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(CLASSIFICATION)
HANFORD TECHNICAL RECORD
GENERAL ELECTRIC

SERIES AND COPY NO.

32

DATE

February 14, 1957

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

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TITLE

Revision of Horizontal Control Rods to Permit Utilization of Neutrons for By-Product Production, 105-C, 105-KE, 105-KW

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AUTHOR

G. A. Newell

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76-58

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BUDGET STUDY REPORT
FY-1959 PLANT AND EQUIPMENT BUDGET

APPROVAL SHEET

~~DECLASSIFIED~~

By Authority of AMT:EN, CG-PR-2

February 14, 1957

10-12-92

Budget Item No. B-55931

by EX HANSEN 10-15-92

Verified By J. E. Savely 10-19-92

TITLE: REVISION OF HORIZONTAL CONTROL RODS TO PERMIT UTILIZATION OF NEUTRONS FOR BY-PRODUCT PRODUCTION - 105-C, 105-KE, and 105-KW.

ENGINEERING BY G. A. Newell Date 2-18-57
G. A. Newell

APPROVED BY J. R. Carrell DATE 2-18-57
J. R. Carrell, Supervisor
Reactor Plant Design
IRRADIATION PROCESSING DEPARTMENT

A. B. Carson DATE 2-18-57
A. B. Carson, Manager
Process Design Operation
IRRADIATION PROCESSING DEPARTMENT

MASTER

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BUDGET STUDY REPORT

FY-1959 PLANT AND EQUIPMENT BUDGET

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February 14, 1957

Budget Item No. B-55931

REVISION OF HORIZONTAL CONTROL RODS TO PERMIT
UTILIZATION OF NEUTRONS FOR BY-PRODUCT PRODUCTION
105-C, 105-KE, & 105-KW

DISTRIBUTION

1. JT Baker	24. GL Locke
2. RH Beaton	25. TH Lyons
3. RS Bell	26. AR Maguire
4. RW Brown <i>See Hughes Program</i>	27. MH Meuser
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12. WF Garetson	35. CA Priode
13. OH Greager	36. W Seeburger
14. AB Greninger	37--38. WW Windsheimer (2)
15. CN-Gross	39. EC Wood
16. WM Harty	40. HF Zuhr
17--18. DD Hovorka (2)	41. JG Zwiener
19. PC Jerman	42. File - 300 Area
20. RT Jessen	43. Extra
21. LW Lang	44. Extra
22. PD Lee	45. Extra
23. CG Lewis	46. Extra

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BUDGET STUDY NO. B-55931

I. INTRODUCTION

A. Purpose

The purpose of this budget study is to analyze the problems involved at 105-C, 105-KE, and 105-KW Buildings to revise the existing horizontal control rods to permit utilization of neutrons for by-product production, compare alternate solutions, and provide necessary budget data on the proposed solution. The sponsor of this budget study is Reactor Operations.

B. Background

Each of the Hanford reactors has a certain amount of its reactivity reserved for control which is necessary to maintain the power level and to adjust the flux distribution within the reactor. A large percent of this reserve activity (available neutrons) is not used for product or by-product production but is absorbed by the horizontal control rod system.

It has been recognized that with the proper selection of rod control material and a revised rod design this reactivity normally controlled by the rods could be used for control and at the same time could produce a by-product.

C. Scope of Study

The scope of this study will include the investigation of the feasibility and the financial justification for by-product production in the horizontal control rods. Time limitations prevent the inclusion of more than one sketch in this report. Calculations will be made to check the physics problems involved and a study will be made of available information pertaining to the problems involved.

II. RECOMMENDATIONS AND CONCLUSIONS

It is recommended that revisions be made to the horizontal rods in 105-C, 105-KE, and 105-KW Buildings and all other necessary equipment be procured and installed to permit tritium by-product production by the irradiation of lithium-aluminum slugs in the rods. The revisions are justified by increasing the reactor production by producing tritium as a by-product without decreasing plutonium production.

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III. STATEMENT OF THE PROBLEM

The problem, involving the existing horizontal rods, is to increase the production of the reactors by utilizing the neutrons normally used to control the reactor, for by-product production also. The by-product would be produced without a change in power level or plutonium production and would not require additional uranium fuel.

IV. DESCRIPTION OF ALTERNATE SOLUTIONS

A. Solution No. 1

The recommended solution for by-product production is to revise the horizontal rods to permit 10 percent lithium-aluminum alloy slugs to be irradiated in them when they are inserted in the reactor for control purposes.

The revision would require replacing six existing rods in each "K" Area, and three rods in "C" Area with new rods with a new tip section design. The tip section of the new rod would consist of a ribbed inner aluminum process tube into which 2-inch diameter slugs would be charged. This process tube would have two ribs on the inside for centering the slugs and three ribs on the outside for centering it in the aluminum tube forming the outside casing of the rod. See Sketch No. SP-8044 which is attached.

The cooling water would flow through tubing in the seal section as it presently does, enter and flow through the outer annulus to the tip end of the rod. It would then return through the annulus between slugs and inside diameter of the process tube to the tubing in the seal section and out of the rod through a hose as with the existing rods.

The 105-K rod diameter would be increased to 3-inch O.D. from 2-5/8-inch O.D. to accommodate the 2-inch diameter by 9-inch long slugs. The graphite channel in the reactor would have to be replaced to accommodate the larger rod and the various rod guides and bearings would be revised also. The drive mechanism would be raised in elevation to accommodate a 3-inch diameter rod. No graphite channel, guides, or bearings would be changed at "C" Area since existing rods are already 3-inch O.D.

The joint between the tip and seal section of the new rods would be designed for easy separation for charging and discharging slugs. The joint would be separated in the outer rod room near the barricade wall and a special discharging mechanism would be attached for discharging the slugs. The mechanism would direct high pressure water into the rod tip outer annulus for flushing the slugs through the mechanism and through a tube into a cask on the floor directly below. Slugs would remain in the cask for approximately

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two weeks or until they cool off enough to be transferred to the reactor storage basin for storage. A discharge mechanism and two casks would be required for each area.

B. Solution No. 2

An alternate method for producing tritium as a by-product would use the helium-three isotope gas in the rods for the absorbing material¹. The helium-three gas would be piped into the rod tip and instead of the rod moving in or out to vary the effect of the rod, the pressure of the helium would be varied. No movement of the rod would be necessary.

V. EVALUATION OF ALTERNATE SOLUTIONS

Reactor control and by-product production with helium-three gas was rejected because of the lack of any experience with this type of a control system which necessarily means that considerable development work would be required before it could be proved useful². This system would require a gas-tight system. A personnel hazard would exist if significant quantities of tritium were lost from the system. Uncertainties also exist in the availability, handling, and storage of helium-three gas.

VI. DETAILED JUSTIFICATION OF PROPOSED WORK

The justification for the installation of the new control rods is based on increasing the reactor production by producing tritium as a by-product without a decrease in plutonium production. The amount of tritium that can be produced in the control rods has been calculated to be 96 grams per year for one "K" reactor and 51 grams per year for one "C" reactor³. The production rate is based on the rod patterns and positions presently being used for each of the reactors.

A. 105-KE and 105-KW - Justification of Proposed Work

Each "K" reactor is using eleven rods for control. A portion of the length of each rod (varies from rod to rod from 20 to 95 percent of the rod length), remains in the reactor at all times. Ninety-six percent of the tritium would be produced by six of the rods which remain inserted 75 to 95 percent of their length. The revisions would be made to these six rods.

1. L.W. Lang - HW-22977 - Report of Invention, dated December 12, 1951.
2. P.H. Reinker - HW-27499 - "Evaluation of HE³ Control System", dated March 25, 1953.
3. W.R. Smit - HW-48133 - Tritium Producing Control Rods at "K" and "C" Piles, dated February 1, 1957.

If tritium is worth its gram equivalent of plutonium, the tritium produced in one "K" reactor per year in six rods would be worth \$306,000.

The estimated cost for the installation of new rods and pertinent equipment is \$1,025,000 for two "K" reactors.

It is estimated that two rods can be installed during a regular discharge shutdown plus one extra day downtime. Work on the rods would not interfere with regular charge-discharge operations, since the work would be done by Minor Construction forces in the rod rooms. Six rods would require a total of three days downtime chargeable to the rod installation. With a value of \$28,000 per day placed on lost reactor production time, a total of \$84,000 production loss would be charged against each "K" reactor installation.

The total cost of the installation for both "K" reactors including the cost of downtime, would be \$1,193,000.

It is estimated that the cost of new slugs and manpower to charge all of the rods, an average of $1-\frac{1}{2}$ times a year, would be \$30,000 per "K" reactor.

With an estimated total installation cost of \$1,193,000 for both "K" areas and an estimated tritium value of \$552,000, the amortization period would be 2.17 years.

B. 105-C Justification of Proposed Work

"C" reactor is presently using five rods for control. The portion of each rod remaining in the reactor varies from 10 to 80 percent of its length. Eighty-five percent of the product would be produced by three rods which always remain inserted 80 percent of their length. These three rods would be revised.

If the tritium is worth its gram equivalent of plutonium, the tritium produced in "C" reactor per year in three rods would be worth \$162,000. The estimated cost for the installation of the new rods and auxiliary equipment at "C" reactor would be \$305,000.

It is estimated that the cost of new slugs and manpower to charge each of the rods an average of $1-\frac{1}{2}$ times a year would be \$15,000.

With an estimated total installation cost of \$305,000 for "C" reactor and an estimated tritium value of \$147,500, the amortization period would be 2.07 years.

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VII. SCHEDULES

	<u>Start</u>	<u>Complete</u>
Development of slugs and discharge mechanism	1-1-58	5-1-58
Design	1-1-58	10-1-58
Procurement	7-1-58	
Construction	2-1-59	6-1-59
Beneficial Use	3-1-59	

In order to start procurement of long delivery items promptly on July 1, 1958, it would be advisable to advance the starting date for design and development to January 1958.

If this project is deferred to start procurement later than July 1, 1958, all dates on above schedule, including beneficial use, will be delayed accordingly.

VIII. ACKNOWLEDGEMENTS

L. W. Lange - Process and Reactor Development
W. R. Smit - Process Design
E. R. Astley - Process Design
J. W. Clinehens - Estimating
G. C. Fulmer - Operational Physics
R. W. Brown - Plant Production and Scheduling
J. W. Dodds - Mechanical Development
R. O. Brugge - Operational Physics

IV. APPENDIX

Project Cost Estimate, 105-K
Project Cost Estimate, 105-C
Sketch - SP-8044 - Horizontal Control Rod for By-Product Production, 105-C and 105-K.

Dev - 9-57 1-58
P.D. 3-58 7-58 9-58 auth D
Design 10-58 8-59
Procure 12-58 11-59
Construct 6-59 10-60 July 1958
Benef. allocations 6-60
delayed

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COMPANY
HANFORD ATOMIC PRODUCTS OPERATION

SCHEDULE 33A

TITLE AND LOCATION OF PROJECT:

Revision to Horizontal Control Rods to Permit By-Product Production
105-KE and 105-KW

PROJECT NO:
AEC
GE

B-55931

Details of Cost Estimate and Significant Costs:

A. Engineering Design - Fixed Amount	\$ 35,000
Development Costs	20,000
B. Construction	
1. Direct Construction Costs	
a. Improvements to Land	
b. Buildings	
c. Other Structures	
d. Utilities	
e. Equipment	
f. Removal Costs Less Salvage	367,000
2. Other Direct Costs	59,000
3. Indirect Construction Costs & Fees	134,000
4. Construction Engineering-Fixed Amount	44,000 - 5%
C. Escalation (5% per year) Two Years	50,000
D. Contingencies (30%) (Approximate)	66,000
Start-up Costs	194,000
E. General and Administrative Costs (5%)	10,000
	46,000

Total Project Cost

\$1,025,000

Details of Basis for Cost Estimate and Significant Costs:

Work performed by Construction Operations

Construction Cost Breakdown:

Temporary Construction	\$ 32,000
Demolition and Removal	59,000
Install Additional Water	
Supply and Drain Piping	32,000
Install new graphite	
Stringers, new rods, guides	
Wall Plugs, seals, including Two	
Discharge Heads (6 each area)	158,000
Storage Cask (2 each area)	28,000
Mint Slug (288 each area)	50,000
Special Tools	26,000
Clean-up and Painting	10,000
Acceptance Tests	5,000
Equipment Usage	26,000
	\$ 426,000

Study Engineer - G. A. Newell
Estimating - J. W. C.

GENERAL ELECTRIC

COMPANY

HANFORD ATOMIC PRODUCTS OPERATION

SCHEDULE 33A

TITLE AND LOCATION OF PROJECT:

Revision to Horizontal Control Rods to Permit By-Product Production - 105-C

PROJECT NO:

AEC

GE

B-55931

Details of Cost Estimate and Significant Costs:

A. Engineering Design - Fixed amount \$ 20,000

Development Costs 20,000

B. Construction

1. Direct Construction Costs

a. Improvements to Land

b. Buildings

c. Other Structures

d. Utilities

e. Equipment

f. Removal Costs Less Salvage

Other Direct Costs

2. Indirect Construction Costs & Fee

3. Construction Engineering-Fixed Amount

4. Escalation (5% per year) Two Years

C. Contingencies (30%) (Approximate)

Start-up Costs

E. General and Administrative Costs (5%)

Total Project Cost

\$ 305,000

Construction Cost Breakdown:

Temporary Construction \$ 15,000

Demolition and Removal 6,000

Install Additional Water

Supply and Drain Piping 12,000

Install New Rods Only, Incl.

One Discharge Head (3 each) 41,000

Storage Cask (2 each) 14,000

Mint Slug (144 each) 12,000

Special Tools 1,000

Clean-up and Painting 4,000

Acceptance Tests 2,000

Equipment Usage 8,000

\$ 115,000

Details of Basis for Cost Estimate and Significant Costs:

Work performed by Construction Operations

Study Engineer - G. A. Newell
Estimating - J. W. C.

SEAL SECTION IN 'K' ROD ONLY
DESIGN AS PRESENT EXCEPT LARGER DIA.

RACK SECTION
SAME AS PRESENT DESIGN

DIA. SLUG

DISCHARGE ELBOW WILL CONNECT TO CASK
WITH FLEXIBLE TUBING.

APPROVED

REV. NO.	DESCRIPTION	REV. BY	DATE	APPRO. BY	DATE
REVISIONS NONE					
CLASSIFIED BY <i>LAURIE</i> DATE 2/4/67					
SCALE: FULL					
DESIGNED BY	DATE	CHECKED BY	DATE	ISSUED BY	DATE
DRS. ENR. GAN	UNVT D-13-57				
U. S. ATOMIC ENERGY COMMISSION HANFORD ATOMIC PRODUCTS OPERATION GENERAL ELECTRIC					
HORIZONTAL CONTROL ROD FOR BY-PRODUCT PRODUCTION					
105C 105K 1900.12					

REV. NO.	DESCRIPTION
REFERENCE DRAWINGS	

END

**DATE
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