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Date of request 9/14/95 Expected receipt of document 10/14/95

Document number K2-453 ^{K/EM-340} Date of document 11/15/46

Title and author (if document is unnumbered)

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Date request received 9/21/95

Date submitted to ADC 12/21/95

Date submitted to HSA Coordinator 9/21/95

(This section to be completed by HSA Coordinator)

Date submitted to CICO 12/21/95 1/11/96

Date received from CICO 1/8/96 3/5/96

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K/EM-340

SANITIZED VERSION OF MONTHLY PROGRESS REPORT FOR OCTOBER 1946

(SANITIZED VERSION OF CRD DOCUMENT # KZ-953)

**Compiled by
S. G. Thornton
Environmental Management Division
OAK RIDGE K-25 SITE
for the Health Studies Agreement**

December 21, 1995

**Oak Ridge K-25 Site
Oak Ridge, Tennessee 37831-7314
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
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PLANT RECORDS AND CARBON CHEMICALS CORPORATION
PROCESS DIVISION
PROCESS DESIGN AND DEVELOPMENT DEPARTMENTS

PLANT RECORDS DEPT.
CENTRAL FILES
REC. 41301
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Date: November 15, 1946

MONTHLY PROGRESS REPORT FOR OCTOBER 1946

Submitted by: J. L. Waters
J. A. Connors

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THEORETICAL ANALYSIS DEPARTMENT
MONTHLY PROGRESS REPORT FOR OCTOBER, 1946

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HE - 21 Review of Technical Data

PLANT RECORDS 1080

Examination of the Kellex curves (Kellex Technical Data Book) and verification of the curves through other sources are still in progress. It is expected that the curves on Physical Properties will be in the publication stage within the week.

Work was begun on Section 4 of the Data Book, "Process Variables". A subsection on psi-values was written in rough form, but was abandoned later with the belief that more accurate data will be available in the future. Compilation of data pertaining to flow rates is now in progress. This section includes a tabulation of such items as installed and design permeability, G-74 and C-616 slope factors, barrier area, etc.

HE - 2 Work Conducted at Request of Operating Departments

A. Separation Performance Studies

1. Concentration Gradients in the 302 Section. A study has been completed of the concentration gradient in the 302 Section under various abnormal operating conditions. This study was made as part of the problem of determining limitations, from the standpoint of critical hazards, on the use of the K-302-5 Cold Traps. The results indicate that the concentration at the top of 302-5 may reach _____ when the cascade is split for a long period of time (several days) at the top of 302-5.
2. Use of Waste Materials as Feed. A series of curves have been developed which give Product rate vs. Feed Concentration, and Waste Concentration vs. Feed Concentration at various feed rates for 412500 and 46000 production. These curves may be used to determine the feasibility of recycling waste material through the plant. If the present K-27 waste material is used for feed at a rate of 3600 Kg T/day, the plant should produce about 75% as much X at 412500 as with 1300 Kg T/day normal feed, and about 74% as much X at 46000. In the case of 412500 production, the present waste would be stripped to about 23025 after being recycled as feed five times at a rate of 3600 Kg T/day. For 46000 production it would require only 4 cycles to reduce the material to about the same concentration.
3. Predicted Productivity at 412500 Operation. The curves of report No. 2.8.11, "Predicted Performance of Combined Plants at High Product Concentrations", which apply to 412500 production have been extended to feed rates as high as 5200 Kg T/day. At a feed rate of 5200 Kg T/day of normal material, the best feed point is in _____ and the product rate is about 18% higher than that obtained with a feed rate of 1300 Kg T/day.

B. Statistical Studies

1. Overall Material Balance on T and X. A study of the precision and accuracy of the stage pressure recorders shows that there is no apparent increase with time in the amount a given recorder is off-calibration.

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A study of the precision and accuracy of the changes in control-valve angles between inventories shows that the changes between building averages agree very closely with what would be expected from the changes within each building. This result implies that there is no building-wise factor affecting changes of control-valve angles. Certain buildings, mostly at the ends of sections, show much larger variability in changes of control-valve angles with time than do the majority.

The uncertainty in $\Delta X_{E,C}$ (the change in Enriched X Inventory in the Cascade) has been calculated for the case of 49000 production. The variance in $\Delta X_{E,C}$ is equal to 0.8 times the square of the fractional confidence limit on the C-616 in the cascade. Thus, if the latter figure is ± 0.2 , the variance in $\Delta X_{E,C}$ is 0.03, which is a considerable fraction of its total allowable variance.

2. Analysis of Plant Productivity. Tests are being run, at the request of the Statistics Section, to determine the effect on waste assays of agitation of the waste drums; to determine the feasibility of weighing feed drums on the waste scales to eliminate bias; and to determine the feasibility of by-passing waste accumulators in waste withdrawal.

Sample points are being installed in interplant lines so that a third measure of productivity may be obtained from the flows and concentrations in these lines.

Daily productivity during the period of 49000 production was highly variable. Nineteen out of twenty daily values lay within $\pm 20\%$ of the average for the period.

A proposed schedule of operations for the 412500 test period was outlined and reported in Report 2.7.9 listed below. This schedule was drawn up in an effort to secure the best possible production data during the test and to determine, by means of the changes in pressures, accurate size-factor data.

3. Statistical Methods. The hyperbolic equation of Psi vs. Tails Pressure for a section contains two constants. These were determined for the new Psi-values obtained from building tests and analyzed by the C-Laboratory. This study showed that there are some errors in the Psi-curves presented in the New Bases Memo (Report 2.8.11). These errors, however, have a negligible effect on the predicted plant productivity.

It was shown that the most precise predictions of psi throughout a pressure range are given when the experimental data are taken at the ends of the pressure range.

- C. Study of Major Revisions and Additions to the Gaseous Diffusion Plant. (An Engineering Development Request, HE-28, was approved for this work on November 8, 1946).

1. Increasing Plant Production. A report has been published concerning "A Program for the Study of Methods of Increasing Plant Production". The following methods are discussed: Replacement of barrier, modifications in present equipment, additional stages at top or bottom of cascade, and other separation methods. These studies will evaluate the proposals from the points of view of productivity, cost, time, and complexity. Specific projects have been suggested for the various Sections.

2. Single Cascade. A study of the performance of a single, rather than overlapped, cascade composed of the K-25 and K-27 Plants, has been completed. The major assumptions were: (1) Section 400 (K-27) assumed to be inserted between Sections 301 and 309; and (2) unrestricted intersectional flow. The results are summarized as follows:

<u>Product Purity</u>	<u>Percent Increase in Product Rate</u>
411500	4
412000	2
412500	1.5

3. Increase in Productivity by the Use of the S-50 Plant. A productivity study of the combined operation of the S-50, K-27 and K-25 Plants at 412500 product purity has been completed, taking into account the limitations imposed by power availability. The study indicates that an increase of 2% in the K-25 product rate may be obtained by using S-50.
4. Plant Overlap. A shorter method for stage-wise determination of optimum plant overlap and interplant flow for the K-25 and K-27 Plants has been developed. This optimization of plant operating conditions is required for studies involving evaluation of relatively small changes in productivity in order that productivity changes will not be "masked" by non-optimum operating conditions.
5. C-816 Separation. The process design of a fractional distillation unit for removal of C-816 from the main cascade at or near Building K-301-4 has been completed. The system consists essentially of a "W" Type Pump, a distillation tower, and associated auxiliary equipment. Calculations based on vapor-liquid equilibrium data determined by the Fluorocarbons Department of the Research Laboratory indicate that the system will lower the concentration in Plant 1 to less than 1% C-816, and that the material removed will contain 1% C-816. The equipment required is, for the most part, available at the plant.
6. Separation of the Isotopes of Elements other than Uranium. Calculations are being made for the production of various isotopes, such as C-13, C-14, O-18, etc., using the spare K-312 building and/or the 20-Stage Pilot Plant. This spare equipment, which cannot be used for U-235 production, could be used to accomplish valuable enrichments of these and other isotopes, particularly if the product is recycled through the stages a number of times.
- D. Stage Properties. The power per cell as a function of tails pressure was predicted from stage properties and circuit balances for each section of the plant for 60-60 and 65-65 cycle operation. In most cases, the results were in good agreement with the available experimental data. It is hoped that more of the curves can be confirmed by experimental data before publication.

Reports Issued:

1. "Synthetic Standards", 2.19.8, J. P. Kelly, 10/1/46.
2. "Effect of Differential Changes on Productivity at 412000%", 2.4.3, W. G. Siedenbug, 9/24/46.
3. "412500 Production at High Feed Rates", addendum to Report 2.8.11, E. Usdin, 10/9/46.
4. "Selection of Barrier for Whitehead Converters", 2.21.5, J. P. Kelly, 10/9/46.
5. "Test of Normality", 2.31.4, H. H. Stotler and C. Daniel, 10/9/46.
6. "Fitting a Straight Line", 2.31.1, H. H. Stotler, 9/9/46.

Reports Issued: (continued)

7. "Bases for Calculation of Plant Performance", 2.8.14, Newman, Levin, Wood and Barnes, 10/10/46.
8. "Proposed Schedule of Operations for the Period October 25, 1946-December 15, 1946", 217.9, G. A. Garrett and C. Daniel, 10/21/46.
9. "Concentration Gradient in 902 Section under Various Conditions of Operation at Product Concentration of 412500", W. G. Sidenburg, 10/24/46.
10. "A Program for the Study of Methods of Increasing Plant Production", J. L. Waters, J. Shaster and J. A. Finneran, 9/23/46.

DESIGN AND DEVELOPMENT DEPARTMENT
MONTHLY PROGRESS REPORT FOR OCTOBER 1946

R. B. Korameyer

P. R. Vanstrum
A. A. Abbatiello

Compiled by: J. A. Martin

HE - 10 Development of a Dry Vacuum Pump

Detailed drawings of a dry vacuum pump have been completed and special parts required for the assembly of a test model have been ordered from outside vendors. The design of a test loop for the pump has been started.

HE - 13 Tests on Valley Iron Works (Type R) Pump

Ten pumps in K-312-1 are being equipped with Hi-grade Flour-Carbon/S-S seals to permit a more accurate comparison of their performance with that of the standard bellows assembly. The carbon seals will also permit the pumps to be operated at higher speeds.

The carbon seal tests on the V.I.W. test loops have been discontinued inasmuch as test data can be obtained from the K-312-1 installations.

HE - 14 The Viscosity Seal Development Program

A.

Work on

The instrumentation for the blower test stands to be used in testing seals is in progress, and the installation of a vacuum system for the seal exhaust and purging is about 50% complete.

Pressure-clearance curves for the seal have been established.

Insulated seal flanges for use in electrical measurements of seal clearance in process gas have been designed and fabricated.

B. Plant Investigations.

1. G-74. A study of the G-74 inleakage and concentration to be expected for 412500 operation has been made and a report issued containing the results of this investigation together with recommendations for the seal feed pressures in K-25 and K-27.

A report has been issued giving estimates of the saving in G-74 consumption during a constant frequency failure which may be expected if the G-74 supply is maintained at lower gage pressures. Estimates were also made as to the maximum pressure drops to be expected in the G-74 lines during a constant frequency failure.

2. Belville Gaskets. A preliminary analysis of the operating life of Belville gaskets indicates that the expected life of neoprene gaskets is in the neighborhood of 240 days.
3. Inspection of Failed Seals. During the month a total of 89 seals were removed from process. Seven were "L" type and 82 were "H" type. The seals were inspected and classified according to the following categories:

Failed Parts Not Evident	10
Melted Solder	16
Heavy Wear and Corrosion	63

HE - 17 Recovery of C-616 from Conditioning Gases

Work on this account is being postponed pending possible revision in the present unplugging method.

HE - 18 Development of Equipment for Recovery of "T" from Waste Process Materials.
(This account was closed on November 1, 1946, and a new Engineering Development Request, HE-29 was submitted to cover additional recovery problems which have arisen).

- A. Recovery of "T" from Carbon. The large furnace was run continuously from 10-4-46 until 10-11-46. During this period, 25,000 lbs. of carbon/alumina mixture were processed. Approximately 1200 lbs. of ash were obtained with an average carbon content of less than 0.5% by weight. Samples have been sent to the Laboratory for "T" analyses in order to determine the material efficiency obtained.
- B. Recovery of "T" from High Assay "Green Salt". A total weight of 1669.67 gms. of high purity T_2O_3 were obtained from the recovery of 2170 gms. of contaminated "green salt" (assay - 66000). The salt was converted to ammonium diuranate by this department and the diuranate was then converted to T_2O_3 by the Trouble Shooting Section of the Laboratory Division.

HE - 22 Fabrication of MFP-10

The 50 ton press has been placed in operation to mold MFP-10 for the valve seat program. Approximately 200 valve seats of various sizes have been molded and machined. An inspection program has been instituted for the finished seats. Present results of this inspection show 10 to 15% rejects.

A total weight of 1620 gms. of P-10 was molded in sheets of various sizes to fill special orders.

HE - 23 Pilot Plant

The twenty converters were stabilized on a furnace stand, and installed in the pilot plant. The system was vacuum tested to a leak rate of less than 10 mcfh.

The plant has been operated on G-74 and is ready for test runs using C-616.

(The first run and psi test on C-616 was made on November 3 and subsequent runs were made during the weeks of November 4 and November 11. Several "W" pumps have been replaced because of leaks and improper clearances under certain operating conditions. It was found that a design change in the control valves is necessary to obtain proper control stability over the full range of pressures).

A total of four of the redesigned W-pumps have been installed in the pilot plant. On test these pumps gave a 50% volumetric efficiency at a 3.3 to 1 compression ratio with discharge pressures up to 16 psia.

HE - 24 Gas Bearing Blowers

- A. 1200 CFM Loop. Process piping and coolant systems are essentially complete. The enclosure is complete except for a ladder and some minor details. Instrument panels have been erected and about half the instruments have been mounted.
- B. CSV Life Test Loop. The instrument panels have been erected.
- C. Services. Electrical services are essentially complete but have not been released by the Electrical Department.

HE - 26 Consumption Studies

- A. K-312-2-3 Process Equipment. Upon dismantling one of the two Whitehead units which were removed from K-312-2-3, a collection of gray-black powder was found at various points within the converter. In addition a layer of the same material was adhering to the barrier facing.

In the case of the second unit, about 200 grams of the gray-black material was removed by shaking the entire Whitehead unit.

A Valley Iron Pump from the same cell has been disassembled. Mechanical scoring in conjunction with considerable chemical corrosion was noted on the steel shaft at the point where it passes through the bronze sleeve bearing.

Present on the bottom valve plate was an appreciable quantity of a dull olive-green powder apparently removed mechanically from the shaft since the greater portion of the corrosion material on the shaft was largely of this same color, the rest being black at the time of disassembly. These observations are in accordance with similar ones made with other equipment when it was noted that black deposits gradually acquired a green color on exposure to the moisture in the air. Such a change is normal and is explained by the hydrolysis of a black reduction compound of FG.

The black material removed from the Whitehead converters does not change color on lengthy exposure to water, suggesting that the pump is not the source of the material.

HE - 27 Converter Unplugging Studies

Work on the miniature test loop has been resumed and preliminary runs with G-74 are underway.

HE - 2 Work Conducted at the Request of Operating Departments

- A. TF₄/PTFE Cubes. A total weight of 7509 gms. of green salt (630700 assay) and 1200 gms. of PTFE were mixed, ground, and molded into 100, one-inch cubes. Eighty of these were crushed to 20 mesh size and the powder was transferred to the Cascade Services Department for experimental work. The other cubes are being used to study material efficiency during grinding.
- B. Fluorinator for T₃O₈ Containing Carbon. The construction work has been completed on the experimental fluorinator for determining the maximum safe percentage of carbon that may be fluorinated with T₃O₈.
- C. Water Corrosion. Results of tests conducted jointly by the Water Department and the Chemical Development Section showed that the deposits in the K-27 Coolers can be removed by acid treatment of the water. The tube deposits in K-27 were found by analysis to consist chiefly of calcium and magnesium phosphates, whereas the deposits in the K-25 tubes are chiefly mud and clay. Pit depth measurements made by E.T.&I. have been made on 12 cooler shells which were removed from process. Two of these had maximum pit depths of 0.122" and 0.13", respectively, while the remaining 10 had maximum pit depth of not more than 0.080".
- The following experimental program has been set up in an effort to find the best method for preventing or minimizing cooler shell corrosion.

1. Galvanic Protection

- a. Cathodic. Three electrodes are being installed in a Size No. 2 cooler, to be located in K-25, so that a reverse electrical current can be applied.
- b. Zinc Strips. Zinc strips are to be installed in a new cooler, to be placed in K-25, with the zinc in contact with the cooler head.

2. Deactivation of Water. Iron turnings are to be placed in the two water filters located at the front of a process building in order to remove dissolved oxygen.

3. Coating Shells with Plastic. Two new cooler shells are to be coated on the inside with plastic before being placed in service in K-25.

D. Recovery of Plugged Converters. Eight plugged converters were treated with C-216 in the K-1401 furnaces. A tabulation of the results is shown below:

Converter	Removed From	Plug %	Reconditioning Treatment			Final Plug
			Time (Hrs)	Temp. Op.	C-216 %	
D-254	306-7-6.1	52.2				13.2
D-7	306-7-4.5	15.8				6.2
D-258	306-7-12.1	8.1				6.2
D-265	306-7-4.1	34.1				10.0
D-62	306-7-4.6	71.3				13.2
D-410	306-2-13.3	35.8				14.8
D-340*	306-2-13.5	40.0				26.7
D-428*	306-2-13.2	37.7				19.8

* These two converters will be given additional C-216 treatment.

The calculated C-216 plug (last column) is that which was added by the C-216 treatment. Accordingly, the residual "T" plug would be the difference between the C-216 plug and the final plug.

E. Testing of Stored Converters Which had Previously Been in the Cascade. Tests on six converters which had been exposed to FG in the cascade show that any plug acquired during storage can be removed by treatment with C-216.

F. Furnace Stand Determination of Plug of Normal Converters. The porosity of four converters, which were removed from K-310-2 with normal plugs, was measured on the furnace stands to determine the percent plug. The results are shown below.

Converter Number	From (Position in Cascade)	Time in Service (Months)	Percent Plug	
			Furnace Stand	Cascade Measurement (average for building)
B-131	310-2-3.1	22	4.4	2.94 ± .74
B-142	310-2-3.6	22	2.6	"
B-169	310-2-7.3	22	0.5	"
B-245	310-2-7.5	22	2.5	"

G. Flash Conditioning Test on Cell 7, K-310-3. After replacing the six converters in 310-3-7 During the conditioning period, 67 gas samples were obtained in order to find out the change in C-216 concentration with time.

From the above data and a knowledge of the loss in "X" versus off-stream time, the optimum conditioning periods for each No. 2 size section of K-25 and K-27 were calculated.

Assuming that all No. 2 converters acquire the same amount of moisture during storage, the following flash conditioning times were recommended for the following buildings at 312000 operation:

<u>Buildings</u>	<u>Recommended Conditioning Time, Hours</u> <u>(after replacement of a complete cell of converters)</u>
402-1 thru 5	
402-6 thru 8	
402-9	
310-1 thru 3	
302-1 thru 5	
303-1 thru 10	

H. Psi Test on K-305-10. A Psi test was run on K-305-10 on Oct. 9th and 10th 1946. Samples were taken at the following tails pressures: A total of 42 stages were included in the test.

I. Effect of Changes in Tails Pressure on Determination of Normal Plug in K-27. The K-27 normal plugging rate appears to be twice that of K-25 and since pressures in K-27 have been changed since start up, some doubt existed as to whether or not the equation for plugging rate held at different pressures. The data obtained on K-402-8 indicate no significant difference in calculated plug at different pressures. The data follows:

<u>Date</u>	<u>No. of Readings</u>	<u>Normal Plug, %</u>
Oct. 6-10	260	4.32 0.72
Oct. 20-24	255	3.60 0.72
Oct. 23	228	3.60 0.72

J. Mobile Product Withdrawal Unit. Preliminary drawings have been completed, showing the arrangement of equipment for a product withdrawal unit. This unit will be similar to the permanent installations now in use, except that it is planned to use mechanical refrigeration in place of L-28. Tests are in progress to determine if this is practical with the refrigeration equipment available.

K. Seal Exhaust Hazards. Boron shields have been designed for installation in the seal exhaust traps where critical quantities of "T" could accumulate. These shields provide protection against hazards by dividing the trap charge into four equal portions. Each portion of the charge can absorb only a safe quantity of "T" and reaction between portions is prevented by a separating wall of boron carbide or borax contained in the shield.

L. Nomograph for Plant I Purging. A nomograph has been prepared to facilitate the selection of optimum conditions for purging the isolated sections in Plant I following a power failure. The nomograph includes the maximum permissible concentration of C-616 in the purge gases from a given section corresponding to a selected purge rate, and the number of stages required to effect the necessary separation. The design of the nomograph is based on a

"B" value for G-74 of 1.225 and a maximum tolerable "rate of X" loss in the purge gases of 0.05% of the normal "X" production rate at 412000 operation.

- M. Size Factor Determination for Size 2, 3, and 4 Equipment. A procedure for securing the necessary data for the accurate determination of size factors for size 2, 3, and 4 equipment during the 412500 test period, (see proposal in the Theoretical Analysis Department report 2.7.9, "Proposed Schedule of Operations for the Period October 25, 1946-December 15, 1946"), has been worked out and approved by Operations. The data will be taken during the period of total reflux prior to 412500 operation. The data for each factor consists of a series of inventories taken before and after a major pressure change in a group of equipment of one size.
- N. Recommended Operating Stage Temperatures for 412500 Operation. In view of the importance of consumption during 412500 operation a revised schedule of stage temperatures, lowered because of the lower stage pressures, has been recommended for this period.
- O. Optimum Conditions for Tops Purge. In cooperation with Operations a study was made to determine the most efficient method of effecting the tops purge operation from the standpoint of productivity and operating cost. Economic balances indicate that:
1. The optimum tops concentration in 306-7 for combined operation with 312-1 is 99% G-74.
 2. The purge gas from the top of 306-7 cannot be stripped of its C-616 economically by sending it to the side purge building.
 3. The most economical tops purge operation is accomplished when recommendation 1. is followed and half of the cells in 312-1 are shut down.
- It was concluded that the only way to reduce further the operating cost of the tops purge would be to carry out the purge and product removal operations in the same unit.
- P. C-816 Concentration in Cascade at Low Operating Pressures. A study of the C-816 gradient in the cascade is described and the reasons for its shape discussed. Corroboration of the theories presented was obtained when a C-816 leak occurred in 402-3.9 on October 28, 1946. A total of sixty pounds of coolant leaked into the cascade of which all but four pounds moved to above 301-4 within four days.
- Q. Product Withdrawal. The redesign of the copper plug now in use in the product withdrawal cylinder has been completed for a tops concentration of 125000. Tests are now being conducted to determine the feasibility of cooling the product withdrawal cylinders by mechanical refrigeration.

Reports Issued:

1. "A New Type Reactor for the Conversion of T_2O_8 to C-616", 3.115.1, Mirkus, Schmidt, 10/2/46.
2. "K-27 'B' Pump Motor Cooling Tests", 4.76.1, (Progress Report), Abbatiello, Janney, Piper, 10/15/46.
3. "Power Requirements for Section K-306 at Optimum Pressure for 412000 Operation and for Additional Cells at the Same Conditions", 3.118.1, Harvey, 10/18/46.

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Reports Issued: (continued)

4. "Saving in G-74 Consumption During Constant Frequency Failure for Different Seal Feed Pressures with a Recommendation for Minimum Pressure", 3.119.1, Grabowski, Kushner, 10/9/46.
5. "Pilot Plant No. 4", 3.32.1, Farber, et al, 10/17/46.
6. "Recommended Stage Temperatures for 412500 Operation", 3.128.1, Crites, 10/25/46.
7. "Average Consumption Rates No. 3 Pumps", 1.73.16, Coughlen, 11/1/46.
8. "G-74 Inleakage and Concentrations at Current Pressures and Pressures proposed for 412500 Operation", 3.107.1, Olson, 9/19/46.
9. "Limitations in the Use of K-302-5 Cold Trap Rooms", Abbatiello, 10/21/46.
10. "Testing of Stored Converters for Moisture Plug", 3.123.1, Nicol, 10/28/46.

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