1 of 1

DOCUMENT NO.
Hanford Code C-44

RL-SEP-866

SERIES AND COPY NO.

DATE
December 1, 1965

GENERAL ELECT **DECLASSIFIED**

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

XX [REDACTED] RICTED [REDACTED] A
THIS DOCUMENT CONTAINS [REDACTED] RICTED DATA
DEFINED IN THE ATOMIC ENERGY ACT OF 1954.
ITS TRANSMITTAL OR DISCLOSURE OF ITS
CONTENTS IN ANY MANNER TO AN UNAUTHORIZED
PERSON IS PROHIBITED.

T I T L E

THORIUM PROCESSING NUCLEAR SAFETY REVIEW

☐ OTHER OFFICIAL CLASSIFIED INFORMATION

THIS MATERIAL CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U. S. C. , SECS. 793 AND 794, THE TRANSMISSION OR REVELATION OF WHICH IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

AUTHOR

E. D. Clayton
R. G. Geier
M. C. Leverett

THIS DOCUMENT MUST BE LEFT UNATTENDED. THERE AN UNAUTHORIZED PERSON MAY HAVE ACCESS TO IT. WHEN IN USE, IT MUST BE STORED IN AN APPROVED LOCKED REPOSITORY. IT MUST BE GUARDED WHILE IT IS YOUR RESPONSIBILITY AND UNTIL YOU HAVE OBTAINED A SIGNED RECEIPT FROM THE PROJECT AND FROM AN AUTHORIZED PERSON. IT IS YOUR RESPONSIBILITY TO KEEP IT AND ITS CONTENTS WITHIN THE LAWS OF THE UNITED STATES. IT IS NOT TO BE LOANED, COPIED, REPRODUCED, OR DISTRIBUTED. IF ADDITIONAL COPIES ARE REQUIRED, OBTAIN THEM FROM THE ISSUING FILE. ALL PERSONS READING THIS DOCUMENT ARE REQUESTED TO SIGN IN THE SPACE PROVIDED BELOW.

ROUTE TO:

PAYROLL NO.

LOCATION

FILE	ROUTE	DATE
100-100000	100-100000	100-100000

SIGNATURE AND DATE

E. D. Clayton

30.5 9.5

2095.

DEC 8 -1965

E. N. Clayton 12-28-65

Before re-routing this document,
authorization must be obtained from
R. E. TOMLINSON

DECLASSIFIED

MASTER

ALL INFORMATION CONTAINED HEREIN IS UNCLASSIFIED EXCEPT WHERE SHOWN OTHERWISE

(CLASSIFICATION)

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

NOTICE

This report was prepared for use within General Electric Company in the course of work under Atomic Energy Commission Contract AT(45-1) - 1350, and any views or opinions expressed in the report are those of the author only. This report is subject to revision upon collection of additional data.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

Code C-44

RL-SEP-866

DECLASSIFIED

This document consists of 17
pages. Copy 1 of 19 copies.
Series **1**

THORIUM PROCESSING NUCLEAR SAFETY REVIEW

by

E. D. Clayton, BNW
R. G. Geier, DUN
M. C. Leverett, GE-NRD

DECLASSIFIED

Classification Cancelled and Changed To
By Authority of SE Gydesen

RLO-CG-4, 8-10-93

By JE Sawley 8-17-93

Verified By RS Schmitt 8-20-93

December 1, 1965

DISTRIBUTION

Battelle-Northwest

1. ED Clayton

Douglas United Nuclear

2. RG Geier

General Electric

3. WE Johnson

NRD

4. MC Leverett

CPD

5. MK Harmon

6. WM Harty

7. HC Rathvon

8. HP Shaw

9. RJ Sloat

10. RE Tomlinson

11. JH Warren

12-17. Extra

18. Files

19. Record Center

RESTRICTED DATA

This document contains restricted data as defined in the Atomic
Energy Act of 1954. Its transmission and disclosure of its
contents in any manner is prohibited.

GROUP 1: Excluded from automatic downgrading and declassification

DECLASSIFIED

RL-SEP-866

ABSTRACT

A review of the nuclear safety aspects of a proposal to process about 150 to 250 tons of thorium containing about one kilogram U-233 per ton has been made. The review was made at the request of the Chemical Processing Department in whose Purex plant the thorium processing will be carried out.

The review group finds that the proposed operation can be conducted with no more risk of criticality than attends the standard plutonium processing in Purex, provided the safeguards planned by the Department are carried out.

The review group also has developed some suggestions by which the Chemical Processing Department could enhance its nuclear safety position in all its processing of fissionable materials. These suggestions take the form of hazards analysis procedure additions and formalization and interpretation of criteria. These suggestions are not meant to imply that present operations in CPD are unsafe, but rather that a continuation of the past trend of upgrading safety is desirable in order to cope with more complex, dynamic and potentially more hazardous future operations.

DECLASSIFIED

RL-SEP-866

THORIUM PROCESSING NUCLEAR SAFETY REVIEW

1. Introduction

As a part of the program to produce sizable quantities of U-233, containing a low level of U-232 contaminant, thorium oxide is being irradiated in the K Reactors. The separation of the U-233 from the thorium oxide will take place in the Purex plant in a special thorium processing campaign. As a part of the planning for this campaign, the Chemical Processing Department requested that the nuclear safety aspects of the planned campaign be reviewed by a group external to the department. The group designated consisted of the following: M. C. Leverett - Chairman, E. D. Clayton and R. G. Geier.

The quantity of thorium oxide to be processed is approximately 150 to 250 tons and the amount of contained U-233 is expected to be approximately one kg per ton. The department has found that it will be possible to process this material with only minor changes in piping and valving arrangements in the Purex plant.

The review group covered all aspects of the proposed operation which appeared to have nuclear safety significance. Meetings were held with various representatives of the Research and Engineering and Purex Plant Sections of the Chemical Processing Department, as shown in Appendix I. Documentary information was received from the Chemical Processing Department as shown in Appendix II. Numerous other discussions between individual members of the review group and various individuals in the Chemical Processing Department were held which are not documented in this report.

The review was requested by Dr. J. H. Warren, General Manager, Chemical Processing Department, in a letter dated July 27, 1965, to E. D. Clayton, R. G. Geier, and M. C. Leverett.

2. General Tests Applied to Thorium Processing Plans

As an aid to its review, the review group established a list of general tests which it felt it should apply to the thorium processing plans. The list established is as follows:

- a. Is there a complete, well defined process flow sheet?
- b. Is there a complete plan or design for all pieces of equipment to be used?

DECLASSIFIED

RL-SEP-866

- c. Is there a clear and documented statement of the responsibilities and authorities of all the participating parts of the design, construction and operating organizations as regards nuclear safety?
- d. Is there an established policy regarding the level of nuclear safety which it will be desired to achieve?
- e. Are there established and adequate quantitative technical criteria by which the margin of safety in a given processing step or equipment can be judged?
- f. Are these criteria translated into specific standards or instructions for use by design and operating personnel?
- g. Are there specific operating procedures which are consistent with these specific standards or instructions?
- h. Are there administrative arrangements which provide for auditing the conformance of design and operations to the standards and instructions?
- i. Will changes in equipment process or operating procedure be subject to the same approvals as were the originally approved process and procedures?
- j. Have the quantitative nuclear safety criteria been consistently applied in the design?
- k. Has there been a careful, imaginative review of the design and procedures to search for potential nuclear accidents and to ascertain that their probability is held to the intended level or lower?

An important additional test which was more or less unconsciously applied, is that of the capabilities of the individuals concerned as measured against their responsibilities in connection with the thorium processing plants.

In most of the important respects the review group arrived at affirmative answers with respect to the General Tests as enumerated above. Further, with respect to the capabilities of the individuals concerned, the review group believes a competent organization is in place.

DECLASSIFIED

RL-SEP-866

The review group obtained the following results upon applying the General Tests.

- a. Process flowsheet definition is excellent.
- b. Plan and design of all equipment pieces is in place. Routine changes from normal processing have been documented. It is significant that about 35 in-canyon routing changes are required. While this appears at first glance to provide the potential for mis-routing, the potential is small because of limited access and the unusual shape of the jumpers. Reroutings in the P&O gallery or changes involving instrumentation would be of more concern due to the ready access.
- c. Responsibilities and authorities are clear and documented. See next section.
- d. Yes, the two-error philosophy is followed, as a minimum.
- e. No, the margin of safety does not appear to be formally identified.
- f. There are operating procedures. Interpretations of the broad nuclear safety objectives of the Department into specific design criteria were not observed.
- g. Yes, the operating procedures are very detailed and specific.
- h. Yes, auditing arrangements are in force.
- i. Yes, the procedures require that equipment changes receive the same approvals as original design.
- j. Yes. The interpretation of the degree to which the minimum should be exceeded is somewhat variable, however.
- k. A careful review has been made, and the flowsheet work and accident possibilities of others has been checked. The review is imaginative to a degree.

DECLASSIFIED

RL-SEP-866

3. Further Evaluation of Procedures and Administrative Arrangements

Processing in the Purex plant - be it Pu-239, U-235 or U-233 which is of interest - relies heavily on administrative control. This fact justifies a critical look at the administrative machinery of nuclear safety in the Department.

The procedures and administrative arrangements under which the thorium processing campaign will be carried out are essentially identical with those in force for the normal plutonium production operations of the Purex plant. Basically, the Research and Engineering Section has been assigned, by Department OPG, the responsibility for establishing process specifications including nuclear safety specifications. The responsibility for incorporating these specifications in plant and equipment design is that of the Facilities Engineering Operation, and the responsibility for carrying out the operation of the plant in a manner consistent with these specifications is that of the Purex Plant Section. The Research and Engineering Section must give nuclear safety approval to equipment or plant designs produced by the Facilities Engineering organization before these may be put into effect. Likewise the Research and Engineering Section maintains detailed surveillance over the operation of the plant by the Purex Plant Section, and has representatives in the plant who are informed as necessary regarding the status of the process. Both the Purex Plant Section management and the Research and Engineering Section management are authorized to direct the suspension of any operation which appears to them to involve undue nuclear hazard. Changes in process require Research and Engineering approval. Changes in equipment in the plant require Research and Engineering approval if they are judged to involve any question of nuclear safety. The authority to make this judgment is restricted within the Plant Section to a designated list of individuals whose experience in the operation and whose technical background qualifies them to make such a judgment. The review group believes that if the administrative procedures and arrangements function as intended by Department management that the arrangements are adequate for the thorium processing campaign. The review group did not investigate deeply the actual application of the Departmental rules and procedures. However, the review group perceived no indication that departures from procedures are at all prevalent or are of a nature such as to significantly affect the level of nuclear safety achieved in the plant operation.

In any event, the review group believes that further tightening up of the administrative procedures of the department would result in difficulties of enforcement. If substantial enhancement of nuclear safety were to be desired, it would be more practical to achieve it by more reliance on engineered safeguards, such as safe geometry vessels, than by further administrative restrictions.

DECLASSIFIED

RL-SEP-866

In administratively controlled operations documentation is of great importance.

The thorium processing flowsheet, nuclear and chemical safety, and equipment requirements are documented in RL-SEP-267 PT I, PT II, PT III, and PT IV. The first three volumes were prepared by Research and Engineering and the fourth by Facilities Engineering. The documents present a preliminary flowsheet and a nuclear safety review based thereon. Also included are a description of the plant equipment and the routing changes required to convert the plant to thorium processing.

Subsequent to the above Process Bases and Specifications are prepared by Research and Engineering. These must be accepted by Processing. The document contains a process description and flowsheet, process control criteria for both nuclear safety and meeting product specifications, a sampling schedule, etc.

In addition to these, specific and detailed Operating Procedures are prepared by Processing and reviewed by Research and Engineering. These contain step-by-step descriptions for startup and shutdown of various segments of the plant. Where applicable, nuclear safety considerations are highlighted again.

The documentation is excellent. It has a strong professional flavor, and it presents a complete picture of the operation, potential problem areas, and means for dealing with them.

4. Evaluation of Nuclear Safety Level Objective and Accident Probability Philosophy

The stated philosophy (OPG 11.9) of the Department is that its operations shall be so carried out that a criticality accident cannot occur unless two errors or equipment faults have occurred.

Although this philosophy has general acceptance throughout the nuclear industry in this country, the statement as made is not very definitive because it does not recognize the wide range of the probability of various kinds of errors. Nor does it recognize that there is a wide variation in the time required to detect and correct an error and hence a wide variation in the probability that a second error can occur while the first is still in effect. These considerations are particularly important in remote control chemical processing where recognition of an error or an out-of-limits situation may depend on the taking and analysis of a sample and the reporting of the results back to the plant and to the Research and Engineering representative. The philosophy as stated also does not take into account the difference between errors of human origin and malfunctions or failures of equipment. Equipment failures are considerably more predictable as to nature than are the errors which an ingenious human can commit.

DECLASSIFIED

RL-SEP-866

This philosophy is not in itself a complete basis for nuclear safety; it must be supplemented with much additional study of particular situations. This fact is well recognized by CPD and examination of its processing operations routinely shows that safety well beyond the minimum called for by the philosophy is actually provided. In CPD, as in the rest of the industry, this increment of safety over and above that formally called for is actually an essential and indispensable part of the safety practices of the Department. It would be desirable to formalize the real safety requirements of the Department. But it is very difficult to do so, and no other similar group has been very successful in this respect either.

The review group learned that it is an informal objective in the operations of the Department to provide that at least two errors or faults are required for criticality in a shielded area, and at least three in an unshielded area. This is an example of a desirable objective whose formalization into official policy has not been found practical because it cannot always be implemented practically.

The review group feels that continued efforts to produce a workable but more specific and more nearly sufficient nuclear safety policy for CPD are desirable. Success in this venture would represent industry leadership as well as helping to develop the capability for the more complex, more dynamic and potentially more dangerous processing operations which probably lie ahead of the CPD plants.

Blanket acceptance of this philosophy is not regarded as prudent, and every effort to improve safety beyond this minimum level should be made.

For the reasons above expressed the review group counsels some special precautions in a few instances where the proposed processing meets the letter of the philosophy as stated. In other words, the review group accepts the Department's statement of its nuclear accident prevention philosophy, but feels that in certain cases it will be necessary to go beyond the minimum level of precautions indicated by the philosophy in order to meet the desired objectives of over-all safety.

Department personnel informed the review group that the philosophy by which the Department actually works is more restrictive than that stated in OPG 11.9, and might be said to be that,

"It shall be impossible for a criticality accident to occur in a shielded area unless there have been two errors or faults, or, in an unshielded area, unless there have been three faults."

Such a philosophy is, in the minds of the review group desirable, although still subject to weakening by too liberal interpretation of what constitutes two distinct and separate faults or errors. If this is indeed the philosophy of the Department, the fact should be reflected in OPG 11.9.

DECLASSIFIED

RL-SEP-866

5. Evaluation of Technical Nuclear Safety Criteria

Primary Method of Criticality Control

The primary method of criticality control is "safe concentration." In geometrically unsafe vessels, the safe concentration is calculated from the minimum amount of U-233 that could be made critical in the vessel under optimum conditions of moderation and concentration assuming a uniform layer of homogeneous solution across the vessel. For the larger vessels under consideration, the minimum mass will be obtained in a layer of solution with the vessel only partially filled. In terms of mass, criticality is more likely to occur in a layer of solution, either from precipitation, or from concentration in a solvent phase on top of an aqueous solution. For example, the minimum critical mass in vessel TK-J5 (assuming a homogeneous layer of uniform concentration) is obtained with a concentration of about 40 g U-233/l for a solution height of only about 18 cm or 7.1 inches. (The diameter of TK-J5 is 76.2 cm.) It might be concluded that the worst amount of solvent is only that amount required for a 7.1 inch layer in the vessel.

The safe concentration is generally much less than the minimum concentration for criticality in the full vessel. Since the concentration is determined from the minimum critical mass value, criticality can only take place provided that the concentration limit is exceeded followed by either precipitation or the accumulation of U-233 in a solvent phase. This conforms with two-contingency philosophy, since two independent operational errors are generally required before criticality is pending.

Criticality Aspects of Pu-239 and U-233

Uranium 233 is somewhat similar to Pu-239 in terms of mass values for aqueous solutions, but there are other differences that need to be considered. Minimum critical masses and limiting critical concentrations for these two fissile nuclides are given below.

	Minimum Mass in Aqueous Solution (Water Reflected Sphere)	Smallest Concentration That can be Made Critical in Aqueous Solution
Pu-239	520 g	8.0 ± 0.3 g/l
U-233	590 g	11.2 g/l

The values of U-233 are slightly larger than those for Pu-239. However, from critical experiments, it is known that the concentration for which the minimum mass occurs with U-233 is nearly double that for Pu-239, and although the mass is larger, the critical volume is in fact smaller. Further differences between Pu and U are shown in the accompanying table.

DECLASSIFIED

RL-SEP-866

These data show that as the cylinder diameter becomes larger, the critical concentration for U-233 exceeds that of Pu-239, but that for the smaller diameter cylinders (for example, 5-inch cylinder) the critical concentration of U-233 is eight times less than that of Pu-239. It thus becomes clear that control limits set for Pu-239 may not be safe for U-233, depending on the vessel in question.

In referring to document RL-SEP-267 PT II, it is evident that a very detailed nuclear safety review has been made in regard to thorium processing and U-233 production. Furthermore, a spot check has been made of some of the limits given in this document. In each case, the limits were found to be conservative.

Estimated Critical Concentrations of Fissile
Isotopes in Infinite Water Reflected Cylinders

<u>Cylinder Diameter (inches)</u>	<u>U-235 (g/l')</u>	<u>U-233 (g/l')</u>	<u>Pu-239 (g/l')</u>
8.0	50	40	30
7.0	80	56	50
6.5	125	70	70
6.0	175	90	100
5.75	200	125	300
5.5	300	140	600
5.0	1000	200	1620
4.5	5000	700	3000

DECLASSIFIED

RL-SEP-866

Dissolver Operation

There is no problem of criticality in the dissolver operation, providing the thorium and uranium remain together. The U-233 content of the irradiated thorium fuel is not high enough for criticality under any conditions. Also, the inadvertent addition of natural uranium would not constitute a criticality hazard.

Decontamination - Partition Cycle and Other Routings

Safe concentration (based on mass limits where appropriate) is used as the principal means of criticality control. These concentration limits are generally much lower than the minimum concentration for criticality with a homogeneous solution. In the event of process malfunctions (reflux, recycle, stoppage of flow, etc.) the safe concentration limit can be exceeded, but the time factor is usually favorable (30 minutes to several weeks). In most cases, the maximum concentration which could be obtained would not result in criticality unless precipitation were also to occur. Thus, a double contingency generally prevails (over-concentration plus precipitation). Where criticality could be achieved through over-concentration alone, without precipitation, the time element is lengthy (up to several weeks) with extremely off-standard flow conditions prevailing. In those situations where a double contingency is not clearly evident, it appears that gross inattention to duty (failure to observe alarms and instrument readings, etc.) would be required by more than one operator over a period of time, before a hazardous condition could develop. This means gross inattention to the chemical flow sheet, both preceding and following the vessel in question. The number of items that the operators would have to fail to recognize is impressive.

It should be recalled, however, that in the six criticality incidents (ex-reactor) that have occurred, each has involved an inadvertent transfer of fissile material from safe to non-safe vessels. The large tanks used in processing thorium fuels represent potential problem areas. As an illustration, TK-J5 is a large cylindrical vessel of 76.2 cm diameter. It is stated that a critical concentration of U-233 could be obtained in a solvent phase on top of the aqueous solution, but that no significant quantity of solvent has been detected in this vessel, and that the agitators would prevent the accumulation of a solvent layer. However, to prevent the possibility of U-233 buildup in solvent, the salting agent will now be added to T-L1. It is noted that if the pump from TK-J5 to T-L1 stops, then some solution (solvent and nitric acid, etc.) could drain back to TK-J5, except that a solenoid valve should prevent this from happening.

DECLASSIFIED

RL-SEP-866

Connections through which solutions may drain from safe to non-safe vessels are not desirable. In one case (not CPD), solution has been observed to syphon through a "closed valve" faster than it could be pumped in the reverse direction with the valve open. Any similar connections or pipe routings whereby solution may drain from safe to non-safe vessels should be carefully examined before operations are begun.

7. Points of Higher than Average Risk in the Process

The review group makes the following observations regarding points of higher than average risk, and regarding possibly desirable modifications of process, equipment or procedure.

- a) The time between sending a sample to the laboratory for analysis and receiving the results back can be several hours. An out-of-limits nuclear safety situation which is detectable only through analysis of samples could in theory exist for a period as long as the interval between samples plus analysis and reporting time -- i.e., from just after taking a normal sample until receiving results back from the next (abnormal) sample. It is not clear that rates of flow and concentrations have in all cases been so chosen as to preclude development of unsafe conditions through a malfunction or error which persists through an interval as long as this. Relatedly, the review group believes that if for any reason the services of the analytical laboratory should be lost or appear to be of questionable accuracy, the event should be treated as seriously as loss or malfunction of a critical process instrumentation system. It is not clear that this attitude in fact prevails.
- b) In view of the unreliability of valves, level indicators and human operators it would be desirable to systematically examine the hazards potential resulting from adding to each process vessel the entire contents of each vessel connected to it if such addition could be accomplished through valve failure, level indicators or human operator error. This does not appear to have been done comprehensively in the hazards analyses so far performed.
- c) In some cases it appears that the definition of what constitutes two errors is questionable. For example failure of an operator to observe an out-of-standard condition is one error; his subsequent failure to correct the condition is not, however, an independent

DECLASSIFIED

RL-SEP-866

error. Indeed it is made inevitable by the former error so that, for safety analysis purposes, if failure to correct the condition could cause criticality, the "two-error rule" has not been met. The review group did not actually find an instance where a single failure-to-observe-and-act could cause criticality. But in some discussions Department personnel showed that they regarded failure-to-observe-and-act as two independent errors. This causes concern on the part of the review group since a 100 percent detailed review of the entire plant and process was an obvious impossibility and one or more applications of this erroneous philosophy may be somewhere in the plant and thought to be quite acceptable.

- d) Although the processing of thorium-U-233 is not greatly different than the processing of uranium-Pu-239, equipment pieces are used for different purposes. In some instances (J-7, H-4, and J-1) fissionable U-233 is handled in very large vessels in the absence of thorium. This obviously causes some concern from the standpoint of nuclear safety, which concern is offset by the evident awareness of the Department that this is a higher-than-average risk area.
- e) Other planned or accidental events which deserve special vigilance are:

Intentional recycling of a process solution

Refluxing of fissile material by improper chemical makeup

Solvent accumulations

Improper salting strength

Introduction of chemicals which might cause precipitation
of fissile material

Leakage of solution either into sumps or backward into other
process vessels.

DECLASSIFIED

RL-SEP-866

8. Conclusions and Recommendations

- a. The proposed thorium processing campaign can be executed with no greater risk of criticality than prevails in processing Pu-239.
- b. Nuclear safety in Purex depends to a marked degree upon administrative control. Wherever practical, engineered safeguards should be substituted.
- c. The Chemical Processing Department "two contingency" philosophy is generally acceptable as a minimum, with the understanding that safety actually provided routinely and significantly exceeds this minimum.
- d. The time delay between sampling and receiving analytical results on the sample can be an important safety factor, and sampling frequency and analysis time should be set with this in mind.
- e. Accidents analyzed should include those starting with valve, instrument or operator malfunction resulting in adding to each vessel the entire contents of each of its directly connected neighbors.

M. C. Leverett

M. C. Leverett, Chairman
Thorium Processing Nuclear Safety
Review Group

E. D. Clayton

E. D. Clayton, Member

R. G. Geier

R. G. Geier, Member

DECLASSIFIED

APPENDIX I

MEETINGS OF THORIUM PROCESSING NUCLEAR
SAFETY REVIEW GROUP*

1. August 19, 1965, with R. E. Tomlinson, W. M. Harty and other CPD members.
2. August 25, 1965, private meeting.
3. October 4, 1965, with CPD members responsible for preparation of Hazards Review of thorium processing.
4. October 26, 1965, private meeting.
5. November 30, 1965, private meeting.

*Only called meetings of the entire group are included. There were numerous meetings of individual group members with particular individuals or groups in CPD.

APPENDIX II

REFERENCE MATERIAL RECEIVED

1. RL-SEP-267, Engineering Study - Thorium Processing - Purex
 - Part I J. B. Kendall, May 12, 1965, Flowsheet
 - Part II J. B. Kendall and H. C. Rathvon, July 13, 1965, Nuclear and Chemical Safety
 - Part III J. B. Kendall, July 3, 1965, Equipment Capacities
 - Part IV R. P. Ehrlich and J. R. LaRiviere, May 26, 1965, Process Design
2. Thorium Process Operation
 - Co-decontamination cycle, G. L. Borsheim, September 25, 1965
 - Partition cycle, G. L. Borsheim, September 25, 1965
 - Second uranium cycle
 - Third uranium cycle
 - Final thorium cycle
 - Transfer of U-233 Rework to the HAF Makeup Tank
 - AMU Makeups
3. Revision of OPG 11.11, August 3, 1965. Product Quality and Process Control.
4. HW-81460, Technical Criteria for the Prevention of Criticality, CPD; April 8, 1964; W.S. Frank
5. HW-82254, Nuclear Safety Guidance in the Use of Water to Fight Fires in CPD Facilities, August 28, 1964. Compiled by R. E. Tomlinson

6. RL-SEP-389 REV, Criticality Safety of Fissile Materials in the Chemical Processing Department, July 28, 1965, J. H. Warren.
7. List of personnel authorized to approve physical changes to plant and equipment; ref OPG 44.5; W. M. Harty, May 20, 1965.
8. RL-SEP-650, Process Bases and Specifications - Thorium-U-233 Separations at the Purex Plant, July 26, 1965, by Separations Process Engineering, CPD.
9. OPG 11.9, "Criticality Hazards Control," General Manager, CPD, February 1, 1963.

**DATE
FILMED**

11 / 23 / 93

END