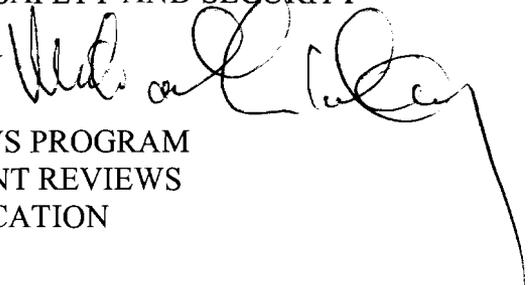




Department of Energy
Washington, DC 20585

January 28, 2009

MEMORANDUM FOR MICHAEL D. LOHR
SECURITY SPECIALIST
OFFICE OF HUMAN RESOURCES AND ADMINISTRATION
OFFICE OF RESOURCE MANAGEMENT
OFFICE OF HEALTH, SAFETY AND SECURITY

FROM: MICHAEL L. KOLBAY 
TEAM LEADER
STATUTORY REVIEWS PROGRAM
OFFICE OF DOCUMENT REVIEWS
OFFICE OF CLASSIFICATION

SUBJECT: Response to Review Request (20090002740-MK)

This responds to your request dated January 26, 2009.

This is a:

- Complete Response
 Partial Response
 Final Partial Response

Findings/Instructions:

- We indicated the result(s) of our review(s) on the first page of the document(s) at attachment(s) 1(see stamp(s)).
- Special considerations apply to this request. This document was previously declassified under action #20080001852 on April 23, 2008. This action was sent to the Office of Health and Safety (HS-10) as a Freedom of Information Act (FOIA) request and HS-10 needs to provide summary information regarding this request to the Department of Energy (DOE) FOIA office.**
- Note that we upgraded/downgraded the classification level of some material to **Top Secret/Secret and/or Confidential.**
- Note that we changed the category of some material to **Restricted Data/ Formerly Restricted Data and/or National Security Information.**



- ___ The document(s) at attachment(s) ___ is/are denied in its/their entirety.
- ___ We bracketed in ___ the DOE classified information and/or Unclassified Controlled Nuclear Information (UCNI) that must be deleted from the document(s) at attachment(s) ___ prior to release.
- ___ We indicated next to each bracket the appropriate FOIA or Mandatory (Executive Order 12958, as amended) exemptions.
- ___ We confirmed that the document(s) at attachment(s) ___ is/are properly classified _____, and we have marked it/them accordingly.
- ___ The document(s) at attachment(s) ___ does not/do not/no longer contain(s) DOE classified information and/or UCNI, and therefore, we have no objection to its/their declassification and/or release.
- XX The document(s) at attachment(s) 1 is/are Unclassified and does not/do not contain UCNI; therefore, we have no objection to its/their release.
- ___ We declassified the document(s) at attachment(s) ___.
- ___ Where applicable, we indicated the name(s) of other agency(ies) and/or office(s) that we recommend review the document(s) prior to its/their release.
- ___ We defer to your office regarding the determination of _____.
- ___ Details and appeal procedures for the requester are at attachment ___.
- ___ OpenNet Requirements are at attachment ___.
- ___ You are also reminded that if you determine any information must be withheld, your denial letter to the requester must be coordinated with the Office of the/your General Counsel.

Please address any questions to Raymond F. "Mike" Rudell at (301) 903-6728.

Attachment(s)
Report, Re: D00014603 (U)

cc w/o attachment(s): Regina G. Cano, HS-10

U.S. Department of Energy - List of Attachments
Receipt Number: MR09329905136

Description (must be unclassified)	Reference Number	Date of Item	Classifi- cation
Document Type: Report MANHATTAN DISTRICT HISTORY - BOOK VII, FEED MATERIALS, SPECIAL PROCUREMENT, AND GEOGRAPHICAL EXPLORATION - VOLUME 1 - FEED MATERIALS AND SPECIAL PROCUREMENT Author: AEC	D00014603		U

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US DOE ARCHIVES
RG <u>MED</u>
Collection <u>MED History</u>
Box <u>Book VII Feed Mats</u>
Folder <u>Vol 1</u>

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This document consists of 323 pages
Copy No. 2 of 4 Series A

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BY AUTHORITY OF THE GENERAL MANAGER
PER (SIGNED) J. C. Clarke XKII-582A
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MANHATTAN DISTRICT HISTORY

BOOK VII, FEED MATERIALS, SPECIAL PROCUREMENT,
AND GEOGRAPHICAL EXPLORATION

VOLUME 1 - FEED MATERIALS AND SPECIAL PROCUREMENT (Extract - 18 pages)

~~CLASSIFICATION CANCELLED~~
~~SECRET~~ - Ret Date
By Patricia Mason DATE 1/12/55
Notice of 1/13/55

~~REVIEWED BY
BY U S DEPARTMENT OF ENERGY
OFFICE OF CLASSIFICATION
JOHN H. HERSHOCK
REVIEWED BY
DATE 9/6/79~~

12/57 BK

CONFIRMED TO BE UNCLASSIFIED

DOCUMENT PREVIOUSLY DECLASSIFIED AS ~~SECRET~~ D0001302/ACTION 20080001852 ON 4/23/2008
BY MICHAEL KOLBAY DOE/HS-98 1/27/2009
DECLASSIFY/TTEAM LWAD

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~~RESTRICTED DATA~~
66914
RESTRICTED DATA
ATOMIC ENERGY ACT 1946
SPECIFIC RESTRICTED DATA
CLEARANCE REQUIRED

200900012740

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Tonawanda Area

- Major E.L. Van Horn - Area Engineer, November 1942 to August 1946.
- Capt. W. Thomas - Operations Officer, November 1943 to March 1946.

Wilmington Area

- Major W.L. Sapper - Area Engineer, December 1942 to November 1944.
- Major Dewey M. Stowers - Area Executive Officer, March 1943 to November 1944; Area Engineer, November 1944 to October 1945.
- Major C.W. Swartout - Production Officer, January 1943 to November 1944.
- Capt. O. Bergelin - Production Section, July 1943 to November 1944; Production Officer, November 1944 to October 1945; Area Engineer, November 1945 to February 1946.
- Capt. G.L. Ryan - Area Engineer, February 1946 to January 1947.

Colorado Area

- Major P.G. Leahy - Area Engineer, March 1943 to August 1946.
- R. Alexander - Tonawanda Area, February 1943 to December 1943; Technical Officer, Colorado Area, December 1943 to December 1945.

Cleveland Area

- Major H.S. Benbow - Area Engineer, February 1944 to June 1944.
- Capt. Wm. E. Dalton - Assistant to Area Engineer, February 1944 to June 1944; Area Engineer, June 1944 to November 1944, and June 1945 to December 1945; Assistant Administrative Officer, Madison Square Area, November 1944 to June 1945 and December 1945 to March 1946.

St. Louis Area and Iowa Area

- Major J.H. McKinley - Area Engineer, November 1942 to November 1943.
- Major H.A. Savigny - Area Engineer, November 1943 to August 1944.

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SECTION 7 - REFINING OF RAW ORES TO BLACK OXIDE
AND SODA SALT

7-1. Operations. - In general, the refining operations (App. 02) consisted of a mechanical crushing and grinding of the raw ores to a fine sandy material, the treatment of this sandy material with acid to extract the uranium content, the partial treatment of the extract with caustic and other chemicals to precipitate the majority of impurities; a further treatment with caustic and other chemicals to precipitate the uranium; and a final roasting or drying operation to produce the refined material as either black oxide (uranium oxide, U_3O_8) or as soda salt (sodium uranate, $Na_2U_2O_7$).

The process developed and used by the Vitro Manufacturing Company for their commercial business, and subsequently used in their contracts with the Manhattan District, had been designed to produce soda salt. The equipment and process were such that this plant operated most efficiently and economically on relatively high grade ores, that is, 50% or greater U_3O_8 content. The Vitro refinery is designed to handle approximately 40 tons per month of gross ore input.

The process used by Eldorado Mining and Refining at its Port Hope plant was also designed for its commercial business and produced black oxide. This process and equipment allowed efficient and economical operations on ore concentrates containing 20% or higher U_3O_8 content. The Eldorado refinery is designed to handle a gross ore input of approximately 225 tons per month and, in addition, has associated facilities for the refining of radium from the uranium ores.

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To fulfill the need for a plant capable of economically and efficiently processing ores or concentrates containing less than 20% U_3O_8 , the Linde Air Products Company refinery at Tonawanda, New York, was originally built and designed to handle American ore concentrates at an input of approximately 540 tons per month, but through subsequent process improvements it has been possible to process both American and African ore concentrates at much higher rates (150-220% designed capacity). Consideration of the type of ore, percent U_3O_8 and other factors have been necessary in determining in which refinery the several ore concentrates should be refined.

The American ores were in reality tailings from previous vanadium refinery operations and were of such low uranium content that it was necessary to concentrate them in successive stages at or near the mine where they were produced, because of the excessive transportation charges which would otherwise have been required in transporting very low-grade ores to Linde's refinery at Tonawanda, New York. Accordingly, it was necessary for the Government to provide preliminary concentrating plants at Uravan and Durango, Colorado, and a central refinery to remove vanadium at Grand Junction, Colorado (App. C1A and D4). The U. S. Vanadium Corporation owned one plant at Uravan, Colorado, which was also utilized in the preliminary concentration step.

7-2. Refining by Eldorado Mining and Refining.

a. Operations. - The first material refined by Eldorado at Port Hope, Ontario, Canada, consisted of the initial 100 tons of 88% (U_3O_8) ore procured from African Metals Corporation, as a trial lot to

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determine the efficiency of refining operations. These ores were delivered to Eldorado in November 1942 and refining was started a month later. At the time of the delivery of the ores, the plant was small and did not have a production capacity of more than 30 tons of black oxide per month. However, the plant was expanded at the expense of the contractor to a point where he was able to deliver 150 tons of black oxide per month when working on 65% African ore. Expansion was started late in 1942 and by February 1943 the capacity had been raised to 100 tons of black oxide per month. Refining operations have continued to date both on African ores supplied under refining contracts and on Canadian ores from which the black oxide produced was sold to the Government.

To 1 January 1947, Eldorado produced, from African ore, approximately 1,832 tons of U_3O_8 . The total cost of the work performed under eight contracts was \$2,823,310, the cost of refining U_3O_8 was \$2,528,560, and the average processing cost was approximately \$0.69 per pound of U_3O_8 in black oxide. In addition to the African ores processed, approximately 847 tons of black oxide have been produced to date from Canadian ores. (See App. F7.)

b. Contractual Arrangements. - As explained in Part B, Section 3, no separate arrangements were necessary with regard to Canadian ores, inasmuch as the uranium was procured from Eldorado in the form of refined black oxide. Thus, as far as contractual arrangements were concerned, the refining of Canadian ores was integrated with the procurement contract. In the case of treatment of African ores, however, the refining contracts only were negotiated with

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Eldorado, who, at the outset of the refining operations on African ores, did not wish to be held accountable and responsible for U. S. Government property in their refinery. Consequently, under Contract W-7405 eng-6 and W-7405 eng-17, the uranium content of the ores was sold to Eldorado but the contracts required the contractor to resell the total quantity of recovered uranium content back to the Government at an increased price which included the refining charges. Under subsequent refining contracts, namely, Contracts W-7505 eng-264, W-7405 eng-281, W-7405 eng-318, W-26-021 eng-21, and W-26-021 eng-26, the ore was accepted for refining by Eldorado with a stipulation that all the uranium content recovered would be returned to the Government, and in each contract a minimum recovery guarantee was stipulated. Because of the importance of the material, close checks were maintained on operations in order to preserve the required secrecy of the work, to protect the heavy financial interest which the U. S. Government had in the materials involved, and to make certain that all materials recovered were returned to the U. S. Government. In addition to refining African and Canadian ores, Eldorado refined crude soda salts to black oxide under Contract W-7405 eng-20. Appendix F7 shows data concerning the refining contracts.

7-3. Refining by Vitro Manufacturing Company.

a. Operations. - The Vitro Manufacturing Company in its Cannonsburg, Pennsylvania, refinery, which was constructed originally by the Standard Chemical Company for processing carnotite ores to recover the radium-vanadium and uranium content, refined from African ores a total of approximately 623 tons of soda salt containing the equivalent

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of 600 tons of black oxide. The refining operations commenced in December 1942 and were conducted under Contracts W-7405 eng-21, W-7405 eng-251 and W-26-021 eng-16. In addition to its work on African ores, Vitro has carried out refining of uranium-vanadium sludges (purchased from Vanadium Corporation of America) under Contracts W-7405 eng-54 and W-26-021 eng-7. The high grade carnotite ore purchased from the Vitro Manufacturing Co., under contract W-26-021 eng-24, was also processed by the Vitro Company under that contract.

b. Contractual Arrangements - A total of six refining contracts were entered into with Vitro, and under these contracts 768 tons of U_3O_8 as soda salt was refined to January 1/ 1947, at an average U_3O_8 recovery of approximately 97%. The total cost of the work performed by Vitro was approximately \$1,203,430 or an average processing cost of about \$0.78 per pound of U_3O_8 , produced in the form of soda salt. Data concerning refining contracts is shown in Appendix F7.

7-4. Refining by Linde Air Products Company - Prior to the development of the project, Linde Air Products Company had been engaged in the small-scale production of commercially pure black oxide. The OSRD, through the University of Chicago and Stone & Webster Engineering Corporation, had made arrangements with Linde for the procurement of small quantities of black oxide and had also discussed the production of specially purified materials by other processes. Linde was selected to be one of the principal processing plants because of its existing association with the project, its know-how in processing uranium, and the inter-relationship between its parent company, the Union Carbide &

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Carbon Corporation, and both the U. S. Vanadium Corporation (one of the suppliers of American ore concentrates of uranium) and the Electro Metallurgical Company (whose experience in metallurgical fields appeared to be valuable to the project).

The Linde black oxide plant located at Tonawanda, New York, was originally designed and built for the processing of uranium-containing concentrates from American ore. These concentrates contained approximately 10% black oxide and 2% vanadium pentoxide (V_2O_5). In the Fall of 1943 alterations were made to the plant to permit the processing of African ore concentrates containing from 6% to 10% U_3O_8 . The product from this plant was black oxide of a grade somewhat superior to the normal commercial black oxide.

In the process used by Linde, the ore concentrate was slurried with sulfuric acid and water for about two hours. Soda ash was added to the acid slurry to precipitate most of the impurities. The slurry was filtered. The filter cake was washed with hot dilute sodium carbonate solution and discarded. The filtrate was treated with ferric and ferrous sulfate to precipitate the residual vanadium and phosphorus. The resultant slurry was again filtered. The cake was discarded. Sodium hydroxide was added to the carbonate liquors to precipitate the uranium as sodium uranate. The sodium uranate was leached in a weak acid solution with ammonium sulfate to form ammonium uranate, which was removed from the slurry by filtering and calcined to form the purified black oxide.

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Under Contract No. W-7401 eng-14, Linde contracted to build and operate a plant for refining African and American ore concentrates to produce black oxide in a first step, for the further processing of the black oxide to produce brown oxide in a second step, and for the conversion of brown oxide into green salt in a third step. The brown oxide and green salt phases are discussed separately in Sections 8 and 9. The total construction cost was \$3,040,230 for all three steps, of which \$1,759,940 was for the refining step. The contract was negotiated on a cost-plus-a-fixed-fee basis, with the fixed fee to apply to operations only. Design of the Linde refining plant was based upon previous pilot plant studies and development work done by Linde. Construction of this plant was completed in July 1943 and the plant started into operation processing American ore concentrates (App. E28, E29). After certain starting-up troubles, the refining step operated at approximately 110% of its designed capacity of 52 tons of black oxide per month until December 1943. In December 1943, operations were changed to consume 10% and 6% African ore. During the period December 1943 through November 1944, consuming African ore the plant operated at 162% of its designed capacity of 52 tons of black oxide per month. In the Spring of 1944, operations were at a rate of 225% of designed capacity. After November 1944, at the request of Madison Square Area, Linde made alterations in the plant and changes in the method of processing in order to increase the extraction of the uranium content from the ore. These improvements resulted in an increase of extraction from 93% to 98% of the ore content. Because of the increase in chemical consumption and the additional operations necessary to secure this

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higher extraction, the unit operating cost in this step increased from approximately \$.80 to \$.85 per pound of black oxide. However, this unit cost would have increased considerably more if other developments in plant operations had not enabled large increases in output and efficiency. In December 1944, operations were changed back to American ore concentrates, and because of developments made during the period of operation on African ore concentrate, operating rates of approximately 150% of the original designed capacity were maintained through January 1946 when all of the available American ore concentrates were consumed. In February 1946 the Contractor began processing 3% African ore. Approximately 10,250 tons of ore were processed during the period February 1946 to (July 18) 1946 at approximately 110% of the rated capacity of the plant. The plant was shut down 18 July 1946 ~~due to~~ ^{because of} insufficient suitable raw material and has been maintained in stand-by since then. Total production to 1 July 1946 was 2,428 tons of black oxide, at a total operating expenditure of approximately \$5,074,260, including material furnished by the Government.

Construction of a high-grade ore refinery, at Mallinckrodt Chemical Works in St. Louis, was started in May 1945 and completed in May 1946. At the end of the year this plant was just beginning to reach quantity production.

7-5. Concentrating of American Ores by U. S. Vanadium Corporation.

The sources of uranium within the United States consisted of carnotite ores, ordinarily containing less than about 2% of uranium, and sand tailings from previous operations for the production of vanadium. Most of the uranium available was in the form of sand tailings which contained from one-quarter to one-half of 1% of black oxide and approximately the same quantities of vanadium. Since it would have been very expensive to transport such a low grade material from its source in the

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SCRAP RECOVERY

REFI

CAN.
PITCHBLNDE
CONCENTRATES
25-30% U_3O_8

APR.
PITCHBLNDR
CONCENTRATES
6-15% U_3O_8

PRELIMINARY
CONCENTRATION

VANADIUM
REFINING

CARNOTITE
ORE
.25% U_3O_8

USV
URAVAN

USV
TAILING SANDS
.25% U_3O_8

USV
DURANGO
URAVAN

GREEN
SLUDGE
10% U_3O_8

USV
GRAND
JUNCTION

YELLOW
SLUDGE
15% U_3O_8

TAILINGS

VCA
MONTICELLO
MATURITA

VCA
SLIMES
1.5% U_3O_8

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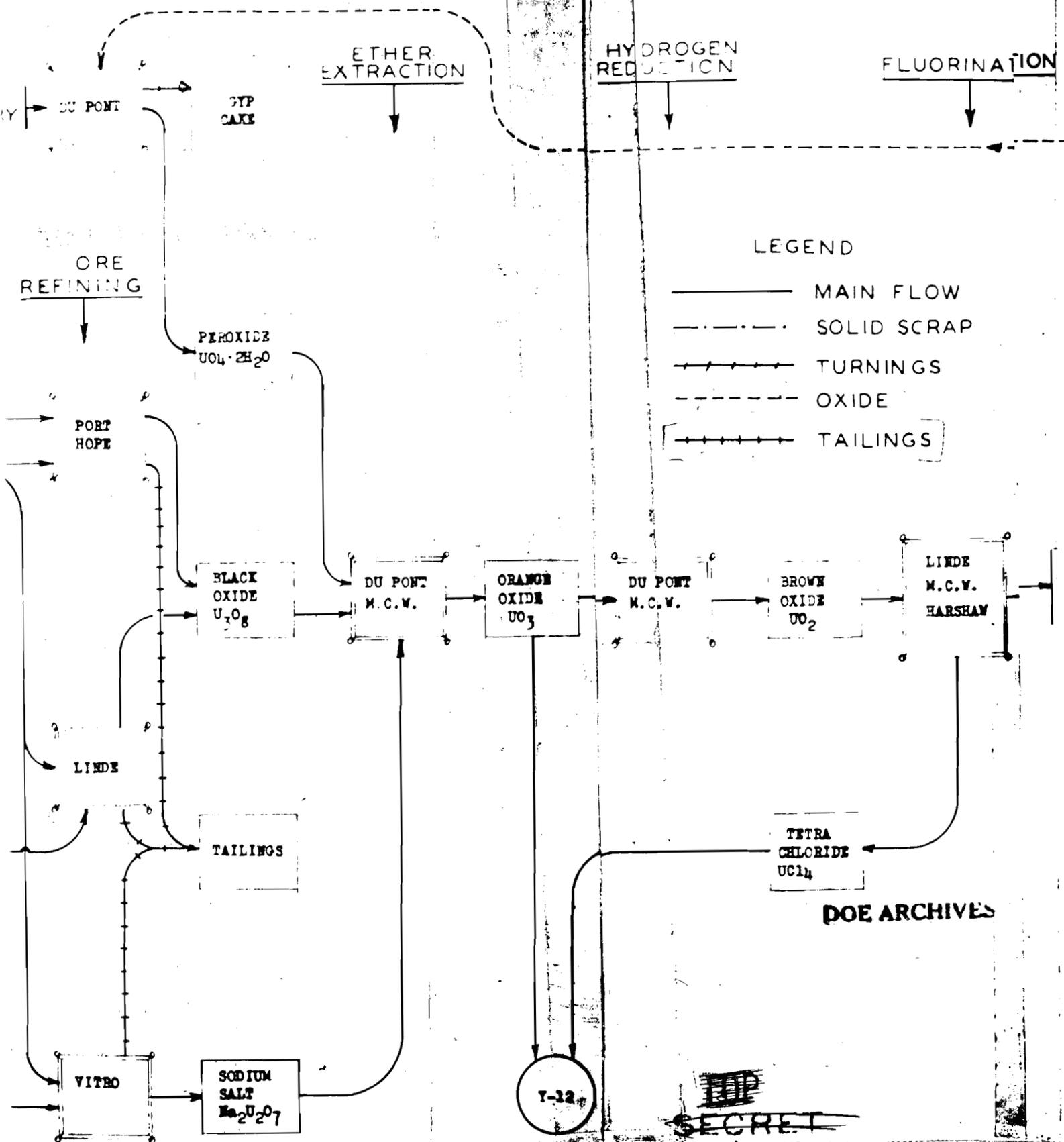
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VI

URANIUM PRODUCTION FLOW DIAGR



LEGEND

- MAIN FLOW
- - - - - SOLID SCRAP
- +++++ TURNINGS
- - - - - OXIDE
- +++++ TAILINGS

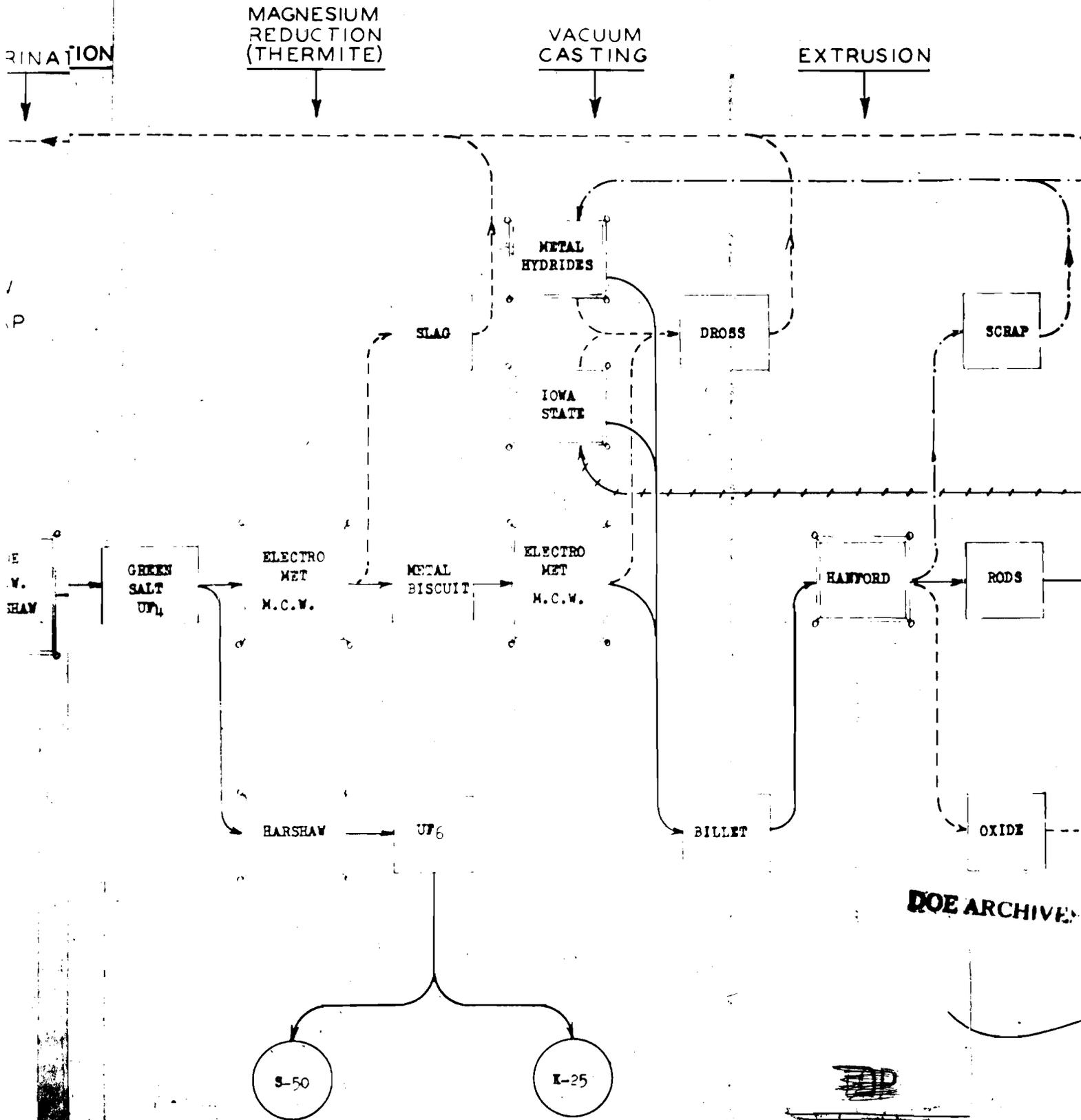
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DIAGRAM (JAN. 1945)

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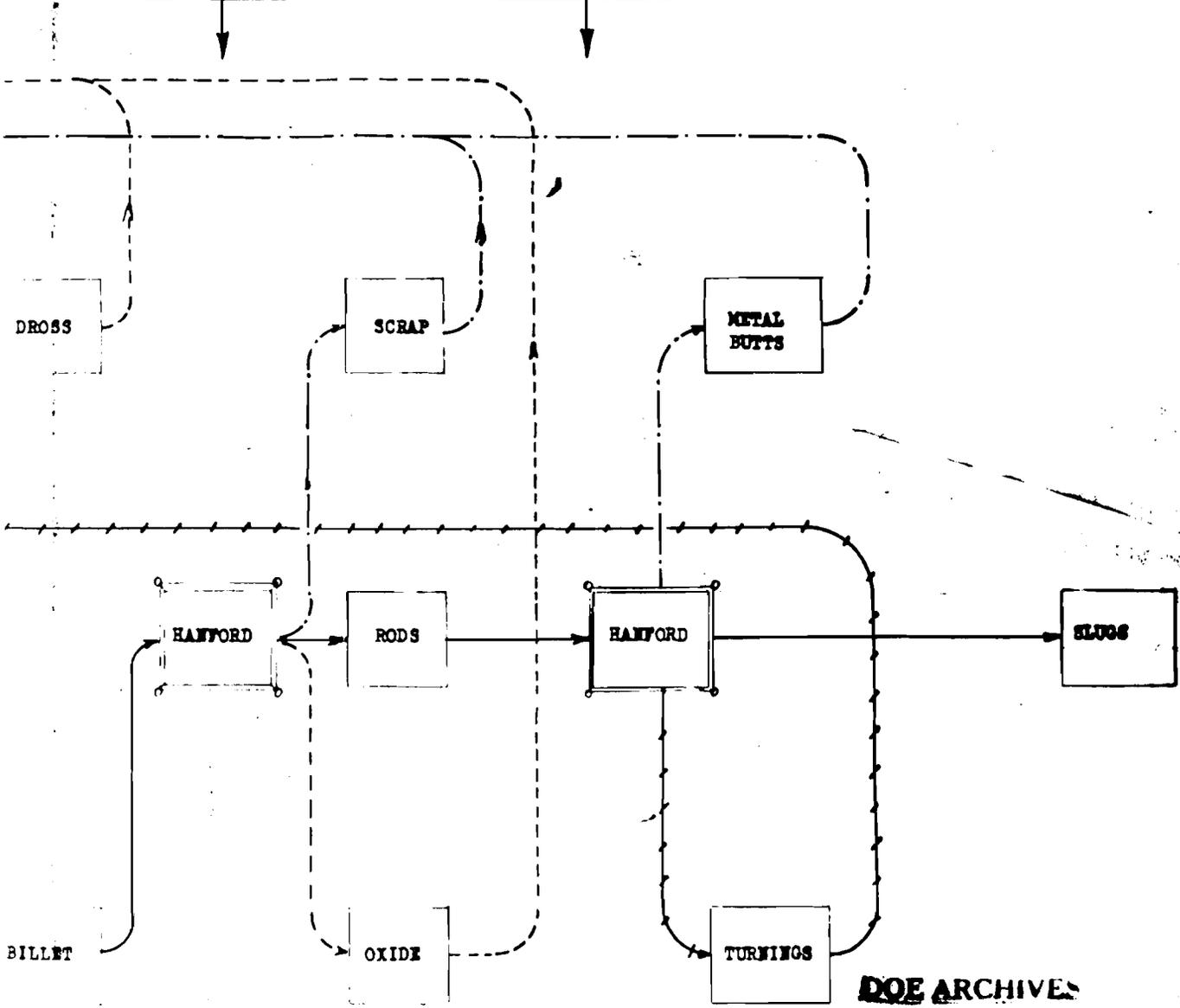
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No. 1

EXTRUSION

MACHINING



BILLET

DROSS

HANFORD

RODS

OXIDE

SCRAP

HANFORD

TURNINGS

METAL BUTTS

SLUGS

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SUMMARY

REFINING OF ORES AND CONCENTRATES

To 1 January 1948⁷

<u>Contract Number</u>	<u>Date of Contract</u>	<u>% U₃O₈ in Ore (Approx.)</u>	<u>Total Tons U₃O₈ in Ore (Approx.)</u>	<u>Tons U₃O₈ Recovered To Date</u>
ELDORADO CONTRACTS:				
N-7405 eng-6	10/21/42	6	73	68
N-7405 eng-17	10/17/42	25	1,251	1,164
N-7405 eng-20	11/24/42	32	48	46
N-7405 eng-264	10/25/43	20	168	160
N-7405 eng-251	1/15/44	20	54	52
N-7405 eng-251	1/15/44	30	111	105
N-7405 eng-318	9/1/44	20	76	71
N-7405 eng-318	9/1/44	26	74	69
N-26-021 eng-21	7/30/45	20	29	27
N-26-021 eng-26		65	75	70
African Ore			1,959	1,832
N-7405 eng-145	5/22/43	30	222)	
N-7405 eng-252	9/11/43	30	532)	687
N-26-021 eng-6*		30	344	20
Stone & Webster Purchase Order 135	7/15/42	30	172	140
Canadian Ore			1,270	862 847
ELDORADO TOTAL			3,229	2,638 2,679
VITRO CONTRACTS:				
N-7405 eng-21	12/24/42	65	66	63
N-7405 eng-251	9/1/43	65	393	379
N-26-021 eng-16	5/13/45	65	164	158
African Ore			623	600
N-7405 eng-54	4/20/43	38	3	3
N-26-021 eng-7	1/1/45	50	144	141
N-26-021 eng-24			26	24
Western Ore			173	168
VITRO TOTAL			796	768
U. S. VANADIUM CONTRACT:				
N-7405 eng-32	1/25/43		875	(881A)

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No. P 7

SUMMARY

REFINING OF ORES AND CONCENTRATES

To 1 January 1948⁷

Total Tons U ₃ O ₈ in Ore (Approx.)	Tons U ₃ O ₈ Recovered To Date	U ₃ O ₈ Refining Cost To Date	Other Refining Costs	TOTAL
75	68	\$ 83,900	\$ --	\$ 83,900
1,251	1,164	1,418,600	--	1,418,600
48	48	37,500	--	37,500
168	160	392,090	231,170	623,260
54	52	127,450	--	127,450
111	105	126,820	18,800	145,620
76	71	116,210	--	116,210
74	69	106,210	34,220	140,430
29	27	44,820	10,560	54,820
75	70	75,460	--	75,460
<u>1,969</u>	<u>1,832</u>	<u>\$2,528,560</u>	<u>\$ 294,750</u>	<u>\$2,823,310</u>
222)				
552)	687	\$ 829,360	\$ --	\$ 829,360
344	20	40,000	--	40,000
<u>172</u>	<u>140</u>	<u>237,600</u>	<u>--</u>	<u>237,600</u>
1,270	862 847	\$1,106,960	--	\$1,106,960
3,229	2,695 2,679	\$3,635,520	\$294,750	\$3,930,270
66	63	\$ 83,500	\$ --	\$ 83,500
393	379	498,900	--	498,900
164	158	199,500	--	199,500
<u>623</u>	<u>600</u>	<u>\$ 781,900</u>	<u>\$ --</u>	<u>\$ 781,900</u>
3	3	4,500	--	4,500
144	141	218,900	--	218,900
26	24	198,150	--	198,150
<u>173</u>	<u>168</u>	<u>\$ 421,550</u>	<u>\$ --</u>	<u>\$ 421,550</u>
796	768	\$1,203,430	\$ --	\$1,203,430
875	(881A)	\$4,871,140**	\$238,390**	\$5,109,530**

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SUMMARY

REFINING OF ORES AND CONCENTRATES

TO 1 JANUARY 1946⁷
(Continued)

<u>Contract Number</u>	<u>Date of Contract</u>	<u>% U₃O₈ in Ore (Approx.)</u>	<u>Total Tons U₃O₈ in Ore (Approx.)</u>	<u>Tons U₃O₈ Recovered To Date</u>
LINDE CONTRACT:				
W-7401 eng-14	11/16/42			
African Ore	11/16/42		1,435	1,338)
Western Ore				964)
Reprocessing Residues				128)
			<hr/>	<hr/>
			6,335	5,891 5,875
			<hr/>	<hr/>

*Deliveries of refined product not complete
**Includes cost of Government-furnished materials
(A) Western ore was concentrated under this contract and delivered to Linde for refining

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SUMMARY

REFINING OF ORES AND CONCENTRATES

TO 1 JANUARY 1946⁷
(Continued)

<u>kg</u> <u>to</u> <u>oz.</u>	<u>Total Tons</u> <u>U₃O₈ in Ore</u> <u>(Approx.)</u>	<u>Tons U₃O₈</u> <u>Recovered</u> <u>To Date</u>	<u>U₃O₈ Refining</u> <u>Cost</u> <u>To Date</u>	<u>Other</u> <u>Refining</u> <u>Cost</u>	<u>TOTAL</u>
	1,435	1,358) 984 : 128)	\$5,074,260**	\$ -	\$5,074,260**
	<u>6,833</u>	<u>5,891</u> <u>5,875</u>	<u>\$14,784,350</u>	<u>\$533,140</u>	<u>\$15,317,490</u>

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act and delivered to Linde for refining

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