with sole responsibility for following and expediting the design, development, and construction of the PWR. In Bettis plant, projectization was carried out to the extent that the Westinghouse engineers and scientists assigned to the PWR project had no responsibilities in connection with other projects.

Prior to the beginning of major construction, a PWR integrated schedule committee was established on February 7, 1955, at a joint meeting of principal representatives of the Naval Reactors Branch, the Pittsburgh area office, the Duquesne Light Co., and the Westinghouse Atomic Power Division. This committee functioned under the chairmanship of J. H. Barker, Jr., PWR project officer, Naval Reactors Branch. The objective of this committee was to prepare an integrated schedule for all major items of production and construction required to meet a March 1, 1957, construction completion date for all phases of the plant except for the nuclear core. The name of this committee was later changed to the PWR coordinating committee and its responsibilities were expanded to include the following:

- (a) Review of PWR construction progress at regular intervals to ascertain that design, installation, and construction of facilities was proceeding in accordance with requirements of the schedule.
- (b) Determination of action necessary to resolve specific problems affecting the construction schedules, referring these matters to appropriate principals if policy was involved or if the committee could not, of itself, agree on a course of action.
- (c) Coordination of activities, such as design and construction of facilities or installation of components, which required the cooperation of more than two organizations for accomplishment.

Membership on the committee was expanded to include representatives of the Stone & Webster Engineering Corp., Burns & Roe, Inc., and of the Dravo Corp. as these organizations became active in the work at Shippingport. The PWR coordinating committee held 36 meetings extending from February 1955 to April 1957.

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On May 2, 1957, H. G. Rickover met at Shippingport with representatives of the Westinghouse, and of the Duquesne Light Co. The purpose of this meeting was to discuss and to take action on important work tasks necessary to complete construction, test, and startup of PWR, especially those tasks requiring extensive advanced planning. As a consequence of this meeting, the PWR coordinating committee was disestablished and a new committee called the PWR operations committee was formed. The function of this committee, which was likewise under the chairmanship of J. H. Barker, Jr., was to study and take such action as might be necessary in order that the PWR plant might achieve full power in the calendar year 1957. The operations committee held 42 meetings between May 1957 and December 23, 1957. On the latter date, the committee was dissolved inasmuch as full power had been achieved at 11:10 a.m. that morning.

One of the principal actions of the PWR operations committee was to set up various task groups to follow and plan for critical tasks which might affect the ultimate achievement of full power operation. These task groups considered such operations as reactor assembly, reactor fueling, core and head installation, core assembly, and instrumentation checkout. The task groups met approximately once a week and submitted a formal report to the PWR operations committee at its regular meeting.

In addition to the foregoing, numerous management techniques were used by H. G. Rickover to insure close control over the PWR project. A critical items report was submitted weekly by the Westinghouse PWR project manager. Commencing in February 1957 a daily teletype from the Shippingport site was dispatched to principals in Washington and in Pittsburgh which provided information on such matters as progress of welding, installation of components, labor problems, and other items which might affect completion of the project on schedule. Finally, personal inspections of the work at Bettis and of the construction at Shippingport were made regularly by H. G. Rickover. At these meetings, in which key principals of the organizations involved participated, problems were discussed freely and future plans of action were established.

INFORMATION AND LIAISON WITH OTHER AGENCIES

Throughout the course of the design and construction of the PWR project every effort was made to disseminate information as widely as possible. This was done for three reasons: First, to make sure that appropriate official bodies were given an opportunity to review design and operating procedures; second, that the public in general would be provided with information as to the progress of the plant; and third, that reactor technology developed in the program would be given rapid and widespread dissemination.

The Commission has an Advisory Committee on Reactor Safeguards, recognized by amendment to the Atomic Energy Act of 1954, which consists of specialists in the various fields appropriate to the study of reactor safety. This Committee reviews the design and operating procedures for each proposed reactor and advises the Commission as to the safety aspects. Operation of a reactor cannot commence without a formal review and approval by the Commission.

The initial contact with the Advisory Committee on Reactor Safeguards (ACRS) was made by H. G. Rickover, members of his staff, and representatives of Bettis plant on January 22, 1954. At this meeting a subcommittee of the ACRS agreed that the Shippingport site and the proposed conceptual design of the plant container appeared satisfactory.

On April 21, 1954, J. H. Barker, Jr., PWR project officer, presented to the ACRS a more detailed discussion of the Shippingport site including site photographs, hydrological, meteorological, and seismological data. In January 1955, the U.S. Weather Bureau was requested to set up equipment at Shippingport to gather meteorological data and the collection of this data began in April 1955.

On May 7, 1955, the entire ACRS held a meeting at Bettis plant at which a presentation and a discussion of safeguards problems was held. On August 31, 1955, at their 14th meeting, the ACRS considered further details of the PWR site and recommended to the Commission that the Shippingport site be considered acceptable. On October 19, 1955, the PWR subcommittee of the ACRS discussed the PWR project, and on January 3, 1956, at its 16th meeting, the ACRS heard a complete summary of the status of the PWR project from a reactor safety standpoint and in a subsequent letter to the AEC, stated that, "the committee is well impressed with the progress being made in defining the behavior of the system under steady State and transient conditions. The committee sees no

new problems in connection with this reactor which would alter its previous recommendations."

On November 1, 1957, the ACRS heard the final PWR safeguards and in a letter dated November 4, 1957, to the Chairman, Atomic Energy Commission, stated as follows: "On the basis of the information presented, the Committee is convinced that adequate safeguards have been incorporated into the design and construction of the pressurized water reactor and adequate operating procedures have been worked out to insure that it can be operated at design power with an acceptably low risk to the health and safety of the public." The safeguards reports are available to the public in chapter 19 of the book entitled "The Shippingport Water Reactor," referred to earlier.

In addition to the review by the advisory committee on reactor safeguards, close contact was maintained with official bodies of the State of Pennsylvania. These included those bodies which have jurisdiction over pressure vessels installed for use in the Commonwealth and those which have jurisdiction over public health.

With respect to use of State codes and regulations in the design of the PWR plant, the policy of the AEC was stated in August 1954 as follows:

"As a matter of general policy, for that portion of the plant which will be the property of the Government and for Duquesne Light Co. property within the reactor area and located on land leased to the Government by Duquesne Light, States codes should be observed where material and equipment are of such a nature that provisions of existing codes are obviously applicable. For those items and facilities which are not defined under existing codes, every effort will be made to comply with those provisions which are most applicable. * * * With respect to radiation exposure and disposal of waste, either industrial or radioactive, State regulations, where and if existing, shall be observed unless standards of the AEC are more stringent. In this case, the latter requirements shall be applicable."

Since the State recognized applicable ASME codes, vessels and equipment constructed by qualified vendors and stamped with National Board numbers were accepted without any special administrative procedure or review by the industrial board of the State Department of Labor and Industry. A study showed that all nuclear plant components covered by the ASME codes could be built as standard ASME code vessels with the exception of the plant containers and certain safety devices and appurtenances.

In the latter cases, meetings were held at Harrisburg, Pa., to resolve code classifications for the components in question. These components received a "Pennsylvania Special" classification. A discussion of the applicable codes and details of the exceptions taken to standard ASME codes may be found in AEC report WAPD-PWR-974, "Pressure Vessel and Piping Codes Applicable to the PWR Reactor Plant."

As early as July 1954, officials of the Pennsylvania State Department of Health were informed as to the Commission's plans with respect to the PWR project. In September 1955, a formal presentation was made to members of the Ohio River Valley Water Sanitary Commission, to representatives of the Pennsylvania State Department of Health, and to representatives of the Commission and of the Public Health Service. In addition to the presentation, these individuals were taken on a tour of the Shippingport site where the proposed plans were explained to them in the field. Extremely close liaison was maintained with the U.S. Public Health Service. In 1955, E. D. Harward, assistant sanitary engineer of the Public Health Service, was assigned to the Pittsburgh area office of the Commission on a full-time basis to follow problems in connection with PWR and other projects.

It was early decided to apply to the State for a permit to discharge industrial and radioactive waste into the Ohio River. Cooperation of the Public Health Service and branches of the Commission was obtained in drawing up and reviewing the permit application with the State; this permit was granted on September 12, 1957. In addition, the Commission and Public Health Service representatives worked closely with the State officials in developing radiation regulations for the Commonwealth of Pennsylvania, which were subsequently enacted into law.

With respect to providing information to the general public, four seminars were held to acquaint representatives of industry with the problems in connection with the PWR. The first three of these, held in March and August 1954, and May 1955 were classified in nature inasmuch as the PWR project had not, at that time, been fully declassified. The fourth seminar, held in Pittsburgh on December 2, 1955, was addressed to ranking officials of industry and was designed to acquaint them with problems which would be encountered in developing and constructing a large-scale nuclear power station. This seminar was completely unclassified and minutes of the proceedings were subsequently published. All information regarding the PWR is now unclassified.

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Du the course of construction at Shippingport, approximately 10,000 visits were made to the site and the facilities. In early 1957 it was found necessary to limit visits to the site because of interference with construction, but as of this date, visits have been resumed under the sponsorship of both the Duquesne Light Co. and the Atomic Energy Commission.

Following an extensive program of hydrostatic testing and checkout of instrumentation, the reactor first achieved criticality on December 2, 1957. On December 18, 1957, at 12:39 a.m., the main generator was synchronized and, as provided for in the contract, the Duquesne Light Co. assumed responsibility to the Commission for the operation of the plant. In the early morning of December 18, 1957, power was first furnished to the Duquesne Light system. On December 23, 1957, the plant first achieved its full power design capability of 60,000 kilowatts of net electrical power on three loop operation. From December 24 to December 28, 1957, the plant made, without incident, a continuous 100-hour full power run at 60,000 kilowatts of net electrical power.

APPENDIX 3

TECHNICAL BENEFITS DERIVED FROM THE NAVAL REACTORS AND SHIPPINGPORT PROGRAMS

It would be difficult to pinpoint all of the benefits which result from a development program as broad as that supporting the naval reactors and Shippingport projects. Perhaps the simplest way to present the story is to start by mentioning a few basic developments of obvious significance and then to summarize some of the lesser known specific technical achievements accomplished by one project. The Shippingport project, being completely unclassified, provides an appropriate example for this discussion.

Zirconium and hafnium are good examples of naval reactor developments of wide application and significance. Until the time we started with the naval program these metals were mere laboratory curiosities and were available only in extremely small quantities. The cost of zirconium at that time was about \$500 a pound and hafnium cost many thousands of dollars a pound. Zirconium now costs about \$10 a pound. Zirconium and hafnium are found together in nature. They are contained in abundance in sands which are available in Florida, among other places. Zirconium is a good structural material for nuclear reactor cores. It does not absorb neutrons. Hafnium, on the other hand, absorbs many neutrons. Therefore, we use it for control rods used to shut the reactor down. It is a strange thing that these two rare metals with such dissimilar nuclear characteristics are found in nature together. We have learned how to separate them at a relatively low price and to produce them by the ton in reactor-grade purity.

More than three commercial companies are now making zirconium and hafnium in the United States, and we are currently using these metals, which were once very rare, in large quantities. They are also being used by others who are designing and building nuclear powerplants.

Another item where we have contributed, is the development of a new reactor core fuel material—uranium oxide. The Shippingport project developed this material as the result of a very extensive development program, after we found that uranium in metallic form would just not do the job. Uranium oxide is now being used by many people designing nuclear power reactors, both in the United States and abroad.

Over the period of the last 10 years, we have developed a great deal of basic reactor physics and heat transfer data, and the analytical techniques for applying these data to reactor design. Many other reactor designs here and abroad are now based on these basic data and these techniques.

Essential parts of any nuclear powerplant are the pressure vessels, the pumps, valves, and the reactor control-rod mechanisms. The naval reactors and the Shippingport programs developed nearly all of the technology for this equipment which, again, is now available for use in the United States and abroad. When you remember that the pressure vessel of the Shippingport reactor is over 30 feet high, more than 10 feet in diameter, more than 8 inches thick, and weighs 250 tons, you will realize what a problem this was. The Shippingport reactor pressure vessel was the most difficult ever built. We have now built up a sufficiently broad base that we can buy reactor vessels, pumps, valves, reactor control mechanisms, and other essential reactor plant equipment from any of several companies—and now so can other reactor designers, who thus benefit from our experience.

ADVANCEMENTS IN REACTOR TECHNOLOGY DUE TO THE SHIPPINGPORT PRESSURIZED WATER REACTOR (PWR) PROJECT

The PWR project has been and is continuing to be an important tool for making significant advances in the technology of pressurized water reactors. These advances started from the beginning of the design of the first PWR core, have continued through its development and manufacture, and are continuing at present through the testing of this core and the development of a complete replacement core (PWR core 2). Some of these specific gains in reactor technology are described briefly below. They cover: atomic powerplant operating experience; fuel and nuclear poison technology; reactor physics; reactor control; reactor thermal, hydraulic, and mechanical design; basic heat transfer studies; reactor core instrumentation; fuel element failure detection system; plant transient behavior; refueling procedures; primary coolant water radiochemistry; disposal of radioactive wastes; development of large reactor plant components.

First of all, as a complete powerplant the PWR has demonstrated how a pressurized water reactor can be integrated into a large utility's electrical power system. The reactor has demonstrated its ability to produce continuously its rated steady power and to respond to load transients with complete safety and without any operating problems. The plant has shown itself to be suitable for operation as a base load station or a peak load station or as a combination of both.

Two major contributions of PWR reactor have been in the field of physics and fuel technology. The PWR has demonstrated the validity of the "seed and blanket" concept in that:

- (a) It is feasible to obtain large amounts of power from a "blanket" of natural uranium and ordinary water by using a "seed" or small highly enriched core as the driving element.
- (b) That it is possible to control the entire reactor core by using control rods only in the relatively small seed volume.
- (c) That this type of core possesses the favorable dynamic response and negative temperature coefficient of a small highly enriched core and yet has the power capabilities of a large reactor core.

In the field of fuel metallurgy, the PWR project has been responsible for the development of uranium oxide (UO_2) as a fuel material for large power reactors. This has been and is continuing to be a major contribution in the field of reactor fuel materials. Extensive testing both in-pile and out-of-pile was performed to permit the use of bulk UO_2 . Through continuing in-pile tests and the operation of the PWR core 1 we expect to find what limitations exist in the use of this fuel material. There is a large number of variables involved, such as fuel temperatures, heat fluxes, fuel element shapes, fuel-to-clad clearance, etc., which can vitally affect the behavior of this material under irradiation. In PWR core 1 the UO_2 is in pellet form and is contained in zirconium alloy (zircaloy-2) rods. In the development of PWR core 2, the replacement core, we are developing a UO_2 compartment plate-type element which has promise of having higher performance elements than the rod-type elements.

The specific advances in reactor technology are summarized as follows:

I. FUEL TECHNOLOGY

A. Radiation and corrosion-resistant uranium alloys

The initial fuel materials development work at Bettis led to the formulation of alloys of uranium which possess high irradiation stability as well as good corrosion resistance to high temperature water. This was accomplished by stabilizing the body-centered cubic phase by additions of molybdenum and/or niobium. Both the fabrication technology required to completely sheath these alloys in zircaloy cladding as well as the heat treatment and compositional variables important in securing materials of suitable performance capabilities were established. The effects of irradiation on both dimensional and chemical stability were measured. A byproduct of this development was the discovery of "reversion" in alpha-transformed alloys to the gamma phase condition and the explanations developed for this phenomenon serve to clarify the nature of the fission process in fuel materials. A development effort, more restricted in scope, was devoted to uranium alloys of the U_3Si composition. Again fabrication conditions and irradiation stability were established; here also the property changes occurring as a result of irradiation serve to reveal important basic characteristics of the fissioning process.

D. UO₂ fuel material development

The thorium or materials contribution of PWR in this field has been the accumulation of information from both in-pile and out-of-pile experiments to permit use of bulk UO₂ as a reactor fuel material. The in-pile experiments have served to set a rational basis for interpreting the thermal performance of UO₂ fuel elements. They have revealed the relations of characteristics of the fuel material (density, extent of sintering, composition, porosity, etc.) and fuel element design (fuel-clad clearance, allowable heat flux, internal atmosphere, etc.) to fuel element behavior. They have permitted formulation of a rational to relate release of fission products, both within the cladding and to the coolant to operational and material characteristics. Continuing experiments as well as experience with Shippingport operation will serve to reveal material limitations to the burnup of this type of fuel element.

Out-of-pile experiments have revealed limitations imposed on fuel element fabrication or operation by Zr-UO₂ reactions. They have furnished information necessary for explanation and prediction of the thermal performance. They have revealed the relations between microstructure, density, characteristics of initial UO₂ powder, sintering times, temperatures, and atmospheres, etc. Continuing experiments are anticipated to permit relating ionic mobility in UO₂ to composition and to the related problem of fission product mobility.

C. The fuel component (the UO₂ pellet)

Mass production techniques were developed for conversion of non-free-flowing UO₂ powder to high density, sintered, precision-dimensioned fuel pellets. Free-flowing granules were made by incorporating an organic binder with the UO₂ powder. Compaction was done by employing a pressure of 125 tons/in² at a rate of 20 pellets/minute. (Normal industrial powder metallurgical practice does not exceed 75 tons/in²). Sintering at a temperature of 1,675° C. for 8 hours produced pellets whose nominal density of 94 percent was controlled within plus or minus 1 percent. Precision dimensional tolerances of plus or minus 0.0005 in on the pellet diameter were obtained by grinding at rates of 25 pellets per minute. These fuel manufacturing techniques have since been adopted for use by a large segment of the reactor industry.

D. UO₂ fuel configurations

As indicated previously, UO₂ in pellet form and inserted in cylindrical rods was developed as the fuel element configuration for PWR Core 1. The information obtained in the course of this development revealed the feasibility and desirability of developing UO₂ in plate form. The potential advantages lie in improved heat transfer performance and in reduction of fuel element fabrication costs. Consequently UO₂ in the compartmented plate type form is being actively pursued for use in PWR core 2.

E. Ceramic oxide seed development

The high degree of irradiation stability exhibited by UO₂ has prompted investigation of other ceramic oxides as matrices, particularly for the incorporation of enriched UO₂. Techniques for the fabrication of UO₂ with oxides of aluminum, zirconium, calcium, and beryllium (with the UO₂ present in various particle size ranges) have been developed, and pertinent properties measured out-of-pile. In-pile information has been obtained on several of these mixtures and further such tests are presently under way. Information already available has indicated the high degree of stability of the ZrO₂-UO₂-CaO fuel as well as the poor stability of the Al₂O₃-UO₂ fuel. This information is not only of direct value with respect to development of highly enriched ceramic fuel materials but also serves to reveal the structural and chemical factors important in determining radiation stability of ceramic fuels in general. For each of the oxides listed above, fuel element fabrication techniques are being developed to permit the incorporation of these materials in potentially useful forms.

F. Zircaloy development

Application of zircaloy as a cladding for UO₂ fuel elements and the consequent in-pile and out-of-pile tests which were performed have served to reveal new facets of zirconium technology, particularly with respect to the pickup of hydrogen by zirconium from high temperature water systems, the effects of irradiation thereupon, and the behavior of hydrogen dissolved in zirconium. The susceptibility of zirconium to hydrogen pickup in high temperature water and its acceleration under irradiation were revealed by in-pile loop tests. Further development, particularly in relation to the PWR core 2 plate development program, revealed the role of nickel contained in zircaloy in accelerating or increasing this absorption

of hydrogen, and has pointed the way toward development of a class of zirconium alloys free of this injurious element. Finally, both in-pile and out-of-pile tests have revealed the redistribution of hydrogen in zirconium under thermal and stress gradients and have furnished the basis for explanation and prediction of this phenomenon.

G. Development of bonding and joining techniques for zircaloy-2

PWR core 2 fuel element development has prompted the formulation and further development of several techniques for bonding zirconium. A technique known as eutectic diffusion bonding has been developed, in which zircaloy surfaces coated with small thicknesses of Cu or Fe are heated to a temperature sufficient to melt a eutectic of these materials with zirconium, thus forming a metal-brazed joint from which the bonding metal can subsequently be diffused into the zirconium. This joining or bonding method has been shown to be capable of producing joints of high mechanical strength as well as good corrosion stability. Further developments initiated for PWR core application include an intensive evaluation of the application of the pressure bonding process for bonding zircaloy components, in which the bonding is achieved by simultaneous application of high temperatures and pressures.

H. Lumped burnable poison material development

To permit extension of core life in PWR cores, there are under investigation various metallurgical techniques for incorporating B^{10} in the concentrations and lump sizes required from nuclear considerations. Two methods are under investigation at present, the one involving fabrication of zircaloy-clad stainless steel- B^{10} alloys in concentrations up to 2 w/o B^{10} , the other consisting of incorporating high density hot pressed B_4C as wafers or platelets in bonded zircaloy-2 compartments. These materials are presently under intensive investigation with respect to radiation limitations, out-of-pile properties and behavior, and suitability for fabrication to dimensions necessary for reactor core application. A byproduct of this investigation has been the development of techniques for metallurgically bonding zirconium to stainless steel.

I. Alternate control rod material development

Investigation of potential replacements for hafnium as a control rod material for PWR has resulted in development of a silver-base alloy containing about 15 percent indium and 5 percent cadmium, which has promise for reactor application. In the course of this development an analytical technique was developed for accounting for the metallurgical changes produced by neutron absorption, and techniques were developed for improvement of creep properties either by grain size control or by use of directly extruded powders. The investigation was extended not only to material development but also to fabrication techniques for full size control rod components. Release of activity from the control rods as a result of plant accident conditions involving dissolved air in the coolant was measured and circumvented by the development of high quality nickel plating procedures which can be applied to full size rod components.

J. Irradiation testing technology

In the course of development of PWR fuel elements it has been necessary continually to refine and advance the art of inpile testing as well as that of post-irradiation hot laboratory examination. Most significant in this connection has been the development of technology permitting the exposure of fuel elements both to irradiation and high-temperature water even under conditions such that the fissile material is exposed directly to the circulating coolant. Such a development was necessary not only to assess fuel element stability under combined conditions of corrosion and irradiation but also to permit prediction of, as well as curative measures for, the effects of fission product release through fuel element clad defects into the coolant.

A second major development undertaken in this connection was the use of zircaloy inpile tubes as containment for high temperature, high-pressure loop systems. This work, which results in more efficient use of test reactor neutron flux, is expected also to furnish valuable ancillary information applicable to prediction of the life of zircaloy for pressure tube in reactor application. Another aspect of inpile technology of potentially broad application is the development of pressure tubes for use in high flux reactors such as ETR in which high values of gamma heating as well as irradiation-induced mechanical property changes introduce severe limitations to design. Experience with operation of such units is expected to yield considerable information concerning the applicability of the design con-

cores employed. Hot laboratory techniques developed for postirradiation examination of PWR fuel elements are also of particular interest with respect to the information gained on handling of relatively large fuel element specimens irradiated to high burnups and obtaining applicable data on metallographic structure, chemical analysis of fuel and cladding, and gaseous fission product release from the fuel.

K. Zircaloy tubing and end capping of Zircaloy fuel rods

From the start of the PWR project the fabrication of zircaloy tubing having the desired integrity was considered a serious problem. Zircaloy had never been fabricated to this shape and all commercial tubing manufacturers were completely unfamiliar with the fabrication characteristics of this material. The only known process of fabricating tubing consisted of drilling bars at a cost of over \$100 per foot of finished product.

As a result of an all-out development effort, a satisfactory process for fabricating acceptable zircaloy tubing was developed. Approximately 150,000 feet of tubing were fabricated meeting the rigid dimensional and material characteristic requirements necessary; i.e., adequate corrosion resistance and leak tightness when subjected to a 50,000 p.s.i. proof test. Yields of final quantities of tubing were comparable to those obtained on other nonferrous materials such as aluminum. As a result of this development zircaloy tubing of various sizes is now available to all reactor designers.

An important and difficult problem that had to be solved in the manufacture of rod type fuel elements was that of sealing the zircaloy tubes with zircaloy end plugs. It was found that a significant amount of porosity would develop in these closure welds and such techniques and equipment had to be developed to overcome this. Finally, an automatic setup for performing these welds was developed and the losses in the welding of these fuel rod end caps was reduced to a very negligible number.

L. Fission products—Release and distribution

The necessity of running inpile tests with deliberately defected fuel elements in order to assess the amount and distribution of fission products that would be released from unintentionally defected elements in the reactor was recognized. An empirical correlation (escape coefficient) was developed relating the rate of release of activity from the fuel to its concentration in the fuel. It was found that, in general, those isotopes which present the greatest hazard from the standpoint of surface contamination are least likely to escape from the fuel. The escape coefficient concept has been adopted by other groups designing UO_2 -fueled reactors, and the values of this coefficient developed by PWR have been used in their calculation. Concurrently with the determination of escape coefficients, the relative affinities of specific radionuclides for absorption on pipe surfaces at high temperature have been measured. These measurements have for the first time permitted a realistic evaluation of the accessibility hazards expected from failure of fuel elements in pressurized water reactors. Only by this means can the fate of each radioactive isotope released be determined, and the radiation fields resulting from soluble versus deposited activity calculated.

II. PHYSICS

The PWR core 1 is demonstrating the suitability of a seed and blanket type core for the generation of large quantities of electrical power for a public utilities system.

The research and development activities occurring as an integral part of the program leading to the design and operation of PWR cores at Shippingport have provided information and insight into a number of areas in reactor physics and nuclear design which are applicable to reactor development in general.

A. Extended burnup of high uranium content fuels—reactivity behavior

Two phases of the PWR program are providing valuable information with regard to the long-lived reactivity behavior of natural uranium fuels. These are: (1) The exposure of up to 10,000 megawatt day-ton (average) which the blanket of the first core will receive if three or four seed lives are completed; and (2) the long term reactivity gains program, which is providing an opportunity to study, under controlled conditions, the reactivity effects associated with exposures of up to 30,000 megawatt day-ton for natural uranium fuel. Such information is vital to a power reactor program involving high uranium 238 content material in reactors of very extended lifetimes and high power. The analysis which is

planned for selected irradiated fuel elements from the core 1 blanket. Including destructive testing will provide information on this subject several years before it will be available elsewhere.

B. Physics measurements at Shippingport

The data obtained from the extensive testing program carried out at Shippingport provides a basis for evaluating the analytical model used in reactor design which has not been available from the operation of other existing power reactors. The data have been obtained in a form which is directly comparable with that obtained from calculations, and therefore the operation of the PWR at Shippingport represents the first thorough check of nuclear design methods against an operating large scale power reactor of long reactivity life.

C. Xenon-induced power oscillations in a large power reactor

The presence of extensive nuclear and thermal instrumentation in the PWR has enabled direct observation of xenon-induced instabilities. Although the possibility of such instabilities had been anticipated, the ability to observe and develop methods for their control in PWR has provided insight into the character of large reactor behavior which will be of direct application in the design of other large power reactors. In particular, the Shippingport experience has demonstrated that:

(1) Adequate instrumentation must be provided in the design of new plants so that the reactor operator can be aware of such oscillations; and (2) an informed reactor operator can easily control the magnitude of such oscillations so that the thermal capability is not exceeded in any local regions of the core. The relatively complete information obtained at Shippingport concerning the behavior of the reactor during an oscillation provides the basis for development of an analytical model which may assist future reactor designers to anticipate oscillatory tendencies in a design sufficiently early to minimize their effects.

D. Critical experimentation

The extensive series of experiments involving PWR mockup critical assemblies has led to the development of several useful experimental techniques. Among these are a method of determining reactor subcriticality by analysis of neutron flux data, a method for obtaining excess reactivity information from moderator height measurements on critical assemblies, and a technique for simulating elevated moderator temperatures in a cold reactor by use of a foamed plastic material. Several innovations in the field of data reduction also have resulted. These include devices for the precise measurement of control rod positions and moderator heights, and a method of automatic compensation for the decay of activities induced in the foils used in flux plotting experiments.

E. Information on the reactor properties of water-moderated, slightly enriched uranium lattices

The TRX critical program, designed to provide basic information on the reactor characteristics of lattices of uranium 238 rods, moderated by light water, was financed in large measure by, and also was motivated by, the PWR project. The information obtained as a result of this program represents one of the most significant contributions to the development of reactor physics technology thus far made in the United States. The development of digital computer codes for use in nuclear reactor design, while somewhat separate from the TRX program, has found its basis in the data provided by the TRX.

F. Self-shielded burnable poisons

An integral part of the development effort on a second core for Shippingport has been the work associated with the analysis of self-shielded poisons for a long-lived, high-power reactor. The emphasis which has been placed on the core 2 objectives has stimulated the development of analytical methods for the treatment of such poisons which would not otherwise be in existence. Such analytical ability is essential to the design of any long-lived power reactor, since in this case control rods alone are not capable of providing sufficient reactivity control. The analytical work and associated experimental effort which has been devoted to the burnable poison problem represent a substantial contribution to the field of power reactor design.

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III. CORE INSTRUMENTATION

The WR project is contributing significantly to the development of compact flow and temperature sensing instrumentation for the determination of the absolute and relative power production in the various parts of reactor cores. In addition, instrumentation has been developed for the measurement of the axial temperature distribution in fuel plates and the detection and location of a failed fuel element. Features which have and are being developed can be categorized as follows:

(A) Accommodate instrumentation, components, and leads within the restricted space available in a compact pressurized water core and in a manner which will not interfere with core refueling procedures. This overall problem required development to accomplish conventional functions such as the joining and sealing of groups of sampling and sensing tubes and the use of flow measuring devices.

(B) The development of new devices to perform new functions for which there was little precedence. Example: The development of a device for obtaining representative mixed samples of the effluent flow from each fuel assembly in order to detect whether any of its elements has failed.

(C) The development of in-pile thermocouples and means for readily replacing these thermocouples in the event of their failure.

(D) The development of a complete core instrumentation system which would not affect the safe operation of the reactor in the event that any part of this system were damaged.

A large amount of testing both in-pile and out-of-pile had to be performed to develop this kind of core instrumentation. Some of the proof testing was done in the naval reactor facility (S1W), Arco, Idaho.

IV. MECHANICAL DESIGN

Significant developments in the mechanical design and arrangements for pressurized water reactors have resulted from the PWR project. For example, the necessary technology was developed to fabricate large pressure vessels having walls over 8 inches thick and using a thin seal weld membrane for making the pressure vessel head joint leak tight. In addition, a large reactor pressure vessel head was developed with a large number of openings so that the reactor could be refueled through these ports in the head without having to remove the pressure vessel head.

Refueling methods were developed such that in PWR it would be possible to obtain information to evaluate various methods of refueling the reactor core; for example, refueling with the reactor vessel head on versus refueling with the reactor vessel head off, and in each case using water or solid shielded containers to provide the necessary radiation protection. Means for holding the fuel clusters in the reactor core and for orificing various sections of the core were developed for PWR core 1 and further advances are being made in these mechanical features in the design of the PWR core 2. All of these features should be applicable in the design of large-size power reactors. In carrying out these new designs special techniques are continuously being developed for calculating and determining the stresses in the various structures due to both pressure and thermal forces.

V. HEAT TRANSFER AND HYDRAULICS AROUND RODS

Adoption of zircaloy-clad oxide rods as the reference fuel element in the blanket region of the core necessitated the formation of a test program to establish the basic thermal and hydraulic parameters for parallel flow between rods. Essentially no such information on rods was available in the literature prior to the start of test work. The test program included isothermal, local boiling, and bulk boiling pressure drop tests and burnout heat flux tests.

In order that calculations could proceed prior to the availability of the test results, it was assumed that correlations obtained for flat plate fuel elements were valid for flow outside of rods. Through the performance of numerous tests it was concluded that both the burnout heat flux correlation and the heating and local boiling correlation obtained for rectangular channels could be conservatively applied to parallel flow outside of rods.

Significant information concerning thermal and hydraulic performance in pressurized water reactor core one has been made available through flow-measuring and temperature-sensing instrumentation. In combination, these two classes of

instrumentation have enabled detailed power-distribution analyses to be made which have confirmed the design predictions of core performance.

The flow-measuring instrumentation has shown that flow distribution in a multiregion orificed core such as pressurized water reactor can be accurately predicted from semiempirical analyses. Measurements of flow through prescribed assemblies of the core were within 1.5 to 2.2 percent of design, with standard deviations of the measurements being ± 2.5 percent. The four coolant inlet nozzles in pressurized water reactor are symmetrically located and spaced evenly around the core. Flow distribution was found to be within the preceding limits with either three or four coolant loops in operation.

The thermocouple instrumentation has required careful calibration and has yielded information which (1) has confirmed power-distribution predictions early in core life, (2) has shown that there is a shifting in power from the enriched seed to the natural uranium blanket, and (3) has provided a measurement of core power symmetry and deviations from symmetry.

A shift of approximately 3.7 percent in seed/blanket power sharing was predicted through nuclear-design studies in the interval of 1,000 to 3,000 EFPH. Thermocouple measured seed/blanket power sharing changed (in the proper direction) by approximately 4.7 percent over the same interval of core life.

Power oscillations across diametrically opposite segments of the PWR core were observed during a maximum xenon override test after approximately 400 EFPH. These oscillations have been monitored through core instrumentation. The period of oscillation has been established to be approximately 24 hours; the magnitude of oscillations has been maintained within prescribed limits (± 6 percent) oscillation have been permitted during certain operations, while in others they were effectively limited to ± 3 percent).

Static power asymmetries upon core startup have also been detected through core thermocouple instrumentation, which has become the basis for calibration of neutron flux detectors, subsequently used to monitor normal operations. Thermocouple evidence is available describing static asymmetries followed by shutdown, xenon buildup, and then during subsequent operations oscillations, the magnitude of which is directly proportional to the static asymmetries.

Information concerning power asymmetries as influenced by various coolant loop combinations will be available from "core asymmetry tests" which have yet to be performed.

VI. COOLANT TECHNOLOGY

PWR has been the first pressurized water reactor to operate from initial startup with the coolant controlled at high pH with a lithium-base ion-exchange resin. In-pile loop tests had early demonstrated that deposition of corrosion products on fuel element surfaces and buildup of radioactivity in the loop are less under high pH operation than at neutral pH. The radiochemical behavior of the PWR system seems so far to confirm these indications.

Advances have also been made in chemical technology associated with the reactor coolant. In particular, new devices have been invented and developed for continuous dissolved hydrogen and oxygen analysis; the concept of continuous sampling of coolant and analysis by a train of instruments was developed for PWR and successfully applied. As a result of PWR-supported work, new knowledge has been gained concerning the performance of base-form ion exchangers for pH control and fission product removal.

VII. REACTOR PLANT COMPONENTS

The main coolant pumps in PWR are the largest hermetically sealed pumps built to date. Their design was based on extrapolation of data from much smaller units and were as far as the manufacturers could reasonably go in 1954. Based on their experience with these units, pump vendors are now willing to make another step change to higher power and pumping capacities.

Similarly, the reactor vessel, steam generators, valves, and other reactor plant components constitute a significant increase in size over previously available equipment.

REPORTING AND DISSEMINATION OF INFORMATION

Many people do not realize the large amount of technical information that the naval and the Shippingport programs are making available to everyone, including all foreign countries. Early in 1957 we established the following policy:

1. All information on the Shippingport reactor is unclassified.

2. naval reactor technology is unclassified.
3. y design and military information remained classified.

In line with this policy we reviewed at that time all of the classified reactor reports issued by our program and we released several thousand publications for dissemination to people working on other reactors.

In addition, we arranged for the Bettis and the Knolls Atomic Power Laboratories to regularly publish unclassified reports several times a year reporting all of the latest developments in naval reactor technology.

We also encouraged our contractors to report their work in technical papers published as Government reports, or in professional journals, or presented before technical societies.

As a result of these actions, the naval reactor laboratories have published—all unclassified and available to everyone—several hundred technical progress reports, several hundred topical reports as Government publications, more than a thousand technical papers in professional journals or meetings, and several thousand technical memorandums, specifications, or drawings. I believe that in the reporting and dissemination of really useful technical information, the naval reactors and Shippingport programs need take a back seat to no one.

I will cite one example which illustrates the kind of technical information we are reporting. The Bettis Laboratory published, in connection with the 1958 Geneva Conference on Peaceful Uses of Atomic Energy, a selection of papers reprinted from their periodic unclassified report on naval reactor and Shippingport technology. The scope and detail of these papers is indicated by their titles, which follow:

REACTOR AND PLANT ENGINEERING

"Hydraulic Test Program for Reactor Core Components," R. Atherton and L. H. Harman.

"Determining Performance Characteristics of a Saturated Steam Pressurizer for Nuclear Power Applications," J. R. Maxwell.

"A Review of Two-Phase Flow Relations," J. S. Busch and J. M. Carpenter.

"Formal Heat Transfer Solutions for Reactor Design," J. S. Busch.

"Transient Temperature Distribution in Pressure Vessels," J. S. Busch, J. P. DeVries, R. C. Nicoll, and R. A. Oerth.

"Study of the Force-Deflection Characteristics of a Belleville Spring," J. E. Meyer.

"Design and Operating Characteristics of a Bed Filter for an In-Pile Test Facility," L. A. Waldman.

REACTOR METALLURGY

"Metallurgical Design and Properties of Silver-Indium-Cadmium Alloys for PWR Control Rods," I. Cohen, E. F. Losco, and J. D. Eichenberg.

"Solubility of Enriched Boron and Boron Compounds," E. S. Byron, J. F. Thompson, and S. W. Porembka.

"A Metallographic Examination of Zirconium and Zirconium Alloys," E. L. Richards and E. A. Wright.

"The Effect of Heat Treatment on the Corrosion Resistance of Zircaloy-2 and Zircaloy-3," J. G. Goodwin.

"The Chemical Displacement Plating of Zirconium and Zircaloy," F. M. Cain, Jr.

"Problems Associated With Uranium Contamination of Zirconium and Zirconium Alloys," B. F. Rubin, P. W. Frank, R. S. Gilbert, and K. H. Vogel.

"X-Ray Examination of Irradiated Uranium Dioxide," E. R. Boyko, J. D. Eichenberg, R. B. Roof, Jr., and E. K. Halteman.

REACTOR CHEMISTRY AND PLANT MATERIALS

"Out-of-Pile Dynamic Loop Tests of Irradiated Fuel Materials," L. A. Waldman and W. T. Lindsay, Jr.

"Corrosion and Erosion of Sintered UO_2 Compacts in High Temperature Water," J. M. Lojek, W. T. Lindsay, Jr., and P. Cohen.

"The Effect of Oxygenated Water on Clad-and-Defected UO_2 Fuel Specimens," J. M. Lojek and W. T. Lindsay, Jr.

"Magnetic Properties of Type 400 Series, 17-4 PH, and AM 355 Stainless Steels," J. V. Alger.

"The Effect of Surface Finish and Galvanic Coupling on the Corrosion Resistance of ASTM A-212 Carbon Steel in Primary and Secondary Water," L. R. Scharfstein.

"Corrosion of Shield Tank Materials in Lithium Chromate Solutions," Rau and K. Jakobson.

"Removal of Radioiodine from PWR Plant Container Air," A. S. Kescon.

REACTOR PHYSICS AND MATHEMATICS

"Review of Methods Used in Control Rod Analysis for Reactor Design at Bettis," A. F. Henry

"Two Dimensional Burnup of a Cell," W. D. Kimball.

"Resonance Capture in Heterogeneous Systems," S. Stein.

"Half-Height Cadmium Slab," R. S. Halgas and M. Bender.

"Critical Experiments on Water-Moderated Lattices of Slightly Enriched Uranium Dioxide (UO_2) Fuel Rods," J. R. Brown.

"Nuclear Design of a Fuel Assembly for an Irradiation Proof Test," S. Sandhaus.

"Synthesis of Three-Dimensional Power Shapes—Application of Flux-Weighted Synthesis Technique," W. N. Lorentz.

"The Use of the Equivalent Bare Core Model for Calculating the Criticality of Slab-Type Reactors and a Comparison to Experiment," R. S. Wick and J. D. Butler.

"Thermal Flux Depressions in Materials Containing Fuel and Boron," R. J. Neuhold and G. F. Boger.

"An Inverted Reactivity Effect," L. O. Herwig and E. R. Sanford.

"Thermal Equivalent Σ_p for Cadmium-Silver Control Rods," A. J. Calio.

"A Lemma of Stieltjes," R. S. Varga.

"Reactor Criticality and Nonnegative Matrices," G. Birkhoff and R. S. Varga.

"Few-Group Fitted Parameters," P. A. Ombrellaro.

"A New Version of the Multigroup Fourier Transform Code for Calculation of Fast Group Parameters," E. Gelbard and H. Bohl.

"The WANDA Spatial Code," O. J. Marlowe and E. Gelbard.

"CANDLE—A One-Dimensional Few-Group Lifetime Depletion Code," E. M. Gelbard, G. W. Hoffman, O. J. Marlowe, and P. A. Ombrellaro.

But the most important vehicle we have for getting out technical information is a series of technical handbooks which we are publishing. They are quite comprehensive and they are all unclassified except for one which contains classified design information. These naval reactors handbooks are:

Published

"Liquid Metals Handbook," first edition, edited by R. N. Lyon, June 1950; second edition, edited by R. N. Lyon, June 1952; third edition, (sodium-NaK supplement) edited by C. B. Jackson; first printing, June 1955; second printing (revised), November 1955; (available from Superintendent of Documents, Washington 25, D.C.).

"Metallurgy of Zirconium," edited by B. Lustman and F. Kerze, Jr., July 1955 (published by McGraw-Hill Book Co., New York).

"The Metal Beryllium," edited by D. W. White and J. E. Burke, July 1955 (published by American Society for Metals, Cleveland).

"Bibliography of Reactor Computer Codes, Report AECU-3078," edited by R. S. Brodsky, December 1955 (available from Superintendent of Documents, Washington 25, D.C. This compilation is being kept current by the Nuclear Codes Group Quarterly Newsletter, inquiries should be sent c/o New York University, AEC Computing Facility).

"Reactor Shielding Design Manual," edited by T. Rockwell III, March 1956 (published separately by Government Printing Office, McGraw-Hill Book Co., New York, and D. Van Nostrand Co., Princeton, N.J.).

"Corrosion and Wear Handbook for Water-cooled Reactors," edited by D. J. DePaul, March 1957 (published separately by Government Printing Office and McGraw-Hill Book Co., New York).

Naval reactor physics handbook, A. Radkowsky, chairman of editorial board. Volume II, "The Physics of Pressurized Water Reactors," edited by S. Krasik, March 1959 (confidential); volume III, "The Physics of Intermediate Spectrum Reactors," edited by J. R. Stehn, September 1958.

In preparation

Naval reactors physics handbook, A. Radkowsky, chairman of editorial board. Volume I, "The Physics of Naval Reactors; Basic Techniques," edited by A. Radkowsky.

"Metallurgy of Hafnium," edited by E. T. Hayes and D. E. Thomas.

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- "Properties of Uranium Dioxide," edited by J. Belle.
"Reactor Heat Transfer and Fluid Flow Handbook," edited by J. Zerbe.
"Nuclear Reactor Design Manual," edited by N. J. Palladino, I. H. Mandil
and B. F. Langer.
"Reactor Plant Piping Handbook," edited by M. Shaw.
"Irradiation Testing and Hot Lab Techniques," edited by D. M. Wroughton,
T. J. Glasson and R. R. Roof.
"Nuclear Poison Materials for Reactor Control," edited by W. K. Anderson and
J. S. Theilacker.

X

TRANSMITTAL SLIP

TO: Under-Secretary of State
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FROM: The Canadian Embassy,
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Security: Unclassified
Date: April 3, 1959.
Air or Surface: Courier
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The documents described below are for your information.

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58 ✓

Copies	Description	Also referred to:
1	Press Release from the Office of the Joint Committee on Atomic Energy - No. 208 of March 12.	<p>2-1</p> <p>1 2 3 4 5 6 7 8 9 10</p> <p>17 APR 1959</p> <p>Handwritten notes: <i>Presumably from [unclear]</i>, <i>11 [unclear] [unclear]</i>, <i>McGovern</i>, <i>St. (11)</i>, <i>June</i>, <i>1941</i>, <i>1942</i>, <i>1943</i>, <i>1944</i>, <i>1945</i>, <i>1946</i>, <i>1947</i>, <i>1948</i>, <i>1949</i>, <i>1950</i>, <i>1951</i>, <i>1952</i>, <i>1953</i>, <i>1954</i>, <i>1955</i>, <i>1956</i>, <i>1957</i>, <i>1958</i>, <i>1959</i>, <i>1960</i>, <i>1961</i>, <i>1962</i>, <i>1963</i>, <i>1964</i>, <i>1965</i>, <i>1966</i>, <i>1967</i>, <i>1968</i>, <i>1969</i>, <i>1970</i>, <i>1971</i>, <i>1972</i>, <i>1973</i>, <i>1974</i>, <i>1975</i>, <i>1976</i>, <i>1977</i>, <i>1978</i>, <i>1979</i>, <i>1980</i>, <i>1981</i>, <i>1982</i>, <i>1983</i>, <i>1984</i>, <i>1985</i>, <i>1986</i>, <i>1987</i>, <i>1988</i>, <i>1989</i>, <i>1990</i>, <i>1991</i>, <i>1992</i>, <i>1993</i>, <i>1994</i>, 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INSTRUCTIONS

1. This form may be used in sending material for informational purposes from the Department to posts abroad and vice versa.
2. This form should *NOT* be used to cover documents requiring action.
3. The name of the person responsible for authorizing the despatch of the material should be shown opposite the words "Despatching Authority". This may be done by signature, name stamp or by any other suitable means.
4. The form should bear the security classification of the material it covers.
5. The column for "Copies" should indicate the number of copies of each document transmitted. The space for "No. of Enclosures" should show the total number of copies of all documents covered by the transmittal slip. This will facilitate checking on despatch and receipt of mail.

APR 7 1959
AM 10:02

encl. à Washington
april 3/59

No. 208

From the Office of the Joint Committee
on Atomic Energy

FOR RELEASE PM
Papers, Thursday,
March 12, 1959

Representative Melvin Price, Chairman of the Research and Development Subcommittee of the Joint Committee on Atomic Energy, stated today that recent recommendations to the Secretary of Defense by General Thomas D. White, Air Force Chief of Staff, calling for initiation of development work on an airframe for a nuclear powered aircraft and a stepup in work on the propulsion system for such an aircraft, are "further evidence" of the importance attached by military experts to accelerating the present aircraft nuclear propulsion program.

Referring to "reservations" which General White has communicated to Defense Secretary McElroy with regard to the Air Force Fiscal 1960 budget, Representative Price stated:

"It is clear that General White and his expert military advisors in the Air Force believe strongly that the aircraft nuclear powered program (ANP) is important to the nation's security interests and that the program is sufficiently advanced technically to warrant the commencement of work on an airframe and propulsion system suitable for first flight.

"The position which the Air Force Chief of Staff has taken underlines the necessity of getting on with the job of developing a ground test prototype propulsion system and making firm plans now for early nuclear flight, including the establishment of target dates.

"It also underlines the desirability, from an engineering standpoint, of proceeding with plans for actual flight testing of the propulsion system as a necessary first step toward eventual development of a fully operational military aircraft.

"The history of aeronautical engineering has repeatedly demonstrated that such initial flight testing is not only useful; it is essential to the development of a combat-ready military aircraft.

"Further delay in taking this step will only serve to put off the day when such a combat-ready aircraft is ready to take its place in the nation's defense system."

From the office of the
Joint Committee on Atomic Energy

No. 210
March 19, 1959
For Immediate Release

Senator Clinton P. Anderson, (D.,NM) Chairman of the Joint Committee on Atomic Energy made the following statement answering inquiries as to the public release by the Department of Defense of classified information concerning high altitude nuclear weapons tests in the South Atlantic last September:

"I am not pleased by the way the ARGUS story (the high altitude shots in the South Atlantic) was turned loose. The Joint Committee was briefed about this last January and many members raised the question as to why it could not be released then. The Department of Defense gave us reasons for keeping it classified 'Secret' and we accepted its reasoning.

"Now it is out in the open and I therefore feel free to release a letter Mr. Durham and I have today sent to General Loper. Obviously there were lengthy preparations for releasing this story. But the Joint Committee on Atomic Energy, which protected the secret label, did not hear officially that it was released until after 10:00 o'clock this morning. That strikes me as a poor example of cooperation. Our letter speaks for itself.

"It is curious that at the same time the Department of Defense was leaking this secret information, it was gagging the Joint Committee on an unclassified but most important bit of information on fallout. I believe the public interest requires that a certain Defense letter to the Joint Committee on Atomic Energy on fallout be made public at once."

Attachment

Attachment

CONGRESS OF THE UNITED STATES
JOINT COMMITTEE ON ATOMIC ENERGY

March 19, 1959

tensions and reduce the dangers inherent in this situation. "Until such arrangements are made and adequate safeguards are actually in effect, however, our best, and so far as I can see out only, sound basis for security is a ready deterrent strength featuring air-atomic power."

Honorable Herbert B. Loper
Assistant to the Secretary
of Defense for Atomic Energy
Department of Defense
The Pentagon
Washington 25, D. C.

Dear General Loper:

On the morning of March 19, 1959, headlines in The Washington Post newspaper announced that the "U. S. Reveals High Altitude A-Tests; Possibility of Anti-Missile Shield Seen." An accompanying front-page story with date line March 18, New York, discussed the high altitude nuclear tests conducted last September by the United States and identified Dr. Frank H. Shelton, Technical Director of the Armed Forces Special Weapons Project, as the person releasing the information.

On January 13 and 19, 1959, you were present in an Executive Session meeting of the Joint Committee on Atomic Energy at which Dr. Shelton and other representatives of the Armed Forces Special Weapons Project discussed these tests, the existence of which were considered classified information. During your testimony on January 19, you mentioned that consideration was being given to a public release of the fact that the tests were conducted and their purpose. You informed the Committee that if a decision was made to release the information, you would "certainly advise the Committee to that effect." Despite your assurance, the Joint Committee was not informed prior to the release.

I would appreciate it if you would advise me concerning the circumstances leading to the release of this previously secret information, when it was declassified and by whom, and the reasons for the manner in which it was released. I would also desire to know why the Joint Committee was not notified in advance of the release.

Sincerely yours,

Clinton P. Anderson
Chairman

Carl T. Durham
Vice-Chairman

No. 211

From the Office of the
Joint Committee on Atomic Energy

FOR RELEASE TO AM's
OF MARCH 22, 1959

Recent classified correspondence by the Defense Department and the Atomic Energy Commission revealing new fallout data was made public today in unclassified form by Senator Clinton P. Anderson, Chairman of the Joint Congressional Committee on Atomic Energy, together with the following statement:

"In commenting the other day on the Defense Department leak of classified information on the ARGUS shots (high altitude shots in the South Atlantic in September 1958) I pointed out that it was curious that the Defense Department at the same time was gagging the Joint Committee on making public some important data on fallout from weapons tests.

"The Defense Department and the AEC have now released their fallout correspondence with classified deletions, and it is made public in the attachments. First is a letter to me dated February 19, 1959, by the Defense Department revealing new data from classified sources on the residence time of fallout in the stratosphere, and the areas of maximum drip-out. Next is a letter from the AEC spokesman, Dr. W. F. Libby, commenting on the Defense Department letter and research project on which it was based. Then there is a transmittal letter from AEC stating their official reservations. Finally there is a brief chronology of our attempts to make this information public.

"The process of making public the ARGUS and fallout information is an example of how difficult it is to make available to the public the information it is entitled to have.

"The February 19 Defense Department letter states that their measurements indicate that the radioactivity in the stratosphere has a residence half life of two years, instead of seven years as had previously been assumed by AEC. It also indicates that there is a latitude band of maximum drip-out of the fallout from the stratosphere which occurs from 35° - 50° north or south. This area includes the northern part of the United States, and the letter states that 'the concentration of Strontium 90 on the surface of the earth is greater in the United States than in any other area in the world.'"

- 2 -

"In layman's language," Senator Anderson stated, "it looks like Strontium 90 isn't staying up in there as long as AEC told us it would, and the fallout is greatest on the United States. Perhaps this information may account, in part, for the recent higher readings of radioactivity in soils and plants.

"This new data appears to further contradict the official doctrine of AEC spokesmen as to residence time of fallout in the stratosphere and the theory that stratospheric fallout tends to drip out uniformly throughout the earth. The AEC letter of February 27, 1959 ought to be checked for consistency with the speech of the same AEC spokesman on March 13, 1959 at Seattle.

"The Joint Committee will look into these matters when it holds its fallout hearings in May of this year under the Chairmanship of Congressman Chet Holifield of the Special Subcommittee on Radiation."

Attachment No. 1

OFFICE OF THE SECRETARY OF DEFENSE
Washington 25, D. C.

FEB 19, 1959

Dear Mr. Chairman:

The following is a brief status report outlining the present programs for analyzing and evaluating the radiation hazards resulting from atomic detonations.

Fallout reports from Operation REDWING (1956), PLUMBBOB (1957), and HARDTACK (1958) are currently under preparation.

The hazards of local contamination from nuclear weapon detonations have been fairly well delineated. However, the difficulty in accurately predicting the rapidly varying atmospheric condition results in uncertainties as to the area of fallout. Predictions of local fallout contours from enemy bombs must be based on a large number of assumptions such as the type of weapon, height of burst, and yield. These unknowns do not allow accurate prediction of fallout from enemy bursts during wartime. Delineation of contaminated areas by airborne radiac instruments after deposition of the fallout is presently practicable and will be of considerable military and civil value during wartime.

The deposition of worldwide fallout or worldwide surface contamination is now beginning to be accurately measured. . . . (Classified portion deleted) . . . Recent indications are that the radioactivity in the stratosphere has a residence half-life of two years (in contrast to the previously assumed value of about seven years) and the present amount of Sr^{90} in the stratosphere would be maintained by the injection of about 6 megatons of fission products per year. The concentration of the Sr^{90} on the surface of the earth is greater in the United States than in any other area of the world. The danger of Carbon¹⁴ and Cesium¹³⁷ has been examined and the immediate probability of any one individual being affected is about 1 in 500,000.

The risk of damage resulting from the testing of weapons is therefore extremely small and much less than other common day occurrences such as X-rays, automobiles, chemical contaminants, household cleaners, etc. However, the probable casualties attributable to radioisotopes from weapons testing when summed over the populations of thousands of years create a moral issue that could be of considerable propaganda importance.

Attachment No. 1

Page 2

The distribution of the radioactive debris in the stratosphere as a result of detonations to date is not clearly defined as to its altitude and latitude variation. The altitude dependence partially determines the drip-out rate and the latitude dependence influences the extent to which the worldwide fallout is uniform over the earth. Tentative conclusions to date indicate that three tenths of the quantity of radioactive debris leaves the stratosphere each year, that the north, south diffusion of radioactive particles in the stratosphere does exist, and that in both hemispheres, there is a latitude band of maximum drip-out which is from 35° - 50° North or South.

There is a need for more experimental and collecting programs in the following areas of the effects and behavior of fallout from nuclear weapons:

- (a) Amount of fallout deposited locally from a low height of burst.
- (b) More accurate determination of the drip-out rate of radioactive particles from the stratosphere.
- (c) Further define the estimate of the amount of radioactivity formed per KT of fission yield.
- (d) The refinement of measuring techniques to account for all radioactivity produced from a nuclear yield.
- (e) Advancements in the knowledge of fireball chemistry, physics and particle behavior.
- (f) Response of biological systems to radiation.

Sincerely yours,

/S/ Herbert B. Loper
Herbert B. Loper
Assistant to the Secretary
of Defense (Atomic Energy)

Honorable Clinton P. Anderson
Chairman, Joint Committee on Atomic Energy

Attachment #2

February 27, 1959

Honorable Herbert B. Loper
Chairman
Military Liaison Committee

Dear General Loper:

In connection with your letter to Senator Anderson of February 19, 1959, concerning radiation hazards resulting from atomic detonations, I have just completed a study of data.....which you kindly made available to us last December. I am sorry that, because of the complexity of the problem and my preoccupation with other duties, I have been so slow in finishing my consideration of the data and in sending on my comments.....

I think your letter to Senator Anderson is an excellent exposition of the present position we are in. There are, however, one or two points you make on which I believe further words are necessary in order to resolve some questions.

The extensive data that have already been published by Project Sunshine and the United Kingdom study group, together with your beautiful..... work, still leave us, despite their great volume and complexity, in some uncertainty, as you say, as to the distribution of the radioactive debris in the stratosphere to both altitude and latitude variation. Since the altitude variation determines in part the drip-out rate and thus the residence half-life in the stratosphere, this quantity is left in some doubt. My own present conclusion is in agreement with yours as stated in your letter, in that my previous value of seven years for this important number is too long and that it should be reduced. In a re-study of this question, being released March 13 in Seattle, a copy of which will be sent you as soon as it is printed, a new value of about four years rather than the earlier seven is arrived at. I find it difficult to push it down to the two years you give as an indicative value.

On the amount of strontium-90 in the stratosphere, at the present time there is a somewhat larger difference in our estimates which may be due to your not having included the Russian series of last October which in itself alone, according to my estimates, increased the stratospheric inventory by about fifty percent..... You give the present inventory as requiring 6 MT (megatons fission equivalent) per year to be maintained at its present level. For a half-life of two years this corresponds to only 17 MT total and appears to leave too little room for the injections from tests before last October, which I estimate still have left some 25 to 30 MT in the stratosphere for a total at present of about 42 MT and

Attachment #2

General Herbert B. Loper - 2 -

a corresponding required rate of injection for steady maintenance of about 7 MT per year. The closeness of this figure to your 6 MT per year number shows how badly we need further information on the actual stratospheric content.

You indicate that the stratospheric fallout occurs at maximum rates in the 30° - 50° bands of latitude in both hemispheres. This old argument still is not quite settled, I believe, although the evidence in favor of your conclusion is increasing. My principal difficulties with it at the moment are that we know that a considerable part of the peak in observed fallout in these latitudes in the Northern Hemisphere is due to tropospheric or local fallout which was never in the stratosphere and the evidence for a corresponding peak in the Southern Hemisphere seems to be rather weak.

With respect to the carbon-14 and cesium-137 hazards, - the laboratories measuring radiocarbon dates in various parts of this country, in Europe and New Zealand have sent me data on the present increase in the carbon-14 content of living matter which amounts to about ten percent of the natural level of carbon-14 from the cosmic rays which in itself corresponds to about 1.5 milliroentgen per year - about 1.5 percent of the average total natural dose rate. Turning to cesium-137, Dr. E. C. Anderson in the Health Division at our Los Alamos Laboratory has just reported data on the human level in the United States and Europe for the late summer and early fall of last year which amount to an average of about 75 micromicrocuries per gram of body potassium for an internal dose rate of about 3 milliroentgens per year. The total cesium-137 fallout in the United States now amounts to about 50 millicuries per square mile. This adds about 1 mr/yr of external dose for a total of about 4 mr/yr due to cesium-137 which is about 3 percent of the natural average radiation dose rate from natural radioactivity and the cosmic rays. I can't tell whether these numbers are in strict keeping with your estimate that the immediate probability of any one individual being affected by bomb test carbon-14 and cesium-137 is about 1 in 500,000 but I think your estimate looks reasonable.

On the many other points in your letter I find myself in complete agreement, particularly about the importance of more experimental and collecting programs on the amount of fallout deposited locally from a low height of burst. Since it may be that we will not again have the opportunity to test devices, at least above ground, it is particularly important to consider whether we may not collect more information on

Attachment #2

Honorable Herbert B. Loper - 3 -

this point from past tests. I believe there are some possibilities of doing this and I suggest that we undertake such a program jointly right away.

Sincerely yours,

W. F. Libby
Commissioner

Distribution:

1. Honorable Clinton P. Anderson
2. Rear Adm. Edward N. Parker
3. Dr. Frank Shelton
4. Dr. Lester Machta
5. Mr. John A. McCone
6. Mr. Harold S. Vance
7. Mr. John F. Floberg
8. Mr. John S. Graham
9. Gen. A. R. Luedecke
10. Gen. A. D. Starbird
11. Dr. Charles Dunham

Attachment # 3

Copy of letter to the Joint Committee, received March 21, 1959
from the AEC

This is in reply to your letter of March 9, 1959, by which you forwarded a copy of General Loper's letter to Senator Anderson dated February 19, 1959, and requested our comments thereon.

Commissioner W. F. Libby has written his comments to General Loper in a letter dated February 27, a copy of which was sent to Senator Anderson at that time. For your convenience another copy of Dr. Libby's letter is attached.

The revised estimates of stratospheric burden and the residence time presented by General Loper are consistent both with the data referred to by General Loper and with the "ASH CAN" data obtained by the Atomic Energy Commission in its balloon sampling up to 90,000 feet. However, it should be kept in mind that knowledge of the stratospheric content alone is not sufficient to determine retention time. In addition one needs the knowledge of either the stratospheric injection or of total stratospheric fallout as a function of time. Within the range of accuracy with which fallout has been measured, observed fallout to date is not incompatible with General Loper's estimate of the injection rate which would be required to maintain the present stratospheric burden.

The two main reasons for the uncertainty in the stratospheric burden and residence time are (1) that the entire stratosphere has not been adequately surveyed from pole to pole and up to altitudes beyond which the overlying radioactive debris can be confidently neglected and (2) that the data obtained at the higher altitudes by balloon only are subject to sizable sampling errors, uncertainties of collection efficiency of the sampling filters, and radiochemical analysis errors due to the small amounts collected.

Attachment #3

As a consequence of these uncertainties we do not consider that the data now available are sufficiently decisive to resolve the differences between the estimates of stratospheric content and retention time made by General Loper and the higher estimates given by Dr. Libby in his letter to General Loper. It may be observed that on the basis of the estimates made by General Loper the total worldwide fallout of long-lived radioactive fission products anticipated from all tests up to date would be roughly two times the total deposition so far and that on the basis of Dr. Libby's estimate the total would be roughly three times.

We concur with General Loper in recognizing the need for further investigations along the lines suggested in his letter. We plan to continue our efforts in all these fields. In particular, we hope to be able to differentiate Operation Hardtack surface-burst debris and high-altitude debris, by analysis of tungsten and rhodium isotopes respectively, and, in turn, to distinguish these from the recent USSR debris. In this way it should be possible to obtain a much better picture of the actual patterns and rates of spread of stratospheric debris originating in different latitudes and altitudes.

The information bracketed in red on the first page of the attached copy of Dr. Libby's letter of February 27, 1959 is considered by the originating agencies to be Confidential Defense Information. With these deletions Dr. Libby's letter is declassified.

Sincerely yours,

General Manager

Enclosure:

Cpy ltr to Gen. Loper frm Com. Libby,
dtd 2/27/59

Attachment No. 4

Brief Chronology of action by Joint Committee on Atomic Energy
to make public Defense Department Report on Fallout:

- Dec. 1958 Dr. Libby furnished new data by Defense Department indicating that the radioactivity in the stratosphere has a residence half-life of two years instead of previously assumed value of seven years.
- Feb. 20, 1959 Joint Committee received fallout report by the Department of Defense dated February 19, 1959 classified "Confidential - Restricted Data."
- Feb. 27, 1959 Confidential letter sent to Defense Department by Dr. Libby with copy to Joint Committee Chairman in which Dr. Libby arrived at new value of four years instead of previous seven years.
- Mar. 9, 1959 Joint Committee by letter this date to the Defense Department questioned the reasons for the Confidential classification of the report and inquired as to what extent the information could be discussed in public without compromising classified information.
- A separate letter this date was also sent to the AEC requesting the Commission's views on the report and to what extent the conclusions affected previous assumptions and statements.
- Mar. 13, 1959 Restudy by AEC of worldwide stratospheric fallout released at Seattle, Washington, in which no mention of Defense Department study is made and which maintains position of a residence time of five to ten years, selecting six years as the mean residence time of stratospheric fallout. Results of another AEC analysis "Project Ash Can" which indicated a residence time of three years was discounted as being doubtful. No mention was made that the Department of Defense conclusions of residence half life of two years tended to support results of "Project Ash Can."

Attachment No. 4
Page 2

Mar. 18, 1959 By letter, the Defense Department advised the Joint Committee that only one sentence in the report contained classified information and after identifying it went on to state:

"Although the remainder of the letter is unclassified; the Department recommends that it not be discussed in public because there is not full agreement as to the interpretation of the data that has been obtained so far. We believe it would be far better before the data and conclusions are made public that there be a close agreement amongst the investigators concerned. Therefore, we believe that until the results are more than preliminary, the CONFIDENTIAL classification should remain on the letter."

Mar. 20, 1959 Letter received by Joint Committee from the Defense Department advising the report could be made public with deletion of the one classified sentence.

Mar. 21, 1959 Letter received from AEC stating what portion of Dr. Libby's Confidential letter of Feb. 27, 1959 to the Department of Defense does not contain classified information.

Letter and report released by Joint Committee after deletion of classified information.

FOR RELEASE

1:00 P.M. March 11, 1959

Address of Senator Clinton P. Anderson,
Chairman, Joint Committee on Atomic Energy,
before the Regional Meeting of the American
Bar Association, Pittsburgh, Pennsylvania -
March 11, 1959

LAWYERS, LEGISLATORS AND THE ATOM

First of all, let me express my delight in being privileged to come to a regional meeting of the American Bar Association while your president is a distinguished citizen of my home state of New Mexico. We are all proud of Ross Malone - no one more than I am - and I know I speak for the state when I thank you for the honor you have paid him, and through him to the Land of Enchantment.

As a non-lawyer surrounded by distinguished members of the bar, I appreciate the feeling Daniel must have had in the Lion's Den. While I have had some experience in dealing with the legal mind, since well over half my colleagues in the United States Senate are members of the legal profession, I am compelled to talk to you today in the language of a non-lawyer and as a legislator who has high hopes that the future safe development of the atom will benefit our country and mankind.

Today I shall review with you some of the current legal-policy problems now before the Joint Committee on Atomic Energy, and suggest some areas where lawyers could and should be more active in helping solve some of the challenging problems arising out of the increased uses of atomic energy.

The late Gordon Dean gave a speech here in Pittsburgh in 1951 on "The Impact of the Atom on Law." I wish he were alive today to review the

-2-

progress we have made in solving the various problems he then saw. Even at that early date, Mr. Dean stated that we, who have heavy responsibilities in this area, needed more assistance from the leaders of the bench and bar. As you shall see, this will be one of the theses of my remarks, too.

There is another reason why I am glad to be speaking to you here in Pittsburgh. It gave me an opportunity to visit the Shippingport atomic power reactor this morning with Admiral Rickover who directed its development and construction, with Charley Weaver and John Simpson of Westinghouse, who supervised the job for Westinghouse, and with Jim Ramey, executive director of the staff of the Joint Committee on Atomic Energy, who took part in the negotiations for its construction on behalf of the Chicago office of the Atomic Energy Commission. This atomic power plant is our only full-scale prototype in operation, and is obtaining a wealth of research and operating information essential to our atomic technology. I look for it to go far beyond the 60,000 kilowatts it can now deliver and through experiment and improvement reach twice or three times that output. I understand we also made some legal progress in contract drafting on the AEC-Westinghouse contract covering the Nautilus and Shippingport projects.

Once before I was bold enough to venture into the legal arena, when I spoke on "Some Aspects of Law in the Atomic Age" before the Northeastern Regional Meeting of the American Bar Association in Hartford, Connecticut, on April 16, 1956. At that time I tried to outline what I believed to be some of the chief legal problems in the transition period of the Atomic

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Age from war to peace. Some of these problems have been solved, some are still with us, and, of course, some new legal "brain twisters" will be included in my talk today.

For example, one of the big legal and policy problems as we saw it in 1956, was the problem of domestic third party liability from atomic accidents, and means of insurance and indemnity. This was thought to be the main bottleneck to rapid development of the private atomic power program. As a result of study, we enacted the Price-Anderson Indemnity law. But we find now that the atomic power program is still lagging and there are other legal and policy problems still facing us. Foreign indemnity, for example.

Framework of Atomic Energy Development

The atomic energy program under the 1946 and 1954 acts has mainly been a Government sponsored and financed program carried out under contract between AEC and industrial and university and non-profit contractors. Thus the Government has been acting in a proprietary capacity, and the applicable law has been that of Government contracts as construed by Federal and State courts, -- more importantly, by that protector of the Federal purse, the General Accounting Office.

More recently, under the Atomic Energy Act of 1954, which permits private ownership of power reactors and encourages extensive use of radioisotopes, the AEC has been shifting gradually to a parallel role of regulator of private atomic development, particularly as to health and safety. In this

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capacity, AEC is exercising sovereign police powers of the Government. And the applicable law is that called "Administrative Law," first applied by AEC itself as a rule-making and adjudicative body, and then subject to appeal to the Federal Courts under the Administration Procedure Act.

Many of the problems of atomic energy development have grown out of these dual proprietary-regulative roles of the AEC.

As I mentioned to you earlier, I shall discuss these problems from the standpoint of a legislator, not as a lawyer. In Congress, for example, we have been reviewing the various problems of atomic hazards for the past several years, and determining legislative and administrative mechanisms for protecting the public and employees from these hazards. To a lawyer such problems are initially individual problems of third party liability, tort claims, and workmen's compensation. It is only when you join up in a bar association that you begin to look at the legal-policy problems, and consider the social implications. At this point our viewpoints begin to get closer together.

Atomic Energy and State and Local Governments

It has been pointed out many times that the atomic energy industry "grew upside down." Most industries begin on the local level, and come under Federal regulation only when they begin to spread across state lines and affect interstate commerce. The atomic energy industry, on the other hand, was created during the war under conditions of secrecy and was nurtured and developed by the Federal Government. Now it is becoming more a part of our peacetime economy, and local and state governments -- traditionally the protectors

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of the health and safety of their citizens -- are becoming involved.

The Federal Atomic Energy Act provides a comprehensive framework for Federal development and regulation but is silent as to the role of the states in regulating the atom.

Indeed, at the present time there is considerable uncertainty, from the legal point of view, as to how far the states can go in regulating atomic energy within their boundaries. My lawyer friends tell me that there are two lines of cases, in other areas, on the question whether the Federal Government has "pre-empted the field."

You lawyers can discuss California v. Zook (336 U.S. 725) and Pennsylvania v. Nelson (350 U. S. 497). To me the general question seems to be: Are the provisions of the Federal Atomic Energy Act "so pervasive that it preempts the field" of regulating the atom?

Faced with this dilemma, the states have to date moved cautiously, but the legal uncertainty still remains.

Ten states have adopted laws similar to the so-called Atomic Energy Coordination Act, a model bill recommended by the Council of State Governments. This Act establishes an atomic energy Coordinator as adviser to the Governor, and directs all state departments to examine their laws and regulations to determine whether they need overhauling to cope with the atom. This appears to me to be a sound and logical first step for a state approaching its new atomic responsibilities.

Seven states (California, Connecticut, Massachusetts, Michigan, New York, Pennsylvania and Texas) have gone farther and adopted so-called comprehensive radiation regulation codes. These regulations set forth maximum permissible doses of radiation, and so forth, and generally parallel the AEC or Federal regulations.

Minnesota recently adopted regulations which raise the direct legal or constitutional question. The Minnesota regulations require that before someone constructs a reactor in that state, he must submit the plans of the reactor to the state health officer for examination. The state health officer may require additional plans and information, and may delay commencement of construction of the reactor. In addition, the regulations provide that the state health officer must give his express approval before the reactor can begin to operate on its nuclear fuel.

Could a reactor builder, who has already obtained a license from the Federal AEC, after a lengthy procedure, ignore the Minnesota health officer? Could he say: "I have my Federal license, and I believe your regulations requiring me also to obtain a state license are invalid, and therefore I intend to build my reactor without regard to your regulations." What if the reactor will be Federally-owned as at Elk River, but operated by a co-operative like the Elk River Co-op with the conventional facilities owned by the co-op?

A further question arises if, as in the case of the Northern States Power Company, an atomic power plant is built in South Dakota just across the river from Minnesota, where the prevailing winds blow toward Minnesota and particularly Minneapolis and St. Paul. What can Minnesota do about a reactor in South Dakota that might shower a little "fallout" on

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Minnesota?

How would you, as a lawyer, advise the utility on these matters?

Now, I, myself, doubt that any reactor builder would take the attitude of ignoring his own state government or an adjoining one, but the legal and policies questions are still unsettled. Thus there are increasing demands that the Joint Committee and the Congress examine these questions and "spell out" in the Federal Act just how far the Federal Government authority goes, and just how far the state and local governments can go in regulating the atom.

The Committee has therefore scheduled hearings in May of this year on Federal-State Cooperation in the atomic energy field. Perhaps the subject can be broken down into types of activities. For example, one might apply different criteria to the activities of reactor licensing, waste disposal, and transportation, on the one hand, and isotopes and site selection on the other. In some of these areas perhaps the Federal Government should obtain exclusive jurisdiction. In others perhaps the responsibility can be transferred to the states. In still others perhaps concurrent responsibility would be the best solution.

These "jurisdictions" are lawyers' terms. To a layman, the questions could be stated from the Federal standpoint as: Should the Federal Government hang on to its powers, or should it let loose of them, or should it store some of the "powers" in the ice box for later definitive consideration?

But I would urge you, as lawyers, to find out what type of atomic energy laws and regulations your state or local government has adopted or

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hopes to adopt, and help us evaluate the proper division of responsibilities. I think all of us agree that harmonious and non-convlicting regulations are desired at all levels of government--Federal, state and local. The dual goals are to protect the health and safety of the public, and at the same time to develop this new source of energy without subjecting it to unduly burdensome regulations.

Employee Radiation Safety and Workmen's Compensation

A very interesting series of hearings began today before our Subcommittee on Research and development and will continue for two more days this week and three days next week. These hearings are on employee radiation safety and workmen's compensation laws, and we are scheduled to receive testimony from scientists, medical experts, and lawyers. It is interesting, in fact, how closely interrelated each of these professions is in the atomic energy field.

From the legal point of view, I might mention that practically everyone agrees that state workmen's compensation acts are, at the present time, quite inadequate, insofar as radiation injuries are concerned. Many of them do not recognize radiation injuries as an occupational hazard and almost all of them have inadequate statutes of limitations. In many cases radiation injuries do not become evident until many years after the employee or the individual was first exposed.

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In my opinion, there is an urgent need for each state government to examine its workmen's compensation laws and bring them up to date to accord with the facts of life in this, the Atomic Age. In addition, each state government should also consider the feasibility of adopting the Atomic Energy Coordination Act recommended by the Council of State Governments.

Liability and Tort Problems - Indemnity and Insurance

I have already mentioned an atomic energy legal problem, which is an old friend and a favorite "brain twister" for lawyers: that of tort and liability problems in the event of a reactor accident. The Joint Committee has grappled with this problem for a number of years. We have received testimony to the effect that the probabilities of a reactor accident are very remote, but that the liability claims could exceed \$5 billion in property damage alone if such an accident should occur. (What a field for the lawyer of tomorrow!) The damages would not be caused by an explosion, as in the case of an atomic bomb, but through the release of radioactive materials from the core of the reactor, much like fallout from a weapon, which would contaminate the countryside for miles around.

The legal question of the liability of the reactor owner has not yet been tested in the courts. We cannot say with certainty yet whether a reactor operator will be held liable only for negligence, or whether he must assume absolute liability under the old English rule of Rylands v. Fletcher. No doubt the injured plaintiffs will argue that the reactor owner was operating a

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"dangerous instrumentality" and therefore that he is absolutely liable for any damages incurred by a reactor accident, even without proof of negligence on his part.

In 1957, when Congress enacted the indemnity amendments to the Atomic Energy Act of 1954 (generally referred to as the Price-Anderson amendments), it avoided -- and wisely so in my opinion -- these difficult questions of liability, but instead set up a governmental indemnity framework to make available funds to protect the injured, regardless of whom the courts should find liable. The necessity for governmental action arose because of the possibility of extensive damages, far exceeding the amounts which private insurance firms, even through pools were able to offer. Under the Price-Anderson Act formula, an operator of a large nuclear power plant is required to obtain the maximum available private insurance, up to \$50 or \$60 million, and above that amount the Government will provide an indemnity of \$500 million dollars. The statute then provides a limitation of liability procedure and permits apportionment of claims above that amount. In the event a serious reactor accident went beyond the half billion limit, petition could also be made to Congress for special reimbursement, as in the case of the Texas City disaster several years ago.

The purposes of the Price-Anderson Indemnity Act were twofold; first, to protect the public by providing indemnity funds; and second, to encourage private industry to design and build reactors, without fear of possible huge liability claims which could bankrupt any reactor company.

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In 1958, after hearings, Congress amended the Price-Anderson Act in two respects. First, with respect to non-profit educational institutions, it was provided that AEC could waive the normal requirement of private insurance coverage, in order that these institutions could participate in the program. Secondly, the Act was extended to cover nuclear liability claims arising out of the operations of the NS SAVANNAH, our first nuclear-powered merchant ship, even in its operations outside the continental limits of the United States,

This brings me to a legal "brain twister" of international proportions. Many of our private industrial companies are manufacturing reactors, or reactor parts, for installation abroad, particularly in Western Europe under the new EURATOM program. Some of these manufacturers are worried about indemnity problems. What happens if a reactor manufactured in the USA has an accident ten years later, for example, in Belgium, releasing radioactivity causing extensive damages in the Netherlands and France, as well as Belgium? No doubt many of the injured persons would be sorely tempted to seek to establish liability on the part of the USA manufacturer, or even on the part of the U. S. Government which had furnished the nuclear fuel.

Last year, in the Euratom Cooperation Act of 1958, the Congress added a special section 8 providing that the U. S. Government would assume no liability by virtue of its assistance in the Euratom program. At the present time, serious efforts are being made to encourage the European countries,

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or the Euratom six nation Community itself, to enact some sort of an international liability convention or treaty which would provide protection to suppliers, similar to the protection provided by the Price-Anderson Act for suppliers of reactors constructed in this country. I am glad to report that some progress is being made in this direction, and that both the six nation Euratom Community, and the 13 nation OEEC organization have drafted conventions and agreements which should help resolve these difficult international indemnity questions which might arise out of the operations of nuclear reactors.

Licensing and Regulation of the New Atomic Industry

As lawyers, you will no doubt appreciate that nuclear reactors-- in fact all atomic activities--must be closely regulated by the AEC, either by contract or through some sort of licensing procedure. A great deal of the support for the new atomic industry has come through AEC contracts with private companies, and these contracts contain extensive provisions concerning health and safety procedures to be followed by the contractor.

In addition, any person desiring to possess nuclear fuels, or build a nuclear reactor, must first obtain a license from the AEC, and be subject to AEC regulations and inspection procedures. This is required by the Atomic Energy Act itself in order to maintain accountability of these valuable materials from a national defense viewpoint, and also to assure adequate operating and handling procedures to protect the health and safety of employees and the public.

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In 1956, I requested the Committee staff to study some of these problems, and subsequently in 1957 the Joint Committee published a staff study entitled "A Study of AEC Procedures and Organization in the Licensing of Nuclear Facilities." In 1957 I also introduced a bill in the 85th Congress to require public hearings and public reports by the Advisory Committee on Reactor Safeguards on all applications for a construction permit and license to operate large scale nuclear reactors. After hearings, these two provisions were subsequently incorporated into the Price-Anderson Indemnity Act amendments. As lawyers, you can appreciate the importance of public hearings on questions of great and vital interest to the public which must live in the area of a new reactor. I believe you can also appreciate the advisability of having made public a report by the distinguished scientists on the reactor safeguards advisory committee analyzing the safety features of the proposed reactor.

As for site selection, I wrote as follows in a recent Nucleonics article:

"I believe we are about at the stage where the Congress should consider whether to require the AEC to establish criteria (by means of a regulation) for the selection of sites for atomic power plants. Along with the criteria might be a requirement that applicants for a construction permit must submit alternative site proposals, with a further proviso that no permit should initially be issued for a site tentatively disapproved by the Committee on Reactor Safeguards. I am still of the opinion that it is absurd to permit tens of millions of dollars to be invested in an atomic power plant at a site where there is substantial doubt among experts as to whether the plant will be safe at that location."

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One difficult and important question remains in the licensing and regulation field: the organization of the AEC itself. At the present time the Commission issues licenses after examining safety questions. At the same time it has promotional and developmental responsibilities, and provides financial assistance in many cases to the same organization which it licenses. Many of the AEC employees understandably become technically enthusiastic about certain reactor projects and the advances they will make in the technology, while other employees must look at these same designs with "fishy eyes" to determine safety questions. In both cases, although the subordinates may make recommendations, the ultimate decisions must be made by the five-man Commission itself.

Eventually, I believe that the Commission's adjudicatory responsibilities must be separated from its operating and developmental responsibilities, by the establishment of an independent board to issue licenses and consider safety and regulatory questions. It is only a question of timing. Have we reached the stage in development where the AEC should be separated into two agencies?

I leave this question for you lawyers to ponder.

Atomic Energy Patents

No atomic energy legal discussion is complete without mentioning patents, so we have scheduled hearings in April of this year on this subject which is so near and dear to the hearts of at least some lawyers. As every good patent lawyer knows, the Atomic Energy Act of 1954 contains some

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special, and some unusual, provisions concerning inventions and patents in the atomic energy field. Most members of the patent bar are vociferous in their demands that these provisions in the Act be repealed, and that "normal" patent laws apply in the atomic energy field. But from our preliminary examination of the subject, we find that there is no such thing as "normal" patent laws.

The main question we will consider in our April hearings is whether we should extend the so-called "compulsory licensing" provision in section 153. But we will also want to consider possible other improvements and deletions from the Patent Section, and particularly international patent protection.

Within a week or two the Joint Committee will distribute some background materials on atomic energy patent policies and procedures which the Committee staff has accumulated. These will be made available and published in the form of a Joint Committee print, and I would be glad to send any member of this audience a copy, if he would be so kind as to write a letter of request to me or to the Joint Committee on Atomic Energy in Washington. This print will be distributed at this time in order to provide background information for those interested in preparing for the hearings, and then we will go into the special problems of atomic energy patents more thoroughly during the hearings next month.

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Conclusions

In conclusion, what can I suggest you lawyers do to contribute towards the development of the atom:

First, I believe that you can participate in or form committees of your local Bar Associations, as well as the present American Bar Association Committee, to study some of these legal-policy problems which I have briefly described. These problems are not esoteric or imaginary; they are real and fascinating; they press for decisions.

Second, lawyers can carry out their traditional responsibilities by offering advice and counsel at all levels of the Government -- local, state and national. City and state governments are grappling with the new problems of how to develop and regulate the atom. As I have mentioned, new questions are also constantly emerging on the national and international levels concerning atomic development. I urge you to follow these developments and to assist those of us in Government having heavy responsibilities by giving us your advice and counsel. In most of these fields we all must play by ear -- and we would welcome you into the orchestra.

The scientists have led the way in unlocking the mysteries of the atom. The engineers are making realities out of the promise of atomic power. The lawyers can give it a better day in court.

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ATOMIC ENERGY COMMISSION
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FOR IMMEDIATE RELEASE
(Tuesday, March 10, 1959)

AEC RELEASES DATA ON HARDTACK BOMB TESTS

The Atomic Energy Commission has released additional information on the HARDTACK series of nuclear tests in response to requests from seismologists and scientists.

The information concerns previously announced detonations, 16 held last spring and summer at the Commission's Eniwetok Proving Ground in the Pacific and 19 at the Nevada Test Site last fall. New data on the attached pages include the names of the shots, their geographical coordinates, placement, exact time of firing and some yields.

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HARDTACK PHASE I SHOTS

<u>Shot Name</u>	<u>Geo. Coordinates</u>	<u>Type Shot</u>	<u>Local Time (1/10 Second)</u>
Fir	Lat 11°41'27" N Long 165°16'25" E	Surface Barge	5/12/58 0550:00.1 W
Koa	" 11°40'30" N " 162°12'20" E	Surface	5/13/58 0630:00.1 W
Yellowwood	" 11°39'37" N " 162°13'31" E	Surface Barge	5/26/58 1400:00.1 J
Maple	" 11°41'14" N " 165°24'54" E	Surface Barge	6/11/58 0530:00.1 W
Aspen	" 11°41'27" N " 165°16'24" E	Surface Barge	6/15/58 0530:00.1 W
Walnut	" 11°39'37" N " 162°13'31" E	Surface Barge	6/15/58 0630:00.1 J
Redwood	" 11°41'14" N " 165°24'54" E	Surface Barge	6/28/58 0530:00.1 W
Elder	" 11°39'48" N " 162°13'48" E	Surface Barge	6/28/58 0630:00.1 W
Oak	" 11°36'28" N " 162°06'28" E	Surface LCU Hull	6/29/58 0730:00.1 J
Cedar	" 11°41'27" N " 165°16'25" E	Surface Barge	7/ 3/58 0530:00.1 W
Dogwood	" 11°39'48" N " 162°13'48" E	Surface LCU Hull	7/ 6/58 0630:00.2 J
Poplar	" 11°41'17" N " 165°15'52" E	Surface Barge	7/12/58 1530:00.1 J
Pine	" 11°39'22" N " 162°13'11" E	Surface LCU Hull	7/27/58 0830:00.2 W

NOTE: Date and time are local

W - time for WWVH

J - time from JJY Japan, uncorrected for transit time

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HARDTACK PHASE I SHOTS

<u>Shot Name</u>	<u>Geo. Coordinates</u>	<u>Type Shot</u>	<u>Local Time* (Second)</u>	
Yucca	Lat 12°37'00" N Long 163°01'30" E	High Altitude	4/28	1440:00 N
Teak	" 16°44'14" N " 169°31'36" W	High Altitude	7/31	2353:05
Orange	" 16°23'46" N " 169°32'05" W	High Altitude	8/11	2332:08

* Time of incidence of shock wave on the earth's surface.

NOTE: Date and time are local.

N - Corrected time by NBS.

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HARDTACK PHASE II SHOTS

<u>Event</u> <u>(Placement)</u>	<u>Date</u>	<u>Firing Time</u>	<u>North Latitude</u>	<u>West Longitude</u>	<u>MSL (Feet)</u>	<u>Arrival of</u> <u>Air Shock</u>	<u>Approx. Yield</u>
EDDY (Balloon)	Sep 19	0600:00	37°05'11.732"	116°01'25.329"	4686.5		83 tons
MORA (Balloon)	Sep 29	0605:00.1	"	"	5686.5	0605:01.4	2 KT
TAMALPAIS (Tunnel)	Oct 8	1400:00.1	37°11'43"	116°12'01"	6616.0		57 tons
QUAY (Tower)	Oct 10	0630:00.1	37°05'41.385"	116°01'25.078"	4343.0	0630:00.1	84 tons
LEA (Balloon)	Oct 13	0520:00.1	37°05'11.732"	116°01'25.329"	5686.5	0520:01.4	1.5 KT
HAMILTON (Tower)	Oct 15	0800 ⁺ 1	36°48'08"	115°55'55"	3132.3		1.0 ton
LOGAN (Tunnel)	Oct 16	2200:00.1	37°11'03"	116°12'04"	6141.0		5 KT
DONA ANA (Balloon)	Oct 16	0620:00.1	37°05'11.732"	116°01'25.329"	4636.5	0620:00.5	36 tons
RIO ARRIBA (Tower)	Oct 18	0625:00.1	37°02'27.551"	116°01'33.289"	4075.0	0625:00.1	92 tons
SOCORRO (Balloon)	Oct 22	0530:00.1	37°05'11.732"	116°01'25.239"	5636.5	0530:01.0	6 KT

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HARDTACK PHASE II SHOTS (Cont'd)

<u>Event (Placement)</u>	<u>Date</u>	<u>Firing Time</u>	<u>North Latitude</u>	<u>West Longitude</u>	<u>MSL (Feet)</u>	<u>Arrival of Air Shock</u>	<u>Approx. Yield</u>
WRANGELL (Balloon)	Oct 22	0850:00.1	36°47'52"	115°55'44"	4576.1	0850:01.2	100 tons
RUSHMORE (Balloon)	Oct 22	1540:00.1	36°47'52"	115°55'44"	4714.2	1540:00.3	180 tons
SANFORD (Balloon)	Oct 26	0220:00.1	36°47'52"	115°55'44"	4576.1	0220:00.8	4.5 KT
DeBACA (Balloon)	Oct 26	0800:00.1	37°05'11.732"	116°01'25.239"	5686.5	0800:01.3	2.5 KT
EVANS (Tunnel)	Oct 28	1600:00.1	37°11'41"	116°12'17"	6620.2		200 tons
MAZAMA (Tower)	Oct 29	0320:00.1	37°07'35"	116°02'27"	4252.5		0
HUMBOLDT (Tower)	Oct 29	0645:00.1	37°02'57"	116°01'28"	4053.7		6 tons
SANTA FE (Balloon)	Oct 29	1900:00.1	37°05'11.732"	116°01'25.239"	5686.5	1900:01.5	1.25 KT
BLANCA	Oct 30	0700:00.1	37°11'09"	116°12'07"	6138.5		23 KT

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FOR RELEASE AT 8:00 P.M.,(E.S.T.)
THURSDAY, MARCH 6, 1958

BACKGROUND INFORMATION ON THE DEEP UNDERGROUND SHOT (RAINIER)
AT THE NEVADA TEST SITE

INTRODUCTION

The following material has been compiled from official issuances and statements by the Atomic Energy Commission and its contractors and draws heavily on interim technical reports to the Commission by the University of California Radiation Laboratory at Livermore, California, which had primary interest in the experiment.

The deep underground shot, Rainier, was detonated at 10 A.M. Pacific Daylight Time, Thursday, September 19, 1957 at the Nevada Test Site.

The shot device was one with a known yield of 1.7 kilotons, designed by the Los Alamos Scientific Laboratory. It was placed in a chamber 6 ft. by 6 ft. by 7 ft. at the end of a tunnel approximately 1,900 feet long that had been bored horizontally into the side of a tufa (volcanic) rock mesa near the northwest corner of the Nevada Test Site. The shot chamber was about 900 feet under the mesa top, and about 800 feet from the steeply sloping hillside.

Firing of Rainier shot was controlled primarily from a special forward control point installed in an existing timing station about 10 miles from the tunnel mouth. Members of the Nevada Test Organization viewed the effects of the detonation from a forward area about 2-1/2 miles south of the tunnel mouth. Some spectators saw a ripple on the side of the mesa as the shockwave moved upward. A few felt a slight movement in the earth under their feet, but most felt nothing.

Clearly visible were spurts of dust rising from the side of the mesa caused by rock being dislodged from the visible side of the mesa crown. Dust created as rocks rolled down the steep hillside caused a loose cloud which slowly dissipated.

Radiological surveys conducted after the shot showed that no radioactivity was released into the atmosphere.

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PURPOSE AND HISTORY OF RAINIER SHOT

Many persons had considered the idea of containing a nuclear detonation deep underground following early test firings of nuclear devices. The specific test method employed at NTS last September 19 grew out of suggestions by Dr. Edward Teller of the University of California Radiation Laboratory and of David Griggs of the University of California at Los Angeles. The project was planned and conducted by the Livermore Branch of the UCRL.

Preliminary calculation and design of the experiment were carried out at Livermore by B. Sussholz. He designed a self-sealing tunnel in which the shock from the explosion would close with rock a portion of the tunnel before the air shock wave, traveling through the tunnel, reached the sealed off portion. G. T. Pelsor, of the Livermore Laboratory, further refined the theoretical work initiated by Mr. Sussholz and designed and improved a simplified version of the tunnel which was adopted for the Rainier tunnel design. The overall coordination of the experiment was the responsibility of O. E. Violet.

WHY THE EXPERIMENT WAS CONDUCTED

A number of operational benefits was expected to be derived from deep underground detonations of nuclear devices. Among these were: (a) Total absence of fallout. (b) The absence of blast and flash effects on off-site residents and travelers. (c) Elimination of radioactive clouds which interrupt and interfere with air traffic.

PROBLEMS OF UNDERGROUND PLACEMENT

Both technical and environmental problems had to be answered before a deep underground shot could be firmly scheduled and fired.

When a nuclear device is detonated atop a tower, suspended from a balloon, or dropped from an airplane, photographic and other measurements can be made of the growth of the fireball, and samples of the fission products can be readily captured for radiochemical analysis. Obtaining measurements of a like nature when the burst was deep underground required the development of new techniques.

Environmental problems included determining the proper depth of placement to avoid breaking the earth's surface,

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possible contamination of ground water, and seismic or earth shock effects both on and off the test site.

PRELIMINARY STUDIES

Several methods of underground placement were investigated by the test division of UCRL at Livermore in 1956. Of the two methods considered most feasible, it was determined that a horizontal tunnel would be superior, from the standpoint of both cost and accessibility, to a vertical shaft or drill hole. The U. S. Geological Survey was asked to analyze the geological structures in and surrounding the mesa that had been selected as the most favorable site for the Rainier detonation, and to determine, to the extent possible through high explosive detonations, the containment and seismic aspects of a nuclear detonation inside the mesa.

As part of the USGS studies, two high explosive charges were fired in a tunnel bored into the mesa face. A 10-ton charge was fired at a depth of 92 feet and a 50-ton charge at a depth of 165 feet below the surface. Results obtained from the two detonations were scaled up to the approximate two kiloton yield of the selected nuclear device, and conclusions drawn on the basis of such scaling.

CONCLUSIONS FROM PRELIMINARY STUDIES

Conclusions drawn from the U. S. Geological Survey studies were that no crater was expected from the Rainier detonation, but that probably the rock would be fractured to the surface; the shot tunnel would be considerably damaged by spalling, or caving in of the ceiling and walls; and large blocks of rock would be dislodged from the top of the mesa. Small quantities of radioactive gases, fission products, and possibly steam or water might be vented through cracks in the rocks and seismic waves "earth shock" generated by the Rainier explosion would be below damage levels at a distance of about 10 miles, well within the test site and adjacent Las Vegas bombing and gunnery range.

ADVISORY PANEL ESTABLISHED

An advisory panel was established several months before the scheduled date of the Rainier detonation to examine the question of whether a deep underground nuclear explosion might trigger an earthquake. Among the topics suggested for panel study were: (a) frequency of natural earthquakes in the area so as to provide an estimate of the probability of a coincidental earthquake, and (b) consideration of the possibility of ground

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water contamination. The advisory panel was composed of three authorities in the field of seismology and geophysics who are Roland Beers, of Rensselaer Polytechnic Institute, Troy, N.Y.; Perry Byerly, University of California, Berkeley; and David Griggs, University of California at Los Angeles. Members of the panel who are specialists on ground water contamination are George B. Maxey, Illinois Geological Survey, Urbana, Ill., and Sheppard T. Powell, Baltimore, Maryland.

After completing its study the panel reported in April 1957, that the proposed shot would not generate seismic signals any larger than those produced by the largest air bursts previously fired at the test site; that no earth shock would be felt in Las Vegas; and that the detonation would not trigger a natural earthquake. Seismological experts on the panel pointed out that earthquakes themselves do not trigger other earthquakes. They felt further that if there had been a geological situation in the test site region favorable for the triggering of an earthquake, earlier detonations at NTS, or the great Nevada earthquake of December 16, 1954, would have triggered it.

The panel reported also that the possibility of ground water contamination was very remote.

On the basis of the panel's report a decision was made to continue with preparations for firing the deep underground shot.

DESCRIPTION OF RAINIER TUNNEL

A contract for drilling the Rainier shot tunnel was let to E. C. Nickel & Co. of Arcadia, California in April, 1957 on a low bid of \$314,210. The tunnel design that had been finally adopted called for boring through the mesa's tufa rock for a total distance of 1,900 feet.

The tunnel design called for a horizontal shaft 6 feet wide by 8 feet high. Toward the tunnel's end, the shaft made a right angle turn to the right and then made another right angle turn to the right after which it looped back upon itself until the shot chamber was reached in the middle of the "hook" thus formed. The purpose of the tunnel shape was to locate the detonation chamber so the nearby tunnel shaft would be closed by blast effects before any energy manifestations could travel around the "hook" and escape through the tunnel.

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STRUCTURE OF THE MESA

The geological name of the rock formation in which the tunnel was drilled is "Oak Springs Tuff". The rock formation is quite similar to those found in many places throughout the Nevada Test Site. It was deposited originally through volcanic activity.

The tufa or tuff is a rather porous rock and it is felt that this feature, which permitted the rock to serve as an absorber for the nuclear detonation, prevented the ground shock waves from being felt more strongly at a distance from the shot mesa.

EXPLORATORY EFFORTS AND RESULTS

Early exploration of the shot tunnel to within 200 feet of the center of detonation resulted in finding no radiation above background. Considerable damage to the tunnel was found in the last 300 feet that was still open. At approximately 200 feet from ground zero the tunnel was sealed by rock.

A drilling contractor, E. J. Longyear Co. of Minneapolis, Minn., had been employed to perform core drilling operations and it was decided to begin drilling from the top of the mesa. The drilling system contained built-in safety features and was designed for remote operation in the event the drill penetrated a high pressure region. The drilling was continued to a point at the same elevation as ground zero, at which point the drill had been displaced about 17 feet off center. During the drilling operation a cavity about 25 ft. in depth was encountered at a point about 385 ft. above ground zero and below the cavity the drill passed through broken rock until drilling was discontinued. At no point in this drilling operation were any high-pressure regions or pockets encountered. After the vertical drilling had reached the level of ground zero, the operation was suspended and horizontal drilling was begun from within the tunnel at a position 211 ft. from ground zero. The first hole drilled from within the tunnel was aimed directly at the point of detonation and about three and a half months after the detonation encountered zones of relatively high radiation and thermal temperature within 100 ft. of ground zero. The normal rock temperature was about 63 degrees fahrenheit. At a distance of 60 ft. from ground zero a rock temperature of 113 degrees F. was encountered and this decreased to a fairly constant reading of 90 degrees F. from a distance of 35 ft. in to ground zero. Subsequent drilling to volumes below the point of detonation revealed temperatures as high as 190 degrees F., or almost to the boiling point of water. A maximum radiation reading of about 45 roentgens per hour was recorded at about 50 ft. below ground zero.

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SEISMIC EFFECTS

Because of the unique deep underground placement of the Rainier device, seismologists and geophysicists were interested in earth measurements that might be obtained from registering shock waves created by the detonation. Even though a panel of experts had concluded that earth waves would be no greater than from some previous air detonations at NTS, particular efforts were made by many seismologists to record the effects of the shock waves generated by the Rainier detonation.

When the device was detonated, only a few persons of many who witnessed the event from the forward control area, 2-1/2 miles from ground zero, felt any earth shock, and off-site the earth movement was so slight that it could be recorded only on extremely sensitive seismological instruments. The earth waves were recorded at seismological stations at Los Angeles, about 250 miles, air line, from the shot mesa. This was the maximum distance at which the shock was recorded.

*Not true re
data evidence*

GENERAL CONCLUSIONS

Instruments used for measurements of the Rainier detonation, located in and around the shot chamber, operated successfully. Livermore scientists feel that the results obtained by instrumentation verified their calculations that a nuclear detonation not only can be contained in a deep underground location, but that diagnostic and other necessary measurements can be obtained successfully.

They concluded that certain experiments which require good collimation and massive shielding can best be accomplished underground. Another conclusion, after studies of the mesa through observation of the exterior and through drilling, was that shots with much larger yield could be fired in a deep underground chamber with little or no resulting air contamination and with no seismic hazard.

It was concluded also that practically all of the fission products were trapped in highly insoluble fused rock so no ground water contamination problem resulted.

CONCLUSIONS FROM DRILLING OPERATIONS

From the heat and radiation levels recorded and from the condition of the shattered and crushed rock around the shot zone, it was concluded that the detonation had created a spherical cavity around ground zero, and that for a very brief time the rock around the circumference of the cavity had been formed into a glass-like substance so that in effect a "Glass Ball" about

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110 feet in diameter existed.

Quite soon, it is believed the weight of the shattered rock above the glass ball crushed the sphere and rock fragments fell into the cavity and filled it. The falling rock resulted in a cavity at the top of the crushed rock zone, and it was this cavity that had been encountered in vertical drilling operation 385 feet above ground zero.

There had been speculation before the Rainier device was detonated that the intense heat and pressures generated might result in the formation of precious gems of some kind. Drilling operations have uncovered no evidence that such gems were created, and it is believed unlikely that they exist in or around the shot area.

FURTHER INVESTIGATIONS OF SHOT ZONE

In an effort to obtain more detailed knowledge of the effects of the Rainier detonation within the burst area, a tunnel shaft now is being dug toward ground zero from the original shot tunnel. The new shaft originates near the point from which the horizontal core drilling was conducted. Tunnel operations are being performed by Reynolds Electrical and Engineering Company, support contractor to the Atomic Energy Commission at the Nevada Test Site.

INFORMATION GAINED FOR PEACETIME APPLICATIONS

As has been announced, the Livermore Branch of the University of California Radiation Laboratory now is engaged in "Project Plowshare," an investigation into the possible application of nuclear detonations for peacetime purposes.

Considerable information that will be of interest in "Project Plowshare" was obtained from the Rainier detonation and the studies that have followed it. For example, it has been calculated that the underground shot produced at least 50,000 tons of permeable broken rock and an additional 400,000 tons of crushed, but relatively impermeable rock. The large masses of broken rock suggest such applications as use in mining to break up ore bodies for removal or leaching, and in oil strata to free crude oil trapped in relatively non-porous rock formations. It also is considered possible that heat resulting from an underground detonation in oil strata might increase the production of oil in certain situations by making it flow more freely through the rock formation.

Other possible peacetime applications include:

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1. Piping water into a rock formation heated by a contained nuclear detonation to form steam for producing power or for other uses.

2. Placing various materials around a device to be detonated deep underground so as to effect changes in the materials through nuclear reaction.

3. Further investigations of the makeup of the earth's crust through seismic studies of earth waves resulting from deep underground detonations.

4. Moving earth in quantity, such as in digging a large canal.*

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FOR RELEASE AT 8:00 P.M. (E.S.T.)
THURSDAY, MARCH 6, 1958

BACKGROUND INFORMATION ON LOS ALAMOS AND LIVERMORE NUCLEAR
PROPULSION PROJECTS AND THE STATIC TEST AREA BEING
DEVELOPED AT THE NEVADA TEST SITE

Scientific theory that nuclear energy can be superior to chemical energy for long-range propulsion of man-made vehicles through the atmosphere or particularly through outer space evolved soon after the fact of controlled fission was demonstrated. In early 1955 the Atomic Energy Commission decided to go ahead with formal research programs to determine the feasibility of nuclear rocket propulsion systems for atmospheric and space vehicles. Programs were assigned to the Los Alamos Scientific Laboratory and the University of California Research Laboratory, Livermore, California.

Planning began for field facilities where laboratories could test reactor designs. Isolation is desired because experiments might result in discharge of measurable amounts of radioactive particles into the atmosphere and might result in some ground contamination. The Nevada Test Site was considered ideal for such a site because of existing facilities, such as housing and feeding accommodations at Mercury; because the existing Las Vegas Branch Office and its several contractors could provide administrative and site services; because government-owned waste land was available in the area; and because it was within reasonable traveling distance from Los Alamos and Livermore. A 12.2 by 39.6 mile portion of the Air Force Las Vegas Range was transferred from the Air Force in 1956 to the Commission. It is immediately west of Nevada Test Site. The Jackass Flats portion of new addition was designated as the site for the installations to support both the Los Alamos and the Livermore programs. One section is designated "400 area" for Los Alamos and another "401 area" for Livermore. Initial contracts for roads and water wells to serve both areas were let in Spring 1957. Another section of the new addition has not yet been named, but was set aside for possible future testing of experimental reactors.

In early 1957 the nuclear rocket propulsion project was restudied from the viewpoints of national urgency, money requirements, and use of personnel and facilities. As a result, it was determined that the Los Alamos Scientific Laboratory was to continue with a program related to nuclear propulsion of rockets (Project Rover), and the Livermore laboratory was to continue with a program for nuclear ramjet propulsion systems (Project Pluto).

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PROJECT ROVER

Project Rover is a Los Alamos study to determine the feasibility of using nuclear power to propel rockets.

Advantages of nuclear propulsion:

Essential advantages are increased payload and essentially inexhaustible source of energy.

Staff members at Los Alamos feel that nuclear propulsion systems toward which they are working would have many advantages over chemical systems for vehicles designed to escape from the earth's gravity field and travel in space.

Project Rover was undertaken by Los Alamos Scientific Laboratory initially on fairly modest scale. Work is spread over several of the Laboratory's divisions, with most of the design work concentrated in "N" Division, which was formed for this purpose. Leader of "N" Division is Raimer E. Schreiber and alternate division leader is R. W. Spence.

Nuclear rocket propulsion system studies at Los Alamos Scientific Laboratory are still in the research and development stage. During studies so far, various concepts have been evolved, and some have been promising enough to justify incorporating into detailed design studies. One or more reactors based on early design studies are to be tested at the Nevada Test Site.

Information gained in Nevada tests is expected to help in formulating more advance design concepts which may lead to construction of prototype nuclear propulsion engines for rockets.

LASL is working only on reactor propulsion systems, not on the rockets or missiles they would propel aloft.

Schedule of field experiments: First tests of reactor systems at NTS are now scheduled late in 1958. Chairman Strauss has said that flight tests of rockets propelled by nuclear powered systems are probably somewhat more distant than two or three years from now.

Rover installations in 400 Area: Approximately \$10,000,000 will be committed, largely through open bid contracts, for Rover facilities at Jackass Flats. Under construction are three major groups of buildings and facilities with supporting roads, water wells and lines, smaller buildings, railroad trackage, electrical power supply feed lines and transformers, and a tank farm.

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Following are facts on the three areas being developed, and the status of construction:

Control Building Area: The major structure being erected is the control building, with a floor area of 9,700 square feet. The building will house the controls and instruments for operating and recording tests to be performed in the test cell area which will be described subsequently. The control building is being constructed of reinforced concrete. Other buildings in the same area, including a generator station for standby power, an administration building, two warehouses, a cafeteria, and a small guard house, are being constructed of steel and aluminum components so they can be moved elsewhere if they are no longer needed for the Rover program. J. A. Tiberti Construction Company of Las Vegas is building the control building area facilities under a fixed cost contract of \$815,572.

MECHANICAL ASSEMBLY-DISASSEMBLY BUILDING

This is a massively constructed concrete structure with 30,000 square feet of floor area where work will be performed, as indicated by the name, on assembling and disassembling reactors and reactor components before and after tests. The building will include shielding and facilities for remote handling of large assemblies which have become radioactive in tests. Located nearby will be a small office and warehouse building, and a guard building. Sierra Construction Company, Inc. of Las Vegas is contractor for the building, under a fixed cost contract of \$2,058,355.

TEST CELL AREA

The test cell itself is being constructed of reinforced concrete, with a floor area of 1,680 square feet. Reactors and reactor systems to be tested will not be housed in the cell, but will be supported on a railway car backed up to the cell, and will be connected to receiving instruments inside the test cell, which will transmit needed information to recording instruments in the control building, which is about a mile and a half away. The railway car bearing the reactor can be moved by a remotely controlled locomotive over a railway line to the shielded portion of the mechanical assembly-disassembly building. Also being constructed in the test cell area are a propellant storage area, water storage tanks, and other facilities. Contractor for the test cell and tank farm is the Petroleum Combustion and Engineering Company of Los Angeles at a fixed cost contract price of \$1,209,000. Pittsburgh-Des Moines Steel Company of El Monte, California, is contractor for the water storage tanks on a low bid of \$107,360.

OTHER CONTRACTS

Contracts have been let also for construction of roads, water wells, and other facilities for the Rover area. These

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include:

- A. Mercury-Jackass Flats access road, Fred Galante and L. B. Wells of Visalia, California, \$890,346.
- B. Water supply wells, Perry Brothers Drilling Company of Flagstaff, Arizona, \$89,325.
- C. Roads within area, J. L. Croft and Sons, Inc., of Saugus, California, \$472,307.
- D. Water distribution system, Hansen Plumbing and Heating Company of San Bernardino, California, \$147,037.
- E. Railroad facilities, A. D. Schader Company of San Francisco, \$252,036.09.

MISCELLANEOUS INFORMATION

Burns and McDonnell Engineering Company of Kansas City, Missouri, is Architect-Engineer for the Rover and the Pluto test areas, and is responsible for designing and engineering the buildings and facilities there.

Reynolds Electrical and Engineering Company will provide support contract services to the new test areas in much the same fashion that it has for the other portions of the Nevada Test Site. Such services include feeding, maintenance of buildings and facilities, minor construction, and various other work as it may be required.

Edgerton, Germeshausen and Grier, Inc., has had its contract with the Commission extended to include certain work on instrumentation in the Rover area. The work will include installing and operating control and recording instrumentation systems.

Federal Services, Inc., will provide security guard services in the new area as it does in the other portions of the Nevada Test Site.

Housing: Personnel working in the Jackass Flats area will be housed at Mercury, the base camp for Nevada Test Site. It is about 20 miles away. Mercury can accommodate approximately 3,500 persons under peak loads such as during full-scale nuclear tests.

PROJECT PLUTO

Studies to determine the feasibility of applying heat from a reactor to ramjet engines will be extended to the Atomic

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Energy Commission's Nevada Test Site in the near future. Experimental and theoretical work on such an application is being conducted by the University of California Radiation Laboratory for the Commission at Livermore, California.

The work, under the direction of Dr. T. C. Merkle, leader of the "R" Division of the Laboratory, is related to research on propulsion of missiles. A ramjet can operate only within the earth's atmosphere as contrasted with a rocket which can travel in free space. Also associated in the program is Atomics International, a division of North American Aviation, Inc., at Canoga Park, California where basic research into reactor materials is being conducted.

Construction at Nevada will include a high temperature critical facility and control building, other assembly and shop structure and utilities. It is expected that invitations for bids on work will be issued in March.

Approximately \$1,200,000 will be expended for this construction.

In studying the possibility of using a high temperature, gas-cooled reactor as a source of heat for ramjets, scientists state that the information developed will be useful in civilian power production.

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Mr. Tremblay

CONFIDENTIAL

February 5, 1959

F. M. Tovell

UNITED STATES ATOMIC ENERGY ACT OF 1954 AS AMENDED

We have now received from the Embassy in Washington a consolidated edition of the Atomic Energy Act of 1954 as amended at the last session of Congress. A copy of this is attached.

The following comments, based on a preliminary study of the new Act, may be of use to you in connection with the forthcoming negotiation of a new agreement on the Exchange of Atomic Information for Mutual Defence Purposes.

General:

The principal changes enacted by Congress of interest to Canada are to be found in Sections 91, 123 and 144. Section 91 deals with cooperation in the field of materials and equipment; Section 123 deals with procedures to be followed for the negotiation, execution and implementation of an agreement; Section 144 deals with exchanges in the field of information.

With regard to materials and equipment, provision has been made for the transfer to friendly nations of special nuclear material for manufacture into atomic weapons or for other military uses by the receiving nation, the transfer to friendly nations for the military applications of utilization facilities (such as nuclear propulsion and power plants), and the necessary nuclear fuels and the transfer to friendly nations of non-nuclear parts of atomic weapons to improve the receiving nation's state of training and operational readiness.

Please return to PH Rm. 279
when signed

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In the field of information, the aim has been to provide for the communication to friendly nations or defence organizations of additional design information necessary to permit essential training and planning, the communication to friendly nations or defence organizations of additional atomic weapons design information necessary to make any delivery systems manufactured by the receiving nation fully compatible with the United States atomic weapons and the exchange with friendly nations (but not defence organizations) of information that will improve the receiving nation's atomic weapon design, development or production capability.

These provisions are conditioned by a number of important provisos as will appear from the following brief analysis of the more important provisions of the Act as amended.

Section 91c:

There was no corresponding subsection in the Atomic Energy Act of 1954. It is this subsection which governs the transfer by "sale, lease or loan" of four categories of materials and equipment for military applications subject to certain conditions, determinations and procedures. These four categories are:

- (A) Non-nuclear parts of atomic weapons (91c(1))
- (B) Utilization facilities for military applications (91c(2))
- (C) Source, by-product or special nuclear material for utilization facilities for military applications (91c(3))
- (D) Source, by-product or special nuclear material for atomic weapons (91c(4))

Under (A), provision is made for the transfer of two distinctly different types of non-nuclear parts. One type, the non-nuclear parts of atomic weapons, relates to the integral components of the weapon itself which could only be transferred to those nations that have made substantial

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progress in the development of atomic weapons. The other type relates to non-nuclear parts of atomic weapons systems which are not integral to the weapon itself but pertain to various kinds of equipment involving restricted data to make possible the operational use and maintenance of the weapon, such as adaptation kits. Non-nuclear parts of atomic weapons may not be transferred to a nation which has made substantial progress in its development of atomic weapons. As the non-nuclear parts of atomic weapons systems are not as sensitive as those in the first category, they may be transferred to a nation provided that the transfer will not contribute significantly to that nation's atomic weapon design, development or fabrication capability and then only for improving training and operational readiness. Utilization facilities (Category B) as defined in the Act would include military reactors and components such as those developed in the naval reactor propulsion programme, the aircraft nuclear propulsion programme or the army package power programme. It would also include spare parts and replacements. Transfers in this category are not subject to the proviso regarding "substantial progress" nor that regarding not contributing significantly to the receiving nation's capability for design, development or fabrication. Items under Category (D) are subject to the restriction that the material must be necessary to improve atomic weapons design, development and fabrication capability and that the receiving nation has made substantial progress in the development of atomic weapons .

Exchanges under these four categories are further restricted by the following conditions:

- (A) Transfers must be in accordance with the terms and conditions of a programme approved by the President.
- (B) The President must make a determination that the transfer will promote and not constitute an unreasonable risk to the common defence and security.

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- (C) The cooperating nation must be a military ally, i.e. a nation participating with the United States in an international arrangement and which is making substantial and material contributions to the mutual defence and security.
- (D) Cooperation must be undertaken pursuant to an agreement entered into in accordance with Section 123.

It is clear that the purpose behind Section 91c(1) is to enable the United States to assist an ally to increase its state of readiness and training and to decrease the number of United States personnel abroad required to maintain and guard non-nuclear components. It is equally clear that the prohibition contained in Section 92 makes it impossible to transfer any nuclear components of an atomic weapon; these must still remain in the custody of United States personnel.

With regard to Section 91c(3), spokesman for the Atomic Energy Commission made it clear during the hearings that it is their intention to apply the authority granted the Commission cautiously as the United States has no desire "to promote the entry of additional nations into the field of nuclear weapons production". Nor would they interpret this section as authorization to furnish fabricated components of weapons nor to transfer to another nation nuclear components to go with the non-nuclear components transferred under 91c(1). It could be used, however, when an ally is proceeding with the build-up of a nuclear stockpile and to prevent waste of effort and the expenditure of valuable resources.

It should be noted that with regard to the words "substantial progress", Congress intended that the cooperating nation must have achieved considerably more than a mere theoretical knowledge of atomic weapons design or have tested more than a limited number of atomic weapons. The cooperating nation must have achieved a capability on its own of fabricating a variety of atomic weapons and constructed and operated the necessary facilities including weapons research and development laboratories, manufacturing facilities, etc. It was also intended that the Joint

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Committee should be provided with full information as to the basis for any determination in this regard.

Similarly with regard to a receiving nation making a substantial and material contribution to the mutual defence and security, Congress understood that such a nation must be a close military ally and that its contribution must be substantial and real.

Both these understandings would apply equally to exchanges of information under Section 144.

Section 123:

The authority granted under Section 91c was made subject to the proviso that cooperation be undertaken pursuant to an agreement entered into in accordance with Section 123. Such agreements must be submitted to Congress and referred to the Joint Committee and will not become effective if within sixty days Congress passes a concurrent resolution stating that it does not favour the agreement. The first day to be counted is the day the Joint Committee receives the agreement. The same proviso applies to agreements on information negotiated under Section 144b and 144c (civilian uses agreements however only have to be before the Committee for thirty days).

It is to be noted that the requirement of the 1954 Act that the receiving nation must guarantee that materials furnished will not be used for atomic weapons or other military purposes is no longer required for transfers under 91c. It is, however, still required in the case of agreements for transfers under any section other than 91c.

Subsection 123a outlines the form an agreement should take, the need to set out its scope, the objectives to be achieved and the categories of information to be involved. The agreement is also to contain a guarantee regarding security safeguards and a guarantee that any material or information transferred will not be transferred to unauthorized persons or to a third country.

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The sequence of events provided for by this section calls for the President to make two determinations that the proposed agreement will promote and not constitute an unreasonable risk to the common defence and security. The first would be made personally when approving the agreement and authorizing its execution and before submitting it to Congress. The second, which could be delegated, would be required prior to the implementation of the agreement. An executive order would be recommended to the President authorizing transmission when the Department of Defence and the Atomic Energy Commission jointly review the proposal to transmit information or transfer materials and jointly determine that the proposed cooperation would promote and not constitute an unreasonable risk to the common defence and security.

Section 144

Section 144 is the section dealing with exchanges of information for mutual defence purposes.

Subsection a contains only one change from the old Act: The insertion of "civilian" before the words "reactor development". It is, however, an important change as it is thereby made clear that only restricted data pertaining to civilian reactor development may be transmitted under this subsection. Information pertaining to military reactors can only be transmitted under Section 144c(2).

Subsection b is a substantially amended version of the corresponding subsection in the old Act. Under the old Section 144b, it was possible for the United States to communicate certain atomic weapons information as for example the configuration of some atomic weapons, the characteristics of these weapons and certain other aspects to permit the development of joint war plans, plans for defence and information to permit evaluation of potential enemy capabilities. Such information, however, had to be limited to the external characteristics such as size, weight, shape, yield and effects, and systems of delivery and important information regarding design or fabrication of the nuclear components could not be revealed. The addition of the words "including design information" now makes this possible

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to some extent. Also, the addition of the words "and other military applications of atomic energy" in (2) and (3), i.e. other than atomic weapons, substantially broadens the corresponding provisions of the old Act to widen the extent of cooperation between an ally or a regional defence organization for the training of personnel and the evaluation of capabilities of potential enemy. For the first time, authority is provided to pass on restricted data necessary to the development of compatible delivery systems for atomic weapons. The revision does not, however, authorize the communication of weapons information with the objective of promoting the recipient's ability as to research, design, development or fabrication of atomic weapons or research, development or design of military reactors. It is limited to information necessary for training, defence planning, compatibility and the evaluation of enemy capabilities; also, the information communicated must promote and not constitute a risk to the common defence and security and a recipient nation must be making a substantial and material contribution to that common defence and security.

Section 144c, which is new, provides for situations where exchanges of information are warranted in the interest of promoting an ally's atomic weapon design, development or fabrication capability or military reactor research development or design. Exchanges (and there must be an exchange) of information on weapons design for this purpose is subject to two important provisos; that communication of restricted data is necessary to improve atomic weapons design, development and fabrication capability and that the recipient nation has made substantial progress in the development of atomic weapons. Exchanges or transmission of information on military reactors is not subject to these provisos, but cooperation in both respects again must be subject to a presidential determination that cooperation will not constitute an unreasonable risk to the common defence and security and that the receiving nation is making a substantial material contribution to the mutual defence and security.

Implications for Canada

The following appear to be the main implications for Canada and points which would have to be borne in mind when

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negotiating and implementing the new military agreement.

- (A) Canada cannot obtain any of the advantages of the Act as amended either in the field of materials and equipment or in the field of information unless we negotiate a new agreement which takes into account the liberalized revisions of the new Act. There must be an agreement for cooperation and its parties must participate by substantially contributing to the mutual defence and security.
- (B) No significant change has been made in Section 92 which prohibits the transfer of atomic weapons. While the non-nuclear parts of such weapons and the non-nuclear parts of atomic weapons systems may be transferred under certain conditions, as can certain utilization facilities for military applications, the U.S. fabricated nuclear components have to remain in U.S. custody. This means that on the basis of the exact wording of the Act as amended Canada could not be given control of nuclear warheads for air defence weapons to be used in Canada. Such weapons for use in Canada would have to be placed in storage depots under United States control until or unless they are ordered transferred to Canada by the President under his constitutional powers in time of war. The same would apply to nuclear warheads assigned to Canadian forces in Europe.

As far as I can judge, the only way that the prohibition contained in Section 92 could be circumvented would be by a special agreement negotiated under Section 121 which provides for the validity of such an agreement even though it may not be in accordance with the Act. Such an agreement, however, would have to be approved by Congress or if in Treaty form by two-thirds of the Senate. Thus it would have to be an unclassified agreement.

It is relevant to note here that in the course of their testimony during the hearings on the

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amendments to the Act, both Mr. Dulles and Mr. Quarles pointed to the difficulties which they could foresee by proceeding under this article. Mr. Dulles stressed the time factor both with regard to the negotiation of the agreement and possible delay in obtaining Senate certification or Congressional approval. There would also be difficulties for the executive branch of the Government in attempting to anticipate what Congress would be likely to approve. Mr. Quarles stressed the point that Congress would probably wish to write in a series of extensive safeguards which would be "at a considerable price in our ability to conduct the military relationships with our allies".

- (C) Canada would not be able to obtain non-nuclear components of atomic weapons as in the absence of a weapons programme, we would not be able to meet the "substantial progress" provision. On the other hand, Canada might be able to get non-nuclear parts of atomic weapons systems as the proviso applying to this category does not imply that we have to have a weapons programme; it says only that the materials so obtained must not contribute significantly to weapon design.
- (D) Canada would be able to obtain under Section 91c by lease, loan or purchase utilization facilities such as military reactors and power reactors (e.g. for the DEW Line) but not the fabricated materials, provided that it can be shown that the receipt of such facilities would not constitute an unreasonable risk to the common defence and security and that we are participating with the U.S. in an international arrangement by substantial and material contributions to the mutual defence and security. Canada could also obtain information on military reactors under Section 144c(2). Such information would not be subject to the same restrictions as weapons design information as set out in Section 144c(1); the only proviso is that there must be a presidential determination

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that the receipt of restricted data will promote and not constitute an unreasonable risk to the common defence and security and that Canada is making a substantial and material contribution to the mutual defence and security.

- (E) In the absence of any weapons programme we cannot obtain information concerning weapons but under Section 144b, we could obtain such restricted data including design information on weapons and other military applications of atomic energy such as reactors as may be considered necessary for training, defence planning, compatibility and evaluation of enemy capabilities provided such information would not promote our ability to design or develop weapons or reactors. Also such information must not constitute an unreasonable risk to the common defence and security and we must be participating with the United States by substantial and material contributions to mutual defence and security. Thus, it would appear possible under this section to obtain further information on the performance, yield, fusing and firing features and loading checks of such atomic weapons as the MB-1, BOMARC, warheads, safety arrangements for A-bombs and H-bombs, the safety factors of the MARK 90 torpedo and advance information on weapons in development in which we might be interested for the above purposes. Such information would also include data regarding salvage, operational difficulties and launcher requirements. In fact, it is probably under this section that we can expect to receive most of the information we would wish to have.
- (F) Section 144b(4) makes it possible for Canada to receive information to help develop delivery systems, including air planes and missiles, which will be compatible with nuclear weapons to be furnished by the United States in the event of war. The only proviso here is that these will promote and not constitute an unreasonable risk to the

- 11 -

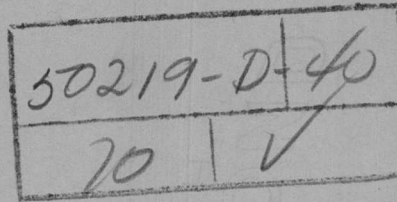
common defence and security and that we will be judged to be making a substantial contribution to the mutual defence and security.

Conclusion:

It is difficult to foresee at this time all that could be obtained in a new military agreement negotiated under the new Act. Those items mentioned above are for the most part examples which were given in the course of the hearings. The picture will only become clear when a more thorough study is made of the new Act and when we have gained some experience with the interpretation United States officials will place on key phrases when actual requests are put forward. In the light of our experience in obtaining information under the old Act and our present military agreement, the evident desire of the United States authorities to cooperate even beyond the exact language of the Act and the assurances we have received from time to time that Canada's needs would be met, give us reason to be optimistic.

F. M. Tovell

D.L.(1) F.M.Tovell/ph



January 28, 1959

H. Williamson, Esq.
Canadian Scientific
Liaison Officer
The Canadian Embassy
Washington

Dear Harry:

I am most grateful to you for the trouble you took to get me five copies of "Atomic Energy Legislation Through 85th Congress, 2nd Session". These are most welcome and will certainly be put to good use here.

I note that you will try to get more copies. Insofar as my own division is concerned, the five you sent us are quite adequate. It could well be, however, that National Defence would like to have some copies in which case I assume that the Joint Staff will be obtaining what is required. On the other hand, from my own experience, I know that the DND people here who are concerned are more likely to poach on us and for only that reason it would be useful to have additional copies.

Trusting that all goes well with you and with best regards,

Yours sincerely,

F. M. TOVELL

F. M. Tovell

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CANADIAN SCIENTIFIC LIAISON OFFICE

1907 K STREET, N. W., WASHINGTON 6, D. C.

Telephone: EXecutive 3-2020, Extension 370

A UNIT OF THE BRITISH COMMONWEALTH SCIENTIFIC OFFICE

REFERENCE

January 26, 1959.

Mr. Freeman Tovell,
Department of External Affairs,
OTTAWA, Canada.

Dear Freeman :-

As you requested earlier, I enclose five copies of "Atomic Energy Legislation Through 85th Congress, 2nd Session". I shall try to get more copies and pass them along.

You will notice that the first item is an up-to-date Atomic Energy Act while the last item, Appendix N, is an index to this act. The Appendices also contain the earlier Atomic Energy Act with a cross reference chart in Appendix D.

Sincerely,

Harry W.

H. Williamson
Canadian Scientific
Liaison Officer.

HW/zw
Encs.

TRANSMITTAL SLIP

UNCLASSIFIED

January 15, 1959.

Courier

Enclosures: - 1 -
- 1 -

TO: The Under Secretary of State for
External Affairs, Ottawa.

FROM: The Canadian Embassy,
Washington, D.C.

The documents described below are for your information

Despatching authority: H. Williamson/cmd

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19 JAN 1959

Copies	Description
1 ✓	Release from Office of the Joint Committee on Atomic Energy, January 6, 1959, No. 188 Forthcoming hearing on the US atomic weapons program.
1 ✓	Release No. 189, January 7, 1959 Briefing of Airforce and CIA representatives on Soviet progress in developing a nuclear powered airplane.

000840

1959 JAN 19 AM 11:24

From the Office of the
Joint Committee on Atomic Energy

For release to AM's of
Tuesday, January 6, 1959

Chairman Carl Durham of North Carolina and Vice Chairman Clinton Anderson of New Mexico of the Joint Committee on Atomic Energy made public today plans for a forthcoming hearing on the U.S. atomic weapons program, including effects of a weapons test cessation or moratorium on the nation's nuclear weapons program.

The hearings have been scheduled for January 12 and 13 and will be held in executive session. On the first day the Committee will be briefed on the results of the "Hardtack" series of nuclear tests conducted last summer in the Pacific test area and last fall in Nevada. On January 13, the Committee will hear testimony on the status of the Geneva negotiations and the effects of a test ban on the nuclear weapons program. Because of the classified nature of the technical aspects of the testimony, the hearings will be held in executive session.

Among the witnesses will be the following:

Dr. Norris Bradbury, Director of the Los Alamos Laboratory at Los Alamos, New Mexico

Dr. Edward Teller, Director of the University of California Radiation Laboratory at Livermore, California

General Herbert B. Loper, Assistant to the Secretary of Defense for Atomic Energy

Brigadier General Alfred D. Starbird, Director of the Division of Military Applications of the Atomic Energy Commission

Others invited to attend are officials of the State Department and representatives of the panel of seismologists appointed on the recommendations by Dr. James Killian, Chairman of the President's Science Advisory Committee. As a result of new and continuing studies, including data from the fall series of underground nuclear tests, the panel has concluded that it is more difficult to identify underground explosions than was indicated by the Geneva Conference of Experts last July.

Representative Durham and Senator Anderson made the following statement in connection with the hearings which have been in the planning stage for several weeks:

"We expect to discuss with the witnesses the dependability of the detection system proposed by the Geneva panel last summer, especially in view of the recent findings by the panel of seismologists.

"We also want to hear about the present status and future policy of the U.S. on the international negotiations for a cessation of weapons tests. The results of the underground tests last fall in Nevada have a direct bearing on these negotiations."

oOo

No. 189

From the Office of the
Joint Committee on Atomic Energy

FOR IMMEDIATE RELEASE
January 7, 1959

Representative Melvin Price (D., Ill.), Chairman of the Subcommittee on Research and Development of the Joint Committee on Atomic Energy, said today that the Subcommittee will be briefed Thursday on Soviet progress in developing a nuclear powered airplane. Representatives of the Air Force and Central Intelligence Agency will present the briefing at 10:00 A.M. in the Committee room in the Capitol.

In commenting on the briefing, Representative Price said:

"Recent published reports claim that the Soviet Union has flight tested or is about to flight test a nuclear powered plane. The Soviets themselves have lent credence to these reports in their recent public statements alluding to the progress they are making in the development of such a plane.

"We want to find out as much as we can of the Russian progress in order to evaluate it in relation to our own program. If the reports are indeed true, they indicate that the Soviets are well on their way to winning new laurels in their effort for technological superiority over the United States.

"We are holding the briefing at this early stage of the Congress to emphasize the importance of the United States being first in developing a nuclear powered plane, both in terms of the national security and world confidence in America's scientific capabilities.

"The Subcommittee intends to hold another hearing later this month to be brought up to date on the progress of our own aircraft nuclear propulsion program in this country."

DL(2) Div. / R. 1. Galpin/mhm

DEPARTMENT OF EXTERNAL AFFAIRS
MEMORANDUM

U. N. DIVISION

TO:
DEFENCE LIAISON (2) DIVISION
FROM: DSI Memorandum of 19 November 1958
REFERENCE:

~~TOP SECRET~~
CANADIAN EYES
Security ONLY
December 19, 1958
Date
File No. 50219-D 40
9974-40
58 - -

SUBJECT: SOVIET DETECTION OF UNITED STATES NUCLEAR TESTS

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LHS (HAR) FEB 22 1985

Your comments on the memorandum under reference were brought to the attention of DNI who, in a letter dated 16 December 1958, reported as follows:

" Available information on submarine sightings in the area of the Marshall Islands reveals no submarine contacts during April, May, or June, 1958. However, on 19 July, a "probable" submarine contact was reported in position 08.30N/166.05E (approximately 40 miles south of Lae Atoll), two days after Test No. 134 of the Hardtack Series. No reports were received in August. On 22 September, 1958, a "probable" submarine was seen off Majuro Atoll, Marshall Islands.

2. It is known that the hydrographic survey vessel VITYAZ arrived in Japan on 11 June, 1958. A KYODO News Service dispatch stated she hurried back from a Pacific scientific cruise because of

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Far Eastern
Div.

- 2 -

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LLS (M&IR)

FEB 22 1959

Heavy radioactivity from the current U.S. nuclear tests series. A foreign dispatch quoting a PRAVDA report of 6 June, 1958, said the ship had encountered "more than 100 times normal" rain radioactivity on 20 May, and had to turn back. None of the ship's crew seems to have been physically affected. It is reasonable to assume that proper equipment for measuring the amount of radiation was held aboard."

Your points were also brought to the attention of DSI which, in a memorandum dated 17 December 1958, commented as follows:

" We agree that Soviet submarines in the area are a highly likely method of obtaining information on US nuclear tests. However, as you know, the two "no-go" countdowns were reported by the USSR as actual tests, hence Soviet observation on these two occasions could not have been visual and/or geophysical. Undoubtedly the countdown transmissions could have been monitored by submarines in the area, although surface vessels would probably be more useful in this regard. DSI might be able to advise on this point."

G.H. SOUTHAM

DEFENCE LIAISON (2) DIVISION

50219-D-40
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O t t a w a
December 16, 1958

Dear Harry:

Thank you very much for your letter of December 5th concerning my request for copies of a consolidated edition of the Atomic Energy Act.

I am certainly most grateful to you for the trouble you have gone to in this matter and I am indeed sorry that it lead you up so many blind alleys . I shall be quite content to wait until the Annual Report of the Joint Committee referred to in your letter will be available and will keep my fingers crossed that this will contain what we would like to have at this end.

Thanking you again for all your trouble.

Yours sincerely,

F. M. Tovell

Mr. Harry Williamson
Scientific Attache
The Canadian Embassy
Washington, D.C.

Mr. Zarkley, Thanks 9/12
Economic Division

Done and return



50219-D-40	
70	50

1746 Massachusetts Ave., N.W.,
Washington, D.C.,
December 5, 1958.

Freeman
D.L. (1)

Return, pls.

Dear Freeman:

I am running into so many dead-ends trying to fulfill your request for copies of a consolidated edition of the Atomic Energy Act that I thought I should give you an interim reply.

No official consolidation has been published. Both State and AEC appear to operate on the same interim basis as we do ourselves. Dick Breithut's advice just wasted my time. The material I obtained from the Joint Committee was valueless. I have ten copies of something coming in from AEC at Germantown but until I see it I cannot evaluate it. If this proves fruitless the best bet is to wait to the end of December when the Joint Committee's annual publication "Atomic Energy Legislation Through the (85th) Congress (2nd Session)" will come off the press. This always contains an up-dated version of the Act as an appendix. We can hope that it will be complete to last summer but even if it is not it will still be the best available.

Yours sincerely,

Harry C.

Mr. Freeman Tovell,
Department of External Affairs,
Ottawa, Canada.

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Ottawa, Nov. 27, 1958.

Dear Harry:

In talking with Jim Langley, we agreed that it would be highly useful to us to have a consolidated edition of the Atomic Energy Act which would include the several revisions passed at the last Session of Congress. We have on our files, of course, a good deal of information, even the texts of various amendments proposed and agreed to. However, it would be a time-consuming task for us to attempt to thread our way through these, and it would be much simpler to have the consolidated version.

2. I am not sure whether by this time any consolidation would be available as a public document, but I would assume that either the A. E. C. or the State Department will have produced their own, if only for working purposes. If copies could be made available to us we could use up to five very easily but, of course, would settle for less, particularly if you have to beg, borrow or steal.

3. With all best wishes,

Yours sincerely,

F.M. TOIVALL

H. Williamson, Esq.,
The Canadian Embassy,
WASHINGTON, U.S.A.

.....

*File Copy***TOP SECRET:
CANADIAN EYES ONLY**

My File No. 9974-40

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Ottawa, 26 November 1958.

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LHS (M&IR)

FEB 22 1985

Your File No. DRBTS 1600-10-4
Your Ref. DSI: A 624

Director, Scientific Intelligence
Defence Research Board,
Department of National Defence,
Room 4601, "A" Building
Ottawa.

Attention: Mr. J. Koop

Please refer to your letter of 19 November 1958 concerning Soviet Detection of United States Nuclear Tests.

Your comments on the Hanson W. Baldwin story were much appreciated by interested authorities in my Department. They had assumed, however, that some of the Soviet information on United States nuclear tests in the Marshall Islands might have come from Soviet submarines lurking in the test area (paragraph two of your letter does not touch on this possibility). I should be grateful for your comments on this suggestion.

I am sending a copy of this memorandum to DNI and would be grateful for his advice as to whether or not any information is available on the presence (or otherwise) of Soviet surface ships and submarines in the Marshall Islands area during the recent "Hardtack" series of nuclear tests.

John Starnes

G. H. Southam
Defence Liaison (2) Division.

c.c. DNI
c.c. U. N. Division; European Division; D.L.(1) Division

done Nov. 26, 1958

000850

DEPARTMENT OF EXTERNAL AFFAIRS

MEMORANDUM

TO: UNITED NATIONS DIVISION
FROM: Defence Liaison (2) Division
REFERENCE:

DOWNGRADED TO SECRET
REBUILT A SECRET
LLS (H&IR)
FEB 22 1985

Security ~~TOP SECRET~~ *Canadian Eyes Only*
Date 21 November 1958
File No. 50219-2-40
9974-40
70

SUBJECT: SOVIET DETECTION OF US NUCLEAR TESTS.

memo to DSI, c.c. to DLT, 42 Dir., D.L.(1) Dir., Eur. Dir. & file, D.L.(2) Dir., done Nov. 26, 1958 Hmnd 25-11-58.

I had assumed that some of the Soviet information had come from submarines in the Pacific. Part of DSI comment suggests that they relied more on Communist type intelligence. Were there any US searches for subs in the area and were any located?

You may remember referring to us an article entitled U.S. AIDES SUSPECT ATOM-TEST SPYING BY SOVIET UNION: ACCURACY IN LISTING PACIFIC BLASTS ASCRIBED TO MEANS OTHER THAN DETECTION by Hanson W. Baldwin which appeared in the New York Times of 10 October 1958. DSI have commented on this article as follows:

"We have reason to believe that the recent Hardtack series of nuclear tests in the Marshall Islands included one or more trials of the so-called "pipsqueak" weapons, i.e. devices with yields considerably less than one kiloton. Hence we agree that the US Long Range Detection System, primarily oriented towards Soviet nuclear testing areas, could not possibly have detected all of the Hardtack tests. We are also convinced that any Soviet system based on the four recognized detection techniques - seismic, acoustic, electromagnetic, and debris sampling - could not have detected all of these tests either.

"The fact that the Soviet list at Geneva included two date-times which did not correspond to actual tests provides an indication of the method by which the Soviet Union may be gaining information on the US nuclear testing program. We have been informed in confidence by the head of the Nuclear Energy Division of CIA that complete countdowns terminating at the precise times given by the Soviet list were conducted at Eniwetok on the two days in question, but that for unspecified reasons the actual detonation did not occur. The inference is obvious.

"Regarding numbers of tests conducted since March 31st, the US carried out 34 tests in the Hardtack series (including two high-altitude shots at Johnston Island), the

CIRCULATION
European Div.
D.L.(1) Div.


- 2 -

UK five tests in their Grapple Y and Z series, and the USSR at least 18 tests in their recent series (including two in the Kapustin Yar rangehead area). We are not sure how many tests were conducted in Nevada in September and October, but we estimate about 15-20. Thus the Soviet Union would have a long way to go to attain parity in numbers. The overall totals are: US - about 160, USSR - at least 73, and UK - 21."

2. This memorandum, and the copies which are being sent to D.L.(1) and European Divisions, should be returned to D. L. (2) Division for filing.

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Defence Liaison (2) Division.

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LIS (M&IR)

OFFICE OF
THE UNDER SECRETARY OF STATE
FOR EXTERNAL AFFAIRS

50219-40	
1	—

OTTAWA,
October 20, 1985

Chairman, Chiefs of Staff
Secretary to the Cabinet

FEB 22 1985

Origin 50210-F&O

*Copies in { 50214-AK-40
50245-40*

Acquisition of Nuclear Weapons

I attach for your information copies of telegram 2105 of October 14 from our Embassy in Washington which deals in part with CINCNORAD's position with respect to the use of nuclear weapons. It would seem that CINCNORAD has not received advance authorization from the President to use nuclear weapons.

2. The telegram deals as well with the general question of arrangements under which Canada might acquire nuclear weapons. We find it particularly interesting that United States officials should suggest that the United States-United Kingdom arrangements, under which the President and the Prime Minister share responsibility for the use of nuclear weapons in certain circumstances, would be relevant to any Canada-United States arrangements.

3. I believe that we should accept the United States offer set out in the attachment. I think it would be appropriate, therefore, to arrange for an early Meeting of Consultation at which the problems connected with the acquisition, storage and control of nuclear weapons might be the primary subject for discussion. There are other reasons as well why an early Meeting of Consultation should be arranged.

4. I understand that at a recent meeting which Mr. Léger had with you it was agreed that CINCNORAD's position with respect to the declaration of intent to use nuclear weapons should be discussed.

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at a Meeting of Consultation. When the possibility of a meeting of the Ministerial Committee on Defence was discussed with Mr. Dulles (Washington telegram 2473, October 9), he assumed that preparatory work for the Committee's meeting would be undertaken at a Meeting of Consultation.

5. I understand that the Cabinet, as a result of its consideration on October 15 of your Minister's submission on the acquisition of nuclear weapons, authorized us to explore, with the United States Government, the terms under which Canada would be able to acquire the necessary defensive nuclear weapons. A Meeting of Consultation would be an ideal first step in carrying out the Cabinet's desires.

6. It may be desirable to limit the agenda of the next Meeting of Consultation. At earlier meetings it has been customary to include as a formal agenda item a review of United States objectives in the world's major diplomatic situations. Perhaps, for the next Meeting of Consultation, we could dispense with this general topic and concentrate primarily on the specific topics of immediate relevance to the December meeting of Ministers. I believe we should, however, include an item on the Far Eastern situation. In the circumstances, the agenda might look something like the following:

- (a) problems connected with the acquisition and control of defensive nuclear weapons in Canada;
- (b) problems connected with the declaration by CINCPAC of increased states of military readiness;
- (c) other matters to be considered by the Canada-United States Committee on Joint Defense.
- (d) the Far Eastern Situation.

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LLS (M&IR)

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7. I assume it would not be necessary under (c) above to deal at length with the substance of the other items which have been proposed for the Ministerial Meeting, i.e. the integration of Canada-United States defense production and cost sharing arrangements to cover the immediate programmes in the air defence field. The first Canada-United States meeting on integrated defence production has already taken place and a further one is scheduled for the middle of November. I understand that cost sharing arrangements are under discussion now between the Department of National Defense and the United States Defence Department. It would seem to involve unnecessary duplication of effort to discuss these items at length at the Meeting of Consultation.

8. I should be grateful if you could let me have your comments on the suggestions outlined above in order that an early approach might be made to the State Department to arrange for a Meeting of Consultation. I suggest that the meeting should be scheduled for about the middle of November, so that we will be given an opportunity to consider what effect our discussions with senior United States officials should have on our briefs for the December meeting of Ministers. Perhaps the Interdepartmental Panel on the Economic Aspects of Defence would serve as a convenient body in which to co-ordinate the results of these various meetings with United States officials before final briefs are prepared for the Canadian Ministers who will attend the December meeting.

(SGL.) N.A. Robertson

Under-Secretary of State
for External Affairs

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NORAD--USE OF NUCLEAR WEAPONS

Copy 18, 50219-40
20-50219-AK-40
21-50210-F-40

WE MET TODAY WITH DALE, ACTING DIRECTOR OF BNA OFFICE OF STATE DEPT, AND JIM PARKER CONCERNING THE RAYMOND STORY WITH RESPECT TO NORAD. DALE CONFIRMED THAT AFTER EXHAUSTIVE INQUIRIES, AND AS HE HAD INDICATED EARLIER, RAYMOND HAD SUBSTANTIALLY MISQUOTED GENERAL PARTRIDGE. IN PARTICULAR HE STATED EMPHATICALLY THAT THE SUBSTANCE OF THE POSITION WAS THAT NO RPT NO ADVANCE AUTHORIZATION HAD BEEN GIVEN BY THE PRESIDENT TO CINCNORAD GOVERNING THE USE OF NUCLEAR WEAPONS. WE UNDERSTAND THAT THE STATEMENT PREPARED FOR MR QUARLES WAS NOT RPT NOT IN THE EVENT USED SINCE THERE WERE NO RPT NO QUESTIONS ON THIS POINT, BUT YOU MAY HAVE NOTICED THAT IN THE GENERAL REPORTS OF QUARLES' PRESS CONFERENCE, HE MADE REF TO THE NEED FOR CAUTION IN PUBLIC STATEMENTS MADE BY USA COMMANDERS IN THE FAREAST(AND ELSEWHERE).

2. DALE WAS AWARE OF THE DISCUSSIONS WHICH HAVE BEEN PROCEEDING PRIMARILY BETWEEN THE MILITARY AUTHORITIES OF THE TWO COUNTRIES RELATING TO THE POSSIBLE ACQUISITION AND STORAGE OF NUCLEAR WEAPONS IN CANADA, AND OF THE FACT THAT THIS GENERAL SUBJECT HAS BEEN UNDER STUDY IN OTT FOR SOME TIME(SEE OURTEL 2630 DEC12/57). HE SAID THAT HE BELIEVED THAT OUR CONSIDERATION OF THE PROBLEMS INVOLVED WITH RESPECT TO CUSTODY, AUTHORIZATION AS TO USE, SAFETY CONSIDERATIONS AND THE LIKE, WOULD BE FURTHERED BY REF TO THE PRACTICAL ARRANGEMENTS WHICH THE USA HAS WORKED OUT BILATERALLY WITH THE UK GOVT OVER A PERIOD OF YEARS AND MOST RECENTLY IN CONNECTION WITH THE IRBM AGREEMENT. HE SAID, FOR EXAMPLE, THAT THE CUSTODIAL ARRANGEMENTS IN BEING IN THE UK WERE BASED UPON THE FORMULA MADE NECESSARY BY EXISTING USA LEGISLATION AND REFLECTED IN THE NATO DISCUSSIONS OF LAST DEC WITH REF TO THE REQUIREMENT FOR USA CUSTODY OF THE WARHEADS. SO FAR AS AUTHORIZATION OF USE IS CONCERNED, HOWEVER, ARRANGEMENTS HAVE BEEN MADE COVERING THE AUTHORIZATION OF THE USE BY USAF AIRCRAFT OPERATED FROM UK BASES OF ATOMIC WEAPONS ON THE JOINT RESPONSIBILITY OF THE PRESIDENT AND THE PRIME MINISTER. A SIMILAR SYSTEM OF JOINT RESPONSIBILITY WAS OPERATIVE IN CONNECTION WITH UK AIRCRAFT ARMED WITH USA NUCLEAR WEAPONS. DALE BELIEVED THAT SUCH ARRANGEMENTS WHICH HAD BEEN

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LHS (H&IR)

FEB 22 1985

PAGE TWO 2501

DEVELOPED EMPIRICALLY OVER A PERIOD OF YEARS WOULD BE RELEVANT TO ANY CANADIAN CONSIDERATION OF SIMILAR OR RELATED PROBLEMS. DALE FURTHER INDICATED THAT THEY WOULD BE READY TO ORGANIZE A MEETING WITH US TO PROVIDE FURTHER INFO ON THESE EXISTING BILATERAL USA-UK ARRANGEMENTS.

3. IN OUR OWN VIEW, THERE IS A GOOD DEAL TO BE SAID FOR TAKING UP THROUGH THE STATE DEPT THE SPECIFIC KINDS OF QUESTIONS WHICH ARE RAISED FOR EXAMPLE IN THE DEPT'S LET OF OCT7 TO GENERAL FOULKES WHICH ARRIVED BEFORE OUR MEETING TODAY WITH DALE. EG MATTERS RELATED TO CUSTODY, USE, AND CONTROLS ON QUANTITIES THAT MAY BE STORED. ON THE BASIS OF THE PROBLEMS POSED IN THIS LETTER, WE SUGGEST THAT IT WOULD BE USEFUL TO PREPARE SPECIFIC QUESTIONS WHICH WE COULD THEN PUT TO THE MEETING HERE WHICH DALE VOLUNTEERED TO ARRANGE. WE THINK IT WOULD BE PREFERABLE TO PROCEED BY SPECIFIC QUESTIONS RATHER THAN TO SEEK GENERAL INFO ABOUT UK-USA ARRANGEMENTS, SOME OF WHICH MAY NOT RPT NOT BE DIRECTLY RELATED TO OUR OWN PROBLEMS. ANY DISCUSSIONS OF THIS KIND SHOULD, OF COURSE, PROCEED IN PARALLEL WITH INQUIRIES WHICH WE UNDERSTAND ARE BEING MADE AT THE PENTAGON THROUGH THE JOINT STAFF HERE. IF YOU AGREE WITH THE FOREGOING, WE SHALL BE GLAD TO RECEIVE AN INDICATION OF THE QUESTIONS WHICH YOU MIGHT LIKE US TO EXPLORE THROUGH STATE DEPT CHANNELS.

4. WOULD IT BE POSSIBLE FOR US TO HAVE COPY OF DRAFT MEMO TO CABINET DEFENCE COMMITTEE REFERRED TO IN PARA 1 YOUR LET OCT7.

FM WASHDC OCT9/58 CONFD
TO EXTERNAL 2468 OPIMMEDIATE

REF YOURTEL DL788(PARA2)OCT7

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NORAD--USE OF NUCLEAR WEAPONS

DALE, ACTING DIRECTOR OF BNA OFFICE OF STATE DEPT TOLD US THIS AFTERNOON THAT THE PENTAGON HAD PREPARED FOR MR QUARLES, WHO IS EXPECTING TO SEE THE PRESS TODAY ON OTHER MATTERS, A BRIEF STATEMENT WITH RESPECT TO THE RAYMOND STORY TO BE USED ONLY REPEAT ONLY IN THE EVENT THAT A QUESTION IS RAISED. THE STATEMENT AS GIVEN TO US WOULD READ AS FOLLOWS:

"AS IS WELL KNOWN, NORAD IS EQUIPPED WITH ATOMIC CAPABLE WEAPONS FOR USE IN DEFENCE OF THIS COUNTRY AND CANADA AGAINST BOMBER ATTACK. THE LAW VESTS THE CONTROL OF THESE WEAPONS IN THE PRESIDENT.

"OBVIOUSLY, FOR SECURITY REASONS, WE DO NOT DISCUSS IN WHAT MANNER THE PRESIDENT MAY EXERCISE THIS CONTROL."

2. DALE THOUGHT IT MIGHT BE HELPFUL FOR US TO HAVE THIS TEXT AND INDICATED HE HOPED TO HAVE FURTHER INFO FOR US ON THE POINTS WE HAD RAISED IN THE NEAR FUTURE.

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50245-40
50210-F-40
50219-AK-40

FM WASHDC OCT3/5/58 SECRET
TO EXTERNAL 2461 OPIMMEDIATE

REF YOURTEL DL788 OCT7

NORAD--USE OF NUCLEAR WEAPONS

WE HAVE BEEN IN TOUCH WITH CJS ABOUT THE RAYMOND STORY IN YESTERDAY'S
NY TIMES AND THE JOINT STAFF IN TURN HAS SPOKEN WITH THE PENTAGON
WHOSE OFFICIALS ADVISED CJS THAT GENERAL PARTRIDGE HAD BEEN
MISQUOTED AND THAT THE STATEMENT ON WHICH THE PRESS REPORT IS
BASED HAD BEEN WELL WITHIN THE EXISTING FRAMEWORK OF THE NORAD
EXCHANGE OF NOTES.

2. WE HAVE ALSO TAKEN UP THE MATTER WITH THE BNA OFFICE OF
STATE DEPT. DALE, THE ACTING DIRECTOR OF THAT OFFICE, CONFIRMED THAT,
FROM THEIR INQUIRIES, THE STORY CONTAINS A NUMBER OF IMPORTANT
INACCURACIES AS TO WHAT WAS SAID BUT ADDED THAT NEITHER THE
PENTAGON NOR THE STATE DEPT WAS PLANNING AT THIS STAGE TO
ISSUE ANY CORRECTIVE STATEMENT. THE GROUNDS FOR THIS WERE MAINLY
THAT ANY STATEMENT OF CLARIFICATION WOULD GIVE RISE TO FURTHER
QUESTIONS. IN VIEW OF THE INTEREST OF THIS GENERAL MATTER TO NATO,
CONSIDERATION IS BEING GIVEN (ALTHOUGH NOTHING HAS BEEN DECIDED AS
YET) TO THE POSSIBLE NEED FOR SOME STATEMENT OF CLARIFICATION BEING
MADE BY THE USA DELEGATION IN THE COUNCIL. DALE SAID THAT THEY WERE
LOOKING FURTHER INTO THE D THAT HE WOULD HAVE SOMETHING
MORE TO SAY TO US BOTH ON THE PRESS REPORT AND ON THE SUBSTANCE
OF THE MATTER IN A DAY OR SO.

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FM WASHDC OCT7/58 RESTD
TO EXTERNAL 2444 OPIMMEDIATE

YOUR ATTENTION WILL ALREADY HAVE BEEN DRAWN TO JACK RAYMOND'S STORY
IN TODAY'S NY TIMES DATELINED COLORADO SPRINGS ATTRIBUTING TO GENERAL
PARTRIDGE THE STATEMENT THAT "HIS IS THE ONLY COMMAND AUTHORIZED TO
FIRE A NUCLEAR WEAPON IN COMBAT WITHOUT THE SPECIFIC APPROVAL OF
PRESIDENT EISENHOWER."

Orig 50309-40

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EXTERNAL OTT OCT7/58 SECRET
TO WASHDC DL733 OPIMMEDIATE

REF YOURTEL 2444 OCT7

NORAD-USE OF NUCLEAR WEAPONS

THANK YOU FOR DRAWING OUR ATTENTION TO THE NY TIMES ARTICLE WHICH ATTRIBUTES TO GENERAL PARTRIDGE THE VIEW THAT HIS COMMAND IS AUTHORIZED TO USE NUCLEAR WEAPONS IN COMBAT WITHOUT THE SPECIFIC APPROVAL OF PRESIDENT EISENHOWER.

2. BECAUSE OF THE POLITICAL IMPORTANCE OF THIS MATTER WE SHOULD BE GRATEFUL IF YOU COULD SEEK THE STATE DEPT'S COMMENTS ON THIS PRESS STORY AS A MATTER OF URGENCY. IF THE PRESS STORY IS ACCURATE WE WOULD WISH THE STATE DEPT TO GIVE US DETAILS ON WHAT EXACT AUTHORIZATION HAS BEEN GIVEN TO GENERAL PARTRIDGE. NATURALLY WE WOULD BE PARTICULARLY ANXIOUS TO HAVE THE STATE DEPT'S COMMENTS ON THAT PARA OF THE PRESS ARTICLE WHICH INDICATES THAT NORAD WAS GIVEN ITS AUTHORIZATION TO USE ANY WEAPON NECESSARY TO CARRY OUT ITS MISSION WHEN THE JOINT CANADA-USA COMMAND WAS ESTABLISHED SEP 1957".

3. IF THE STORY IS INACCURATE WE SHOULD BE INTERESTED TO KNOW IF THE USA AUTHORITIES PLAN TO ISSUE ANY CORRECTIVE STATEMENT.

4. FOR YOUR OWN INFO THE ACCURACY OR INACCURACY OF THIS STORY IS IMMEDIATELY RELEVANT TO RECOMMENDATIONS WHICH WILL BE MADE PROBABLY WITHIN THE NEXT TWO WEEKS TO THE CABINET CONCERNING THE ACQUISITION AND CONTROL OF ATOMIC WEAPONS FOR USE BY CANADIAN FORCES.

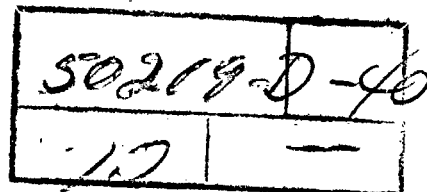
DEPARTMENT OF EXTERNAL AFFAIRS

Subject U.S. - Canada Refers

Date SEP 30 1958

Publication

MONTREAL GAZETTE



'Congress Controls' A-Bombs

By GEORGE KITCHEN

Washington, Sept. 29 — (CP) — U.S. officials said tonight the Congress has the final say on whether the United States can release atomic weapons for use by Canada's armed forces.

Under U.S. atomic law as it now stands, a State Department official said, the Eisenhower administration could not release such weapons to Canada even if it wanted to.

It would have to seek congressional approval before any such step could be taken.

Amendments written into the U.S. Atomic Energy Act by the last session of congress provide that the U.S. Government can supply atomic information, weapons and their components only to allies which already have made substantial development in the production of atomic arms. As of now, Britain is the only Western nation eligible under the terms of the legislation.

Request Delay

The official, commenting on an announcement that the Canadian army had asked the Ottawa government to obtain U.S. atomic weapons for its forces, said any Canadian request, if it comes, will have to be referred to the session of congress opening early in January, for approval.

The request could be put to congress in one of two ways, the spokesman said. One method would be for the Eisenhower administration to introduce an amendment to the Atomic Energy Act which would allow the U.S. to provide Canada with atomic weapons as a close and trusted ally.

The other would be for Canada and the United States to negotiate a treaty calling for the provision of A-weapons and for the administration to submit the treaty to congress for approval.

This would make it clear the weapons would be provided only to Canada. No amendment to the atomic energy act would be needed.

Congress long has resisted any proposal that the United States share its atomic secrets and weapons with other allies. However, in recent years there has been a growing realization here that the defence of Canada as a northern shield between the U.S. and the Soviet Union is of increasing importance to the United States itself.

Missiles Easy

Other U.S. officials said they saw no difficulty in the provision of the Lacrosse and the Hawk missiles, two newly-developed U.S. weapons which Maj.-Gen. Jean Allard, Vice-Chief of the Canadian General Staff, said the Canadian Army would like to obtain from the United States.

The Lacrosse, fired from a mobile launcher, is a general support field artillery attack missile which is designed eventually to replace conventional artillery. Described by military experts here as a highly accurate weapon, it is a ground-to-ground missile and can carry a variety of warheads, including atomic and conventional explosives.

The Hawk, the U.S. Army's newest air defence weapon, is a ground-to-air missile capable of destroying enemy aircraft flying in at low altitudes to attack ground troops and other defended areas. It also can provide a defence against high-level attacks.

Neither of the two missiles is yet in operational use in the U.S. armed forces.



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THE FOREIGN SERVICE
OF THE
UNITED STATES OF AMERICA

14003-44-8
58 150

copy 14003-44-1
United States Embassy,
Ottawa, Ontario,
August 29, 1958.

J.5

Dear Mr. McCardle:

Marselis Parsons has informed me that during the last PJBD meeting in Quebec you asked him what the significance was of the language in Section 121 of the Act Amending the Atomic Energy Act. The language to which ~~he~~ referred reads as follows:

"CHAPTER 11. INTERNATIONAL ACTIVITIES

"Sec. 121. Effect of International Arrangements. - Any provision of this Act or any action of the Commission to the extent and during the time that it conflicts with the provisions of any international arrangement made after the date of enactment of this Act shall be deemed to be of no force or effect."

Mr. Parsons has written me that he has discussed your query with members of the staff of the Special Assistant to the Secretary for Atomic Energy Affairs and has been told that the reasons for including this language were discussed at length by Secretary Dulles when he appeared before the Subcommittee on Agreements for Cooperation of the Joint Committee on Atomic Energy on April 17, 1958. The substance of his remarks is included in the Report of Hearings before this Subcommittee on Amending the Atomic Energy Act of 1954. The hearings thus reported were held on January 29, 30, 31, February 4, 5, 27, March 5, 26, 27, 28, April 17, and May 28. The title of the volume reads "Amending the Atomic Energy Act of 1954". Mr. Parsons hopes that from all this data you may identify the volume to which reference is made. The pertinent part of the Secretary's testimony in answer to questions posed by Senator Pastore may be found on pages 451 through 454.

If you do not have a copy of these hearings, I am sure that your Embassy can supply one or, if you like, I would be happy to try to obtain one for you.

James McCardle, Esquire,
Defence Liaison Division (1),
Department of External Affairs,
Ottawa.

- 2 -

I hope the foregoing information will be of assistance to you.

Sincerely yours,



Milton C. Rewinkel
Counselor of Embassy

Re

Mr. Ducloux' testimony noted above does not explain the significance of the language; rather it explains the reason why in spite of this permission the Executive was seeking specific missions in other sections of the Act.

ESM/

TRANSMITTAL SLIP

TO: **The Under-Secretary of State for**
External Affairs, Ottawa.

FROM: **The Canadian Embassy,**
Washington, D.C.

Security. **UNCLASSIFIED**

Date. **August 5, 1958.**

Air or Surface. **Courier**

No. of enclosures. **- 4 -**

The documents described below are for your information.

Despatching Authority. **H. Williamson/cmd**

50219-D-40
58 ✓

Copies

Description

Also referred to:

4 **D-1**
① 8m House of Representatives Report No. 2253,
Amending the Atomic Energy Act of 1954
as amended (July 22, 1958)

Refer enclosure
cc: S.
Leon D. (Mr. Langley)

file.

copy retained by Jm.

17 AUG 1958

INSTRUCTIONS

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2. This form should NOT be used to cover documents requiring action.
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4. The form should bear the security classification of the material it covers.
5. The column for "Copies" should indicate the number of copies of each document transmitted. The space for "No. of Enclosures" should show the total number of copies of all documents covered by the transmittal slip. This will facilitate checking on despatch and receipt of mail.

1958 RUC 7 000 866

85TH CONGRESS } HOUSE OF REPRESENTATIVES { REPORT
2d Session } No. 2253

AMENDING THE ATOMIC ENERGY ACT OF 1954, AS AMENDED

JULY 22, 1958.—Committed to the Committee of the Whole House on the State
of the Union and ordered to be printed

Mr. PRICE, from the Joint Committee on Atomic Energy, submitted
the following

REPORT

[To accompany H. R. 13456]

The Joint Committee on Atomic Energy having considered H. R. 13456, an original Committee bill to amend the Atomic Energy Act of 1954, as amended, reports favorably thereon without amendment and recommends that the bill do pass.

SUMMARY OF PROPOSED LEGISLATION

This bill amends the Atomic Energy Act of 1954, by amending section 11-0, adding a new subsection 170-1, and amending section 170 e, to extend the provisions of the AEC Indemnity Act to the nuclear ship *Savannah*, the United States first nuclear powered merchant ship. The bill is limited to the construction and operation of that ship, and extends to it the same type of insurance and indemnity protection as approved by the Congress in Public Law 85-256 last year. The present Atomic Energy Act would cover the ship while it is within the United States, and this bill is necessary in order to provide indemnity protection during its operations outside of the continental limits of the United States. The bill authorizes the Atomic Energy Commission to enter into agreements for indemnification similar to those now being processed by the Commission for domestic atomic energy licenses, and also provides for limitation of liability similar to, and in the same amount, provided in present section 170 e of the Atomic Energy Act.

BACKGROUND

The Joint Committee on Atomic Energy considered the problem posed by this bill at hearings on May 8, July 9, and July 17, 1958. Testimony was received from representatives of the Atomic Energy Commission and the Maritime Administration. On July 7, 1958, Mr. Price introduced H. R. 13390, the predecessor to this bill, and similar to it except that the maximum amount of indemnity provided was \$50 million rather than \$500 million. The committee also considered S. 3106 referred to it by the Senate Committee on Interstate and Foreign Commerce, but concluded that an amendment to the Atomic Energy Act was preferable to an amendment to the Merchant Marine Act. The Atomic Energy Commission has had several years of experience in studying liability and indemnity aspects of nuclear incidents, and has published regulations on this subject. In addition, the Atomic Energy Commission must license the nuclear ship *Savannah* to possess nuclear materials and operate the reactor. In the opinion of the Joint Committee it was therefore desirable to have the Atomic Energy Commission which has already accumulated experience in this field administer the indemnity provisions rather than the Maritime Administration. This would not necessarily constitute a precedent for future ships.

The bill provides that the maximum amount of indemnification shall be in the same maximum amount provided by subsection e of section 170, which is \$500 million. Inasmuch as the ship will be owned and operated under contract to the United States Government, it seemed advisable in the opinion of the committee to extend the same total indemnity as provided by existing law for domestic powerplants.

COMMITTEE COMMENTS

The Joint Committee on Atomic Energy was advised of the possible indemnity problems arising out of construction and operation of the nuclear ship *Savannah*, the nuclear powered merchant ship now under construction and scheduled to commence operation in 1960. In order to remove any possible roadblocks in the operation of the ship and in order to provide adequate protection to the Public, the Joint Committee recommends that the provisions of the AEC Indemnity Act be extended to cover this ship, and that the Atomic Energy Commission administer the provisions of this bill in the same manner as the other provisions of the AEC Indemnity Act enacted by the Congress in 1957.

CHANGES IN EXISTING LAW

In accordance with clause 3 of rule XIII of the Rules of the House of Representatives, changes in existing law recommended by the bill accompanying this report are shown as follows (new matter is printed in italics and existing law proposed to be omitted is enclosed in black brackets):

The Atomic Energy Act of 1954 [Public Law 83-703, as amended by Public Law 84-256]:

"SEC. 11. DEFINITIONS.—The intent of Congress in the definitions as given in this section should be construed from the words or phrases used in the definitions. As used in this Act:

"The term 'nuclear incident' means any occurrence within the United States causing bodily injury, sickness, disease, or death, or loss of or damage to property, or for loss of use of property, arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties of source, special nuclear, or byproduct material: *Provided, however, That as the term is used in subsection 170 l., it shall mean any such occurrence outside of the United States rather than within the United States.*

"SEC. 170. INDEMNIFICATION AND LIMITATION OF LIABILITY.³⁵—

"a. Each license issued under section 103 or 104 and each construction permit issued under section 185 shall, and each license issued under section 53, 63, or 81 may, have as a condition of the license a requirement that the licensee have and maintain financial protection of such type and in such amounts as the Commission shall require in accordance with subsection 170 b. to cover public liability claims. Whenever such financial protection is required, it shall be a further condition of the license that the licensee execute and maintain an indemnification agreement in accordance with subsection 170 c. The Commission may require, as a further condition of issuing a license, that an applicant waive any immunity from public liability conferred by Federal or State law.

"b. The amount of financial protection required shall be the amount of liability insurance available from private sources, except that the Commission may establish a lesser amount on the basis of criteria set forth in writing, which it may revise from time to time, taking into consideration such factors as the following: (1) the cost and terms of private insurance, (2) the type, size, and location of the licensed activity and other factors pertaining to the hazard, and (3) the nature and purpose of the licensed activity: *Provided, That for facilities designed for producing substantial amounts of electricity and having a rated capacity of 100,000 electrical kilowatts or more, the amount of financial protection required shall be the maximum amount available from private sources. Such financial protection may include private insurance, private contractual indemnities, self insurance, other proof of financial responsibility, or a combination of such measures.*

"c. The Commission shall, with respect to licenses issued between August 30, 1954, and August 1, 1967, for which it requires financial protection, agree to indemnify and hold harmless the licensee and other persons indemnified, as their interest may appear, from public liability arising from nuclear incidents which is in excess of the level of financial protection required of the licensee. The aggregate indemnity for all persons indemnified in connection with each nuclear incident shall not exceed \$500,000,-000 including the reasonable costs of investigating and settling claims and defending suits for damage. Such a contract of indemnification shall cover public liability arising out of or in connection with the licensed activity.

"d. In addition to any other authority the Commission may have, the Commission is authorized until August 1, 1967, to enter into agreements of indemnification with its contractors for the construction or operation of production or utilization facilities or

³⁵ Public Law 85-256 (71 Stat. 576) added sec. 170.

other activities under contracts for the benefit of the United States involving activities under the risk of public liability for a substantial nuclear incident. In such agreements of indemnification the Commission may require its contractor to provide and maintain financial protection of such a type and in such amounts as the Commission shall determine to be appropriate to cover public liability arising out of or in connection with the contractual activity, and shall indemnify the persons indemnified against such claims above the amount of the financial protection required, in the amount of \$500,000,000 including the reasonable costs of investigating and settling claims and defending suits for damage in the aggregate for all persons indemnified in connection with such contract and for each nuclear incident. The provisions of this subsection may be applicable to lump sum as well as cost type contracts and to contracts and projects financed in whole or in part by the Commission.

"e. The aggregate liability for a single nuclear incident of persons indemnified, including the reasonable costs of investigating and settling claims and defending suits for damage, shall not exceed the sum of \$500,000,000 together with the amount of financial protection required of the licensee or contractor. [The Commission or any person indemnified may apply to the appropriate district court of the United States having venue in bankruptcy matters over the location of the nuclear incident, and upon a showing that the public liability from a single nuclear incident will probably exceed the limit of liability imposed by this section, shall be entitled to such orders as may be appropriate for enforcement of the provisions of this section, including an order limiting the liability of the persons indemnified, orders staying the payment of claims and the execution of court judgments, orders apportioning the payments to be made to claimants, orders permitting partial payments to be made before final determination of the total claims, and an order setting aside a part of the funds available for possible latent injuries not discovered until a later time.] *The Commission or any person indemnified may apply to the appropriate district court of the United States having venue in bankruptcy matters over the location of the nuclear incident, except that in the case of nuclear incidents caused by ships of the United States outside of the United States, the Commission or any person indemnified may apply to the appropriate district court of the United States having venue in bankruptcy matters over the location of the principal place of business of the shipping company owning or operating the ship, and upon a showing that the public liability from a single nuclear incident will probably exceed the limit of liability imposed by this section, shall be entitled to such orders as may be appropriate for enforcement of the provisions of this section, including an order limiting the liability of the persons indemnified, orders staying the payment of claims and the execution of court judgments, orders apportioning the payments to be made to claimants, orders permitting partial payments to be made before final determination of the total claims, and an order setting aside a part of the funds available for possible latent injuries not discovered until a later time.*

AMENDING THE ATOMIC ENERGY ACT OF 1954

5

"f. The Commission is authorized to collect a fee from all persons with whom an indemnification agreement is executed under this section. This fee shall be \$30 per year per thousand kilowatts of thermal energy capacity for facilities licensed under section 103. For facilities licensed under section 104, and for construction permits under section 185, the Commission is authorized to reduce the fee set forth above. The Commission shall establish criteria in writing for determination of the fee for facilities licensed under section 104, taking into consideration such factors as (1) the type, size, and location of facility involved, and other factors pertaining to the hazard, and (2) the nature and purpose of the facility. For other licenses, the Commission shall collect such nominal fees as it deems appropriate. No fee under this subsection shall be less than \$100 per year.

"g. In administering the provisions of this section, the Commission shall use, to the maximum extent practicable, the facilities and services of private insurance organizations, and the Commission may contract to pay a reasonable compensation for such services. Any contract made under the provisions of this subsection may be made without regard to the provisions of section 3709 of the Revised Statutes, as amended, upon a showing by the Commission that advertising is not reasonably practicable and advance payments may be made.

"h. The agreement of indemnification may contain such terms as the Commission deems appropriate to carry out the purposes of this section. Such agreement shall provide that, when the Commission makes a determination that the United States will probably be required to make indemnity payments under this section, the Commission shall collaborate with any person indemnified and may approve the payment of any claim under the agreement of indemnification, appear through the Attorney General on behalf of the person indemnified, take charge of such action, and settle or defend any such action. The Commission shall have final authority on behalf of the United States to settle or approve the settlement of any such claim on a fair and reasonable basis with due regard for the purposes of this Act. Such settlement may include reasonable expenses in connection with the claim incurred by the person indemnified.

"i. After any nuclear incident which will probably require payments by the United States under this section, the Commission shall make a survey of the causes and extent of damage which shall forthwith be reported to the Joint Committee, and, except as forbidden by the provisions of chapter 12 of this Act or any other law or Executive order, all final findings shall be made available to the public, to the parties involved and to the courts. The Commission shall report to the Joint Committee by April 1, 1958, and every year thereafter on the operations under this section.

"j. In administering the provisions of this section, the Commission may make contracts in advance of appropriations and incur obligations without regard to section 3679 of the Revised Statutes, as amended.

"k. [H. R. 13455, reported out by Joint Committee on Atomic Energy on July 22, 1958, recommends a new subsection k.]

"I. The Commission is authorized until August 1, 1967, to enter into an agreement of indemnification with any person engaged in the design, development, construction, operation, repair and maintenance or use of the nuclear-powered ship authorized by section 716 of the Merchant Marine Act, 1936, and designated the 'nuclear ship Savannah'. In any such agreement of indemnification the Commission may require such person to provide and maintain financial protection of such a type and in such amounts as the Commission shall determine to be appropriate to cover public liability arising from a nuclear incident in connection with such design, development, construction, operation, repair, maintenance or use and shall indemnify the person indemnified against such claims above the amount of the financial protection required, in the maximum amount provided by subsection e including the reasonable costs of investigating and settling claims and defending suits for damage."



TRANSMITTAL SLIP

TO: T Under-Secretary of State for
External Affairs, Ottawa.
FROM: The Canadian Embassy,
Washington, D.C.

Security. UNCLASSIFIED
Date. August 5, 1958.
Air or Surface. Courier
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Copies	Description	Also referred to:
3	House of Representatives Report No. 2250 Amending the Atomic Energy Act of 1954, as Amended (July 22, 1958) D-1 238m Refer enclosure - Mr. Langley (Exec. Div.) Hels Jm. done Aug 18/58 copy retained by Jm. 17 AUG 1958	

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85TH CONGRESS } HOUSE OF REPRESENTATIVES { REPORT
Session } No. 2250

AMENDING THE ATOMIC ENERGY ACT OF 1954, AS
AMENDED

JULY 22, 1958.—Committed to the Committee of the Whole House on the State
of the Union and ordered to be printed

Mr. PRICE, from the Joint Committee on Atomic Energy, submitted
the following

R E P O R T

[To accompany H. R. 13455]

The Joint Committee on Atomic Energy, having considered H. R. 13455, an original committee bill to amend the Atomic Energy Act of 1954, as amended, report favorably thereon without amendment, and recommend that the bill do pass.

SUMMARY OF PROPOSED LEGISLATION

This bill adds a new subsection k to section 170 of the Atomic Energy Act of 1954 concerning indemnification and limitation of liability. The new subsection k provides that with respect to any license for the conduct of educational activities issued pursuant to certain sections of the act to a person found by the Commission to be a nonprofit educational institution, the Commission shall exempt such licensee from the financial protection requirement of subsection 170a. Subsection 170 now provides that each such license shall have as a condition a requirement that the licensee have and maintain "financial protection" of such type and in such amounts as the Commission shall require. However, numerous State-owned educational institutions indicated that requirements of State law granted them immunity from tort liability and forbade them from paying premiums for liability insurance protection, and therefore that they might not be able to obtain licenses and participate in the program. It is the purpose of this legislation to authorize the Commission to exempt nonprofit educational activities from the normal requirement of obtaining "financial protection" in order to receive the benefits of section 170 of the act.

Clauses 1, 2, and 3 of subsection k, in substance, make applicable to the exempted licensee the same type of indemnity and procedures as are now applicable to other persons indemnified under section 170 of the act.

Finally, the bill provides that any licensee may waive the exemption to which it is entitled under this subsection.

BACKGROUND

The problems which made necessary this bill were first brought to the attention of the Joint Committee at a public hearing held on May 8, 1958, concerning the operations of the AEC Indemnity Act. During this hearing the following representatives of the Atomic Energy Commission testified on this subject:

Mr. Harold L. Price, Director, Division of Licensing and Regulations, AEC

Mr. Edward Diamond, Associate General Counsel, AEC

Following this hearing the Joint Committee received communications from a number of representatives of educational institutions and from the National Association of Attorneys General indicating the need for corrective legislation to make possible the exemption of State-owned agencies from the financial protection requirement of subsection 170a of the Atomic Energy Act of 1954. In addition, the Joint Committee received letters or statements of opposition to the proposed legislation from two insurance groups.

On June 27, 1958, Mr. Price introduced H. R. 13190, and Senator Anderson introduced S. 4069, identical bills, the predecessors of this bill.

On July 9, 1958, the Subcommittee on Research and Development held a public hearing at which the following witnesses testified concerning H. R. 13190 and S. 4069:

Mr. Harold L. Price, Director, Division of Licensing and Regulations, AEC.

Mr. Paul M. Peterson, general counsel, University of Missouri.

Subsequently, on July 17, 1958, after receipt of the letters from the insurance companies, a further public hearing was held and testimony was received concerning these bills as well as others.

On July 18, 1958, Mr. Price filed a clean bill, H. R. 13455, which was identical to H. R. 13190 except that licenses issued under sections 53, 63, and 81 of the act were included in subsection 170k as well as licensees issued under 104a or 104c.

On July 21, 1958, Senator Anderson introduced a bill, S. 4164, which was identical to H. R. 13455.

At a meeting of the Joint Committee on July 22, 1958, the committee voted to report this bill favorably to the Congress with the recommendation that it be passed.

COMMITTEE COMMENTS

The Joint Committee believes that this legislation is necessary in order to encourage and make possible continuing and increasing contributions by nonprofit educational institutions in the atomic energy

research and training program. Without this legislation, many State institutions might be forced to withdraw from the program or discontinue their plans to obtain and operate research and training reactors. The Joint Committee believes that such institutions are in a position to make a tremendous contribution in this important field and believes that this legislation is therefore necessary.

The Joint Committee recognized that the most acute problem is faced by State agencies because of provisions of State law which make it impossible for them to make payments for liability insurance premiums.

However, the Joint Committee believed that the bill should apply to all nonprofit educational institutions, including privately owned and sponsored nonprofit educational institutions, because such institutions are also participating in the program. It is recognized that the Commission is making educational grants to such institutions and it would seem inconsistent not to extend to them the same benefits as to State-owned agencies. The Joint Committee did not consider this to be a serious inroad in the coverage of the act and insofar as the insurance companies are concerned. Nor does the committee regard it as a necessary precedent for other exclusions.

It is recognized that within the scope of "educational activities" could be included incidental nonprofit research conducted in reactors for outside organizations and industries.

During the hearings it was suggested that the bill should specify that it apply to each construction permit issued under section 185 as well as to any license issued pursuant to section 104a or 104c. However, the committee decided that this was unnecessary in view of the last sentence of section 185 which reads as follows:

For all other purposes of this Act, a construction permit is deemed to be a "license".

It is therefore intended that the Commission shall take cognizance of the above-quoted sentence and that the bill will apply to construction permits for facilities under 104a and 104c as well as for operating licenses under section 104a or 104c.

In addition, during the hearing the definition of "state agency" was discussed, and it is understood that this term includes municipally owned agencies as well as State-owned agencies.

CHANGES IN EXISTING LAW

In accordance with clause 3 of rule XIII of the Rules of the House of Representatives, changes in existing law made by the bill as reported are shown as follows (new matter is printed in *italic*):

The Atomic Energy Act of 1954 (Public Law 83-703, as amended by Public Law 84-256):

"SEC. 170. INDEMNIFICATION AND LIMITATION OF LIABILITY.—

"a. Each license issued under section 103 or 104 and each construction permit issued under section 185 shall, and each license issued under section 53, 63, or 81 may, have as a condition of the license a requirement that the licensee have and maintain financial protection of such type and in such amounts as the Commission shall require in accordance with subsection 170 b. to cover public liability claims. Whenever such financial protec-

tion is required, it shall be a further condition of the license that the licensee execute and maintain an indemnification agreement in accordance with subsection 170 c. The Commission may require, as a further condition of issuing a license, that an applicant waive any immunity from public liability conferred by Federal or State law.

"b. The amount of financial protection required shall be the amount of liability insurance available from private sources, except that the Commission may establish a lesser amount on the basis of criteria set forth in writing, which it may revise from time to time, taking into consideration such factors as the following: (1) the cost and terms of private insurance, (2) the type, size, and location of the licensed activity and other factors pertaining to the hazard, and (3) the nature and purpose of the licensed activity: *Provided*, That for facilities designed for producing substantial amounts of electricity and having a rated capacity of 100,000 electrical kilowatts or more, the amount of financial protection required shall be the maximum amount available from private sources. Such financial protection may include private insurance, private contractual indemnities, self insurance, other proof of financial responsibility, or a combination of such measures.

"c. The Commission shall, with respect to licenses issued between August 30, 1954, and August 1, 1967, for which it requires financial protection, agree to indemnify and hold harmless the licensee and other persons indemnified, as their interest may appear, from public liability arising from nuclear incidents which is in excess of the level of financial protection required of the licensee. The aggregate indemnity for all persons indemnified in connection with each nuclear incident shall not exceed \$500,000,000 including the reasonable costs of investigating and settling claims and defending suits for damage. Such a contract of indemnification shall cover public liability arising out of or in connection with the licensed activity.

"d. In addition to any other authority the Commission may have, the Commission is authorized until August 1, 1967, to enter into agreements of indemnification with its contractors for the construction or operation of production or utilization facilities or other activities under contracts for the benefit of the United States involving activities under the risk of public liability for a substantial nuclear incident. In such agreements of indemnification the Commission may require its contractor to provide and maintain financial protection of such a type and in such amounts as the Commission shall determine to be appropriate to cover public liability arising out of or in connection with the contractual activity, and shall indemnify the persons indemnified against such claims above the amount of the financial protection required, in the amount of \$500,000,000 including the reasonable costs of investigating and settling claims and defending suits for damage in the aggregate for all persons indemnified in connection with such contract and for each nuclear incident. The provisions of this subsection may be applicable to lump sum as well as cost type contracts and to contracts and projects financed in whole or in part by the Commission.

AMENDING THE ATOMIC ENERGY ACT OF 1954

5

"e. The aggregate liability for a single nuclear incident of persons indemnified, including the reasonable costs of investigating and settling claims and defending suits for damage, shall not exceed the sum of \$500,000,000 together with the amount of financial protection required of the licensee or contractor. The Commission or any person indemnified may apply to the appropriate district court of the United States having venue in bankruptcy matters over the location of the nuclear incident, and upon a showing that the public liability from a single nuclear incident will probably exceed the limit of liability imposed by this section, shall be entitled to such orders as may be appropriate for enforcement of the provisions of this section, including an order limiting the liability of the persons indemnified, orders staying the payment of claims and the execution of court judgments, orders apportioning the payments to be made to claimants, orders permitting partial payments to be made before final determination of the total claims, and an order setting aside a part of the funds available for possible latent injuries not discovered until a later time.

"f. The Commission is authorized to collect a fee from all persons with whom an indemnification agreement is executed under this section. This fee shall be \$30 per year per thousand kilowatts of thermal energy capacity for facilities licensed under section 103. For facilities licensed under section 104, and for construction permits under section 185, the Commission is authorized to reduce the fee set forth above. The Commission shall establish criteria in writing for determination of the fee for facilities licensed under section 104, taking into consideration such factors as (1) the type, size, and location of facility involved, and other factors pertaining to the hazard, and (2) the nature and purpose of the facility. For other licenses, the Commission shall collect such nominal fees as it deems appropriate. No fee under this subsection shall be less than \$100 per year.

"g. In administering the provisions of this section, the Commission shall use, to the maximum extent practicable, the facilities and services of private insurance organizations, and the Commission may contract to pay a reasonable compensation for such services. Any contract made under the provisions of this subsection may be made without regard to the provisions of section 3709 of the Revised Statutes, as amended, upon a showing by the Commission that advertising is not reasonably practicable and advance payments may be made.

"h. The agreement of indemnification may contain such terms as the Commission deems appropriate to carry out the purposes of this section. Such agreement shall provide that, when the Commission makes a determination that the United States will probably be required to make indemnity payments under this section, the Commission shall collaborate with any person indemnified and may approve the payment of any claim under the agreement of indemnification, appear through the Attorney General on behalf of the person indemnified, take charge of such action, and settle or defend any such action. The Commission shall have final authority on behalf of the United States to

settle or approve the settlement of any such claim on a fair and reasonable basis with due regard for the purposes of this Act. Such settlement may include reasonable expenses in connection with the claim incurred by the person indemnified.

"i. After any nuclear incident which will probably require payments by the United States under this section, the Commission shall make a survey of the causes and extent of damage which shall forthwith be reported to the Joint Committee, and except as forbidden by the provisions of chapter 12 of this Act or any other law or Executive order, all final findings shall be made available to the public, to the parties involved and to the courts. The Commission shall report to the Joint Committee by April 1, 1958, and every year thereafter on the operations under this section.

"j. In administering the provisions of this section, the Commission may make contracts in advance of appropriations and incur obligations without regard to section 3679 of the Revised Statutes, as amended.

"k. *With respect to any license issued pursuant to section 53, 63, 81, 104 a., or 104 c., for the conduct of educational activities to a person found by the Commission to be a nonprofit educational institution, the Commission shall exempt such licensee from the financial protection requirement of subsection 170 a. With respect to licenses issued between August 30, 1954, and August 1, 1967, for which the Commission grants such exemption:*

"(1) the Commission shall agree to indemnify and hold harmless the licensee and other persons indemnified, as their interests may appear, from public liability arising from nuclear incidents. The aggregate indemnity for all persons indemnified in connection with each nuclear incident shall not exceed \$500,000,000, including the reasonable costs of investigating and settling claims and defending suits for damage;

"(2) such contracts of indemnification shall cover public liability arising out of or in connection with the licensed activity; and shall include damage to property of persons indemnified, except property which is located at the site of and used in connection with the activity where the nuclear incident occurs; and

"(3) such contracts of indemnification, when entered into with a licensee having immunity from public liability because it is a State agency, shall provide also that the Commission shall make payments under the contract on account of activities of the licensee in the same manner and to the same extent as the Commission would be required to do if the licensee were not such a State agency.

Any licensee may waive an exemption to which it is entitled under this subsection."

○

*Prepared for use in External Affairs
Committee - Aug 4.*

Co-operation with the United States on
the Military Uses of Atomic Energy -
Effects of Amendments to Atomic Energy Act.

Mr. G. H. Pearson
82 (1) DW
ITBIL
File - 50219-D-40

At the last meeting of the Committee

the Leader of the Opposition indicated some interest
in the question of co-operation with the United
States on the military uses of atomic energy. He
has in mind, I assume, the effects of recent changes
in the U.S. Atomic Energy Act.

I have already referred twice to this
subject in the House of Commons, once on July 1st
and once on July 7th. There is little that I can
add to these statements, but I shall try to summarize
the situation as we understand it now. Let me say
at once that I cannot go into any great detail

/in a field

in a field which is primarily that of my colleague,
the Minister of National Defence.

Following certain proposals made last
January by the administration, the U.S. Congress
has amended the U.S. Atomic Energy Act, first passed
and
in 1946/subsequently amended in 1954. The purpose
of these amendments was to make easier the transfer
by the U.S. Government of non-nuclear parts, special
nuclear materials and certain restricted data relating
to the use of atomic weapons to friendly countries
who entered into an agreement with the United States
for this purpose. The amendments do not affect the
provisions of the Act which forbid the transfer of
nuclear components of weapons which, if manufactured
in the United States, must remain in the custody of

/United States personnel

United States personnel. Furthermore, amendments added by the Congress establish that only those nations who have made substantial progress in the development of atomic weapons may benefit from the provisions relating to the transfer of non-nuclear parts of atomic weapons, special nuclear materials for research on or development of atomic weapons and restricted data concerning atomic weapons. Nevertheless nations such as Canada, who may not qualify under this provision of the Act, could benefit from the amended Act in the following ways:

(a) they may receive certain non-nuclear

materials such as military reactors which

they were prevented from doing before;

(b) they may receive certain additional
information relating to the military
applications of atomic energy.

Finally, I should like to point out
that the amendments to the Act leave unchanged the
proviso that any part or section of the Act which
may conflict with an international agreement approved
by the Congress entered into after the enactment
of the Act is of no force or effect. Thus an inter-
national agreement could be made with a friendly
country such as Canada for the transfer of information
or materials not permitted by the Act, if approved
by Congress.

I conclude, therefore, that if, under

/the terms of

the terms of its present agreement with the
United States, Canada should decide, for whatever
reason, that a more liberal agreement is necessary,
the possibility exists for it to negotiate such
an agreement, as the United Kingdom has just done.
Whether in fact such/^a new agreement may be necessary
I am not in a position to say.



CSC 1888.1

OFFICE OF THE CHAIRMAN, CHIEFS OF STAFF
OTTAWA

JUL 17 4 35 PM '58

FILE 1888-117 July 1958. J-18

50219-D-40
70 | 52

The Under-Secretary of State
for External Affairs,
East Block,
Ottawa, Ontario.

X Ref on 50219-AA-40
In file
EOM

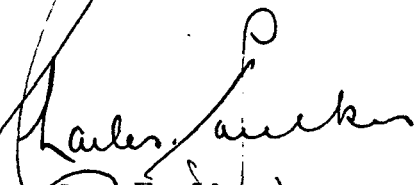
Amendment of United States Atomic Energy Act

1. Please refer to your letter and memorandum dated 2 July 1958 on this subject.

2. Based on the information available at this time, we generally agree with the views expressed in Para. 8 of the memorandum attached to your letter and would emphasize that until the various amendments can be fully interpreted by usage through actual requests based on requirements, the full implications will not be realized but we do not anticipate any difficulties in this regard.

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JUL 18 1958


(Charles Foulkes)
General,
Chairman, Chiefs of Staff

DEPARTMENT OF EXTERNAL AFFAIRS

FILE 50219-D-40

Subject ATOMIC ENERGY

Date July 7th, 1958 Publication HOUSE OF COMMONS DEBATES

File 50219-D-40

7, 1958

1955

country. In reference to the warm request by my hon. friend for an airport in Cornwall, may I say this. I can appreciate the hon. gentleman's tremendous interest in this matter. I am just wondering why a similar interest was not shown in the past. Ever since 1954 the importance of Cornwall and the St. Lawrence waterway was apparent. I am just wondering once more why there should be the sudden interest additional to, of course, the difficulty that I would have experienced in landing in Cornwall where there is no airport.

Mr. Chevrier: May I ask a supplementary question. In view of the fact that the former administration included in the estimates an item for an airport at Cornwall, will the Prime Minister see that the government carries out that project?

Mr. Diefenbaker: Mr. Speaker, I shall look over those estimates of the former government, and they will receive the attention they deserve.

ATOMIC ENERGY

STATEMENT ON CANADIAN PARTICIPATION IN
AGREEMENT AS TO USE FOR DEFENCE
PURPOSES

On the orders of the day:

Hon. Sidney E. Smith (Secretary of State for External Affairs): On Friday last the Leader of the Opposition addressed this question to me:

In view of the pattern of three-power co-operation developed during world war II on atomic matters, could the minister inform the house whether Canada will be invited to join in the agreement signed, I think, the day before yesterday between the United Kingdom and the United States for co-operation on the use of atomic energy for defence purposes?

If I may quote the words of the Prime Minister, that request was too comprehensive for me at the time and I took it as notice. The simple answer to the question is that Canada, while kept informed of developments by both London and Washington did not join in what according to my understanding is a bilateral agreement between the United Kingdom and the United States. It is true that there was tripartite co-operation during the war on atomic energy matters, and I feel confident that such co-operation would be reactivated if and when necessary.

Since the war, however, co-operation with the United States in this field has for the most part assumed a bilateral form. As the Leader of the Opposition will undoubtedly recall, Canada and the United Kingdom have had bilateral agreements with the United States in the atomic energy field, both civil and military, for some years. My understanding is

gjm 50219-D-40

En file - 50219-D-40

43

July 7, 1958.

UNITED KINGDOM-UNITED STATES BILATERAL AGREEMENT ON ATOMIC MATTERS -
QUESTION IN THE HOUSE

The following question was asked by the Leader of the Opposition on July 4:

"Mr. Speaker, I wish to direct a question to the Secretary of State for External Affairs. In view of the pattern of three-power co-operation developed during World War II on atomic matters, could the Minister inform the House whether Canada will be invited to join in the agreement signed, I think, the day before yesterday between the United Kingdom and the United States for cooperation on the uses of atomic energy for military defence purposes?"

ANSWER

The simple answer to the question is that Canada, while kept informed of developments by both London and Washington, did not join in what, according to my understanding, is a bilateral agreement between the United Kingdom and the United States. It is true that there was tripartite cooperation during the war on atomic energy matters and I feel confident that such cooperation would be re-activated if and when necessary. Since the war, however, cooperation with the United States in this field has, for the most part, assumed a bilateral form. Thus, Canada and the United Kingdom have had bilateral agreements with the United States in the atomic energy field both civil and military, for some years. My understanding is that the United Kingdom requirements, which are different from Canadian requirements, are such as to call for a new agreement at this time. When and if Canadian requirements call for a supplementary agreement with the United States, a similar course of action will no doubt be followed.

DL(1)/McCardle/Pearson

50219-D-40	
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UNCLASSIFIED

July 7, 1958

MEMORANDUM FOR THE MINISTER

United Kingdom-United States Bilateral Agreement on
Atomic Matters - Question in the House

The attached answer to the question asked by the Leader of the Opposition on July 4 has been checked with the Department of National Defence orally, and with our Embassy in Washington. Supplementary questions, if any, might more appropriately be answered by the Minister of National Defence.

J. L.

July 5 - 1958

In file.
Jm.

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MR. PEARSON:

UK-US BILATERAL ATOMIC MEMO

answer

There is attached a possible/for the Minister's use. It has been cleared in draft with the Under Secretary.

The immediately relevant (and only) information by way of telegrams are attached on top of file. See also Washington Tel 1323 of June 11 on file.

Should be checked with National Defence, and I suggest with Ed Ritchie in Washington by telephone.

My summary memo of June 30 on US amendments, and Minister's statement in House of July 1 may be useful.

Relevant files 50219-D-40
50219-AK-40
50219-AF-40 } in Registry.

Minister's wish is to reply on July 7 - all must be done with dash and élan!

[Signature]

Mr McCordle

The answer, as finally given, was amended 1) by myself after talking to DND and Washington 2) by Mr Léger 3) by Mr Smith - the last sentence is his. ~~Mr~~ Mr Léger probably knows what the Minister had in mind. I don't.

CB

N-7

caps.

S.C.

brev.

50219-D	-40
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Copy 50219-AK-40

Hon. L. B. Pearson (Leader of the Opposition)

Mr. Speaker, I wish to direct a question to the Secretary of State for External Affairs. In view of the pattern of three-power co-operation developed during world war II on atomic matters, could the minister inform the house whether Canada will be invited to join in the agreement signed, I think, the day before yesterday between the United Kingdom and the United States for co-operation on the uses of atomic energy for military defence purposes?

Hon. SIDNEY E. SMITH (Secretary of State for External Affairs) Mr. Speaker, I will accept that as notice.

TRANSMITTAL SLIP

TO: THE UNDER-SECRETARY OF STATE FOR
EXTERNAL AFFAIRS, OTTAWA, CANADA
FROM: THE CANADIAN EMBASSY
WASHINGTON, D.C.

Security... UNCLASSIFIED
Date... July 3, 1958
Air or Surface.....
No. of enclosures... 2

The documents described below are for your information.

Despatching Authority..... H. Williamson

50219-0-46
70

Copies	Description	Also referred to:
2	S. 4069 -85th Congress, 2d Session - June 27 (legislative day, June 24), 1958 - A Bill to amend the Atomic Energy Act of 1954, as amended. <i>Boyle</i>	<div> </div> <p>JUL 4 1958</p>

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1958 JUL 11 PM 4:00

Hw
(4)

85TH CONGRESS
2D SESSION

S. 4069

IN THE SENATE OF THE UNITED STATES

JUNE 27 (legislative day, JUNE 24), 1958

Mr. ANDERSON introduced the following bill; which was read twice and referred to the Joint Committee on Atomic Energy

A BILL

To amend the Atomic Energy Act of 1954, as amended.

- 1 *Be it enacted by the Senate and House of Representa-*
- 2 *tives of the United States of America in Congress assembled,*
- 3 That section 170 of the Atomic Energy Act of 1954, as
- 4 amended, is amended by adding at the end thereof the
- 5 following new subsection:
- 6 "k. With respect to any license issued pursuant to
- 7 section 104 a. or 104 c. for the conduct of educational
- 8 activities to a person found by the Commission to be a non-
- 9 profit educational institution, the Commission shall exempt
- 10 such licensee from the financial protection requirement of
- 11 subsection 170 a. With respect to licenses issued between

1 August 30, 1954, and August 1, 1967, for which the Com-
2 mission grants such exemption:

3 “(1) the Commission shall agree to indemnify and
4 hold harmless the licensee and other persons indemni-
5 fied, as their interests may appear, from public liability
6 arising from nuclear incidents. The aggregate in-
7 demnity for all persons indemnified in connection with
8 each nuclear incident shall not exceed \$500,000,000
9 including the reasonable costs of investigating and set-
10 tling claims and defending suits for damage;

11 “(2) such contracts of indemnification shall cover
12 public liability arising out of or in connection with the
13 licensed activity; and shall include damage to property
14 of persons indemnified, except property which is lo-
15 cated at the site of and used in connection with the
16 activity where the nuclear incident occurs; and

17 “(3) such contracts of indemnification, when en-
18 tered into with a licensee having immunity from public
19 liability because it is a State agency, shall provide also
20 that the Commission shall make payments under the
21 contract on account of activities of the licensee in the
22 same manner and to the same extent as the Commission

3

- 1 would be required to do if the licensee were not such a
- 2 State agency.
- 3 Any licensee may waive an exemption to which it is entitled
- 4 under this subsection."

85TH CONGRESS
2D SESSION

S. 4069

A BILL

To amend the Atomic Energy Act of 1954, as
amended.

By Mr. ANDERSON

JUNE 27 (legislative day, JUNE 24), 1958
Read twice and referred to the Joint Committee on
Atomic Energy

TRANSMITTAL SLIP

TO: UNDER-SECRETARY OF STATE FOR
..... EXTERNAL AFFAIRS, OTTAWA, CANADA
FROM: THE CANADIAN EMBASSY,
..... WASHINGTON, D.C.

Security.....Unclassified

Date..... July 3, 1958

Air or Surface.....

No. of enclosures..... 2

50219-D-46
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The documents described below are for your information.

Despatching Authority..... H. Williamson/jet

5-17

Copies

Description

Also referred to:

2

"Atomic Data Exchange" - Extract from
Congressional Quarterly-~~for~~-week
ending June 27, 1958--Page 817

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JUL 4 1958

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1958 JUL 1 PM 11:11 Wd 100 8561

tracts and certain baseball players transferred against their wishes, and prohibiting major league teams from owning minor league teams or broadcasting in towns when minor league teams are playing; June 24. Voice.

Sidney R. Yates (D Ill.) -- Delete provision in Walter substitute exempting agreements on broadcasting rights from antitrust law; June 24. Standing, 11-93.

DEBATE -- June 24 -- Celler -- "My bill (the Committee version) does not interfere with the reasonable operation of baseball or any professional team sport." Under the substitute "the only things that they (club owners) cannot do which might involve a violation of the antitrust laws are a very few business aspects which concern admissions, pop, beer and peanuts."

Keating -- The substitute bill "is designed to achieve the dual objectives of uniform treatment and protection from unwarranted legal harassment in a clear and constructive way.... Constant intervention in the affairs of these sports by paternalistic do-gooders will lead to nothing but trouble for all concerned."

ATOMIC DATA EXCHANGE

The House June 19 and the Senate June 23 passed slightly different versions of a bill (HR 12716) amending the Atomic Energy Act of 1954 to permit increased exchange of atomic weapons information and material with U.S. allies. The Senate, after agreeing to two restrictive amendments, sent the bill to conference.

BACKGROUND -- After talks with Britain's Prime Minister Harold Macmillan, following Soviet success in launching the first earth satellite, President Eisenhower Oct. 25, 1957, said he would seek changes in the Atomic Energy Act of 1954 to permit closer cooperation with Britain and other allies. Administration proposals were sent to the Joint Atomic Energy Committee Jan. 27. (Weekly Report p. 649) After considerable modification, and the insertion of a new provision allowing Congress to veto any exchange agreements, the Committee June 5 reported clean bills (S 3912 -- S Rept 1654; HR 12716 -- H Rept 1849). (Weekly Report p. 707)

HOUSE ACTION

The House June 19 passed HR 12716 by a 345-12 roll-call vote. (For voting see chart p. 842) In urging passage of the bill without amendment, Chairman Carl T. Durham (D N.C.) of the Joint Atomic Energy Committee cited the testimony of Secretary of State John Foster Dulles that it was "indispensable both to our collective security policy and to our disarmament policy." Debate centered on two amendments -- both rejected -- offered by Rep. Frank Thompson Jr. (D N.J.)

PROVISIONS -- As passed by the House and sent to the Senate, HR 12716:

Authorized transfer to other nations of non-nuclear parts of atomic weapons, utilization facilities for military applications and special nuclear material for development of military applications, but not for use in atomic weapons.

Authorized transfer of special nuclear material for use in atomic weapons, and of secret information concerning atomic weapons, to any nation that "has made substantial progress in the development of atomic weapons," when such transfer "is necessary to improve its atomic weapon design, development, or fabrication capability."

Expanded existing authority to exchange limited categories of classified information to cover "the

development of compatible delivery systems for atomic weapons" and "other military applications of atomic energy."

Restricted all transfers of material and information to nations making "substantial and material contributions to mutual defense" and required a Presidential finding that the transfer "will promote and will not constitute an unreasonable risk to the common defense and security."

Provided that every proposed agreement for cooperation with another nation lie before Congress for 60 days (30 days only in 1958), during which period it might be disapproved by concurrent resolution.

AMENDMENTS REJECTED

Frank Thompson Jr. (D N.J.) -- Define the phrase "substantial progress in the development of atomic weapons" by including the specific yardsticks set forth in the Committee report; June 19. Voice vote.

Thompson -- Add to provision for Congressional review of exchange agreements a requirement that the Joint Committee bring before the House and Senate any resolution of disapproval filed by any Member; June 19. Standing, 8-51.

DEBATE -- June 19 -- Durham -- HR 12716 does not "authorize the transfer of nuclear weapons...to any nation." Only Britain would qualify, under the bill, to receive special nuclear material for use in weapons.

Craig Hosmer (R Calif.) -- "If anyone tried to make an international agreement with France at this point, it could not be gotten past this Congress."

Thompson -- "This bill, by permitting more and more weapons to get into more and more hands, greatly multiplies the problems of reaching an inspectable disarmament agreement."

SENATE ACTION

The Senate June 23 passed HR 12716 by voice vote, after amending and substituting for it the text of S 3912. Sen. John O. Pastore (D R.I.), in charge of the bill, agreed to accept two amendments offered by Clinton P. Anderson (D N.M.). Anderson withdrew a third amendment which Pastore refused to accept. Two other members of the Joint Atomic Energy Committee -- Sens. Richard B. Russell (D Ga.) and Henry Dworshak (R Idaho) -- spoke against the bill.

AMENDMENTS ACCEPTED

Anderson -- Confine the transfer of non-nuclear parts of atomic weapons, as well as of special nuclear material for use in weapons, to nations that have "made substantial progress in the development of atomic weapons;" June 23. Voice vote.

Anderson -- Delete provision permitting transfer of classified information relating to "other military applications of atomic energy;" June 23. Voice.

DEBATE -- June 23 -- Anderson -- Without his first amendment (above), the bill would open "the door pretty far in an effort to assist the fourth, fifth, sixth, or seventh nation to achieve atomic weapons capability."

Pastore -- "We have placed in the bill about all the safeguards we can place in it against an administration which might be loose."

Dworshak -- "The pending bill presents an unworkable program which might be an irritant, rather than a help, to our allies.... We stand to exchange more atomic secrets than we would gain."

Russell -- Found it "tragic" that the Senate has "overwhelmingly committed" itself to the "thesis of sharing or giving...advanced by the Department of State."

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4 JUL 1958

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TO EXTERNAL 1702

INFO LDN WASHDC BONN PERMISNY GENEVA EMBASSYPARIS

USA ATOMIC ENERGY ACT

IN NATO COUNCIL THIS MORNING USA REP REFERRED TO PASSAGE OF ATOMIC ENERGY BILL AND SAID THAT HIS GOVT FEELS THAT AMENDMENTS TO THE ACT SHOULD STRENGTHEN WHOLE ALLIANCE BY FACILITATING TRAINING OF PERSONNEL IN USE OF ATOMIC WEAPONS AND DEVELOPMENT OF COMMON DEFENCE PLANS.

2.HE SAID THAT, UNDER NEW ACT, USA AND UK HAVE REACHED AN AGREEMENT ON EXCHANGE OF INFO AND MATERIAL IN FIELD OF MILITARY USE OF NUCLEAR ENERGY. USA REP EXPRESSED OPINION THAT THIS AGREEMENT ALSO WOULD STRENGTHEN ALLIANCE AS A WHOLE. HE SAID THAT IT WOULD BE MADE PUBLIC ONLY AFTER IT HAS LAY BEFORE CONGRESS FOR PRESCRIBED 30 DAYS AND HAS BEEN SIGNED BY THE PRESIDENT.

3.UK REP WELCOMED BOTH THESE DEVELOPMENTS, ASSOCIATED HIMSELF WITH USA REPS VIEWS REGARDING THEIR IMPORTANCE FOR ALLIANCE AND EMPHASIZED HIGHLY SENSITIVE NATURE OF THE INFO PENDING ITS RELEASE, IN VIEW OF THE PRIOR INTEREST OF UK PARLIAMENT AND OF CONGRESS.

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H. J. M.

DEPARTMENT OF EXTERNAL AFFAIRS, CANADA

OUTGOING MESSAGE

Copy 50219-AK-40

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	JUL2/58	50219-D-40		CONFIDENTIAL							
TO: WASH DC	NUMBER		PRECEDENCE		COMCENTRE USE ONLY						
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INFO:											

Ref.:

Subject: AMENDMENT OF USA ATOMIC ENERGY ACT

THANK YOU FOR HELPFUL REPORTS YOU HAVE BEEN SENDING ON AMENDING OF USA ATOMIC ENERGY ACT. WE WOULD DRAW YOUR ATTENTION TO HANSARD JUL1 WHICH RECORDS MINISTER'S ANSWER IN HOUSE TO QUESTION WHICH WAS SUBJECT OF OURTEL DL558 JUN25.

2. WE HAVE ALSO BEEN INFORMED BY EARNSCLIFFE THAT ANNOUNCEMENT OF NEW UK-USA AGREEMENT IN ATOMIC ENERGY FIELD WILL BE MADE WITHIN DAY OR TWO. WHILE WE WERE NOT GIVEN A GREAT DEAL OF INFORMATION ABOUT AGREEMENT WE BELIEVE IT IS MEANT TO COVER (A) EXCHANGE OF INFORMATION NECESSARY FOR IMPROVEMENT OF ATOMIC WEAPONS DESIGN DEVELOPMENT AND MANUFACTURING ABILITY AND (B) PURCHASE BY UK OF A COMPLETE NUCLEAR SUBMARINE PROPULSION PLANT.

3. WE SHALL CONTINUE TO BE INTERESTED IN FURTHER REPORTS FROM YOU ON DEVELOPMENTS OCCASIONED BY PASSAGE OF AMENDED ATOMIC ENERGY ACT IN USA.

LOCAL
DISTRIBUTION

ORIGINATOR	DIVISION	PHONE	APPROVED BY
SIG..... NAME J.J. McCardle/McL...	DL(1)	6-7921	(Signed) PAUL TREMBLAY NAME.....

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50219-D-40	
43	58

X-4 50219-AK-40
CONFIDENTIAL

July 2, 1958

The Chairman, Chiefs of Staff
Department of National Defence

Amendment of United States Atomic Energy Act

I refer to your letter of June 30 on this subject. My Minister replied in the House on July 1 to the question in this context which had been asked by the Leader of the Opposition on June 25. The Minister's reply was a somewhat revised version of the draft sent to you under cover of my letter of June 27.

A background memorandum concerning the amendment of the United States Atomic Energy Act was prepared in this Department, drawing together all the information available to us last week concerning the effect of the amendments to the Act. The memorandum may require revision in light of additional information which will become available to us after the passage of the revised Act in the United States. I attach a copy of the memorandum. (See file under date June 30)

I should be most grateful if we could have any comments you would wish to make on the memorandum. Our object is to try to bring together in one paper all the relevant information concerning the implications for Canada of the amended United States Act. Since the amendments in the main seem to be concerned with the military applications of atomic energy, we should like to be certain that the paper takes into account the views of military experts on the matter.

Original Signed by

DOUGLAS LEPAK

Under Secretary of State
for External Affairs

CC: Sec. to Cabinet

3.7.1105

000903

DEPARTMENT OF EXTERNAL AFFAIRS

File 5219-D-40
43

Subject

A. 210.10

Date

JUL 2 - 1958

Publication

TORONTO GLOBE AND MAIL

More Data From U.S. On Nuclear Weapons Expected by Smith

Ottawa, July 1—Rather than restrict co-operation in the use of atomic weapons for mutual defense, the U.S. Government is seeking to liberalize the terms of its atomic energy legislation, External Affairs Minister Smith told the Commons today.

He was replying to a question by Opposition Leader Pearson, who had asked whether representations were being made to Washington on amendments to the U.S. Atomic Energy Act which he said, would prevent Canada from obtaining U.S. nuclear weapons and would even make it illegal for the United States to give Canada any information as to the design of such weapons.

Mr. Smith said that the Government had closely followed the discussions of the amendments in Washington.

"The U.S. Government," he said, "is being kept fully aware of possible Canadian military requirements and we anticipate we would experience little difficulty because of the amendment under consideration in making any future arrangements with the U.S. Government in the military application of atomic energy which may be necessary for our joint defense."

The opposition leader's question implied that the amendments would make the U.S. law more restrictive.

"I can with assurance tell the House," said Mr. Smith, reading from a previously prepared statement, "that this is the exact opposite of the intent of the U.S. Administration as indicated in the hearings which have taken place over some months."

President Eisenhower had asked Congress to enact legislation to enable the United States to exchange appropriate scientific and technical information with friendly countries. At the present time, with the amending bill still under discussion, it was impossible, Mr. Smith said, to be certain of all the implications for Canada or any other interested country.

After the new act became effective, there would be a

period when important interpretations of it would have to be made. The amendments would certainly seem to improve more latitude for co-operation between the United States and friendly countries than the former law provided.

"It is for this reason," the minister said, "that the Canadian Government anticipates that future Canadian defense needs, insofar as this area of co-operation with the United States is concerned, will be served just as in the past by the necessary degree of U.S. co-operation in this field that has been possible under existing U.S. legislation."

As amended, the U.S. law would provide for the supply of restricted U.S. information on the development of atomic defense plans, the training of personnel in the use of atomic weapons, the evaluation of enemy atomic weapon potentials and the development of compatible systems of firing atomic weapons.

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AMENDMENTS TO USA ATOMIC ENERGY LEGISLATION

THE AMENDED BILL, IN THE FORM DESCRIBED IN OUR EARLIER MSG, HAS NOW BEEN PASSED BY BOTH THE HOUSE AND SENATE AND WAS SENT TO THE WHITE HOUSE YESTERDAY FOR SIGNATURE. IT SHOULD THEREFORE BECOME LAW ALMOST ANY TIME. THE EXPECTATION IS THAT THE FIRST USA-UK BILATERAL AGREEMENT UNDER THE NEW LEGISLATION WILL BE COMPLETED AND LAID BEFORE CONGRESS WITHIN THE NEXT FEW DAYS. WE ARE TOLD THAT SOME MINOR DIFFICULTIES AROSE IN THE LATER STAGES OF THE NEGOTIATIONS BUT THAT NONE OF THESE SEEM INSUPERABLE.

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INWARD TELEGRAM TO THE HIGH COMMISSIONER FOR THE UNITED KINGDOM OTTAWA

THE SECRETARY OF STATE FOR COMMONWEALTH RELATIONS LONDON

SENT: 1:50 a.m. 1st July 1958.

RECD: 9:08 a.m. 1st July 1958.

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Ottawa No. 1077, Canberra No. 953,
Wellington No. 674.

My immediately preceding telegram.

Following is text of Foreign Office
Guidance telegram No. 169 of 27th June.

BEGINS.

My Guidance telegram No. 167.

(a) In reply to questions about any sections or annexes which cannot be made public on security grounds, the Ministry of Defence will say that as with the previous bilateral agreement (1955) there has been a mutual exchange of information regarding security standards and the understandings reached on these are not suitable for publication.

(b) In the permitted fields for each exchange the information passed will cover both past experiences and future development.

(c) Her Majesty's Government's position on nuclear tests remains unaltered in that we want to retain the right to continue tests until we are satisfied that all countries have given them up under a general disarmament agreement which provides the necessary control and inspection arrangements. It is much too early to be

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TELEGRAM TO THE HIGH COMMISSIONER FOR THE UNITED KINGDOM OTTAWA

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able to judge what effect this agreement may have on our requirements for future tests. Even in pursuance of our policy of interdependence it is only reasonable to assume a fair contribution to the common effort by both sides and the agreement envisages this in Article 1. What we hope is that we shall now not have to carry out tests which duplicate tests already made by the United States. However, tests to prove weapons designed and developed in the United Kingdom for our common defence purposes and for our independent deterrent weapons will still be needed.

(d) The agreement does not mean that we shall discontinue our own research and development in the field of nuclear submarine propulsion, although it is not possible here and now to predict when the stage of building a British submarine will be reached.

(e) Although we shall hope to get information which will speed development of our nuclear warheads, the United States Atomic Energy Act as amended still does not allow supply of United States warheads.

(f) If asked what we give America in exchange, the Ministry of Defence will say that the agreement is clearly written as an exchange of information and not a one-way passage. In the agreed fields each country will give the other the benefit of its atomic research and development information.

ENDS.

EC 1.7.58.

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