DECLASSIFIED

HW--27318

DE93 002079

RECORD

- #1 - HA Carlberg
- #2 - RH Beaton
- #3 - CW Harrison
- #4 - TW Hauff
- #5 - RT Jaske
- #6 - EP Lee - FAR Stainken
- #7 - WK MacCready
- #8 - JS McMahon
- #9 - JE Maider
- #10 - RO Mehann
- #11 - PH Reinker
- #12 - JH Warren - KT Perkins
- #13 - ET Wells
- #14 - WK Woods
- #15 - Yellow File
- #16 - 700 File
- #17 - 300 File

Classification Cancelled (Change 1)

DECLASSIFIED

By Authority of CG-PR-2

RM Iten 5-12-92

By PM Eick 10-7-92
J.W. Wells - 10-8-92

This document consists of
6 pages. No. 1
of 1 copies. Series A.

COPY 1 OF 1, SERIES A

INSTALLATION OF REACTOR GAS REFRIGERATION SYSTEM - 105-C
PROJECT C-431

March 5, 1953

The data and material for this document were collected and prepared by Mr. R. T. Jaske, Process Engineering Unit.

References:

- I. HW-24895 - "Testing and Operation of "H" Pile Hot Water Recirculation System," J. H. Warren - G. E. McCullough from R. W. Vivian - S. L. Nelson, July 7, 1952.
- II. HW-23342 - "Corrosion of Process Tubes from 100-F," Progress Report to File from R. S. Dalrymple, January 28, 1952.
- III. HW-26521 - "Gas Refrigeration at 100-C," G. M. Roy from C. Sege, December 12, 1952.

RECEIVED

300 AREA
CLASSIFIED FILES

REPRODUCED FROM BEST
AVAILABLE COPY

DECLASSIFIED

DECLASSIFIED

Page -2-

Richland, Washington
March 5, 1953

H. A. Carlberg, Manager
Plant Engineering
HANFORD WORKS

INSTALLATION OF REACTOR GAS REFRIGERATION SYSTEM - 105-C
PROJECT C-431

RECOMMENDATION:

It is recommended that the Design Committee approve the installation of a refrigeration system in the 105-C gas circulation system for removal of moisture from the reactor following a process tube leak as was previously approved by the C-431 Project Committee. Engineering studies show that this refrigeration system is necessary to provide sufficient water removal capacity in order that the water absorbing capacity of the system furnished by the silica gel towers will not be a limit to the rate at which a reactor can be rehabilitated following a serious leak.

SUMMARY:

The need for increasing the effective rate of the reactor gas drying system for 105-C was first realized when the Manufacturing Department utilized the hot water recirculation system at 100-H. It was apparent from this test that the recirculation system was desirable and also that the capacity of the dryers was limiting as reported in Ref. I.

As a result, the Design Section was requested to install the necessary facilities to increase the gas drying rate to the maximum rate at which the moderator could be expected to release moisture. Studies of the problem showed that the hot water recirculation and the refrigeration systems should be incorporated in the 105-C design. Only the former was actually installed due to delay in equipment arrival.

The capacity of the "C" dryers without gas refrigeration is inadequate to remove water at the maximum rate at which graphite can dry during hot water recirculation.

If the hot water recirculation system is used at 85° C to 95° C for graphite drying, the potential drying rate, following a 1000 gallon leak, will be 14 gallons of water per hour. The "C" dryers can now remove a maximum of 10 gallons of water per hour. The addition of a refrigeration unit to the "C" gas system will increase the capacity of the gas drying system to 20 gallons of water per hour.

DECLASSIFIED

DECLASSIFIED

Page -3-

H. A. Carlberg

March 5, 1953

SUMMARY: (continued)

Assuming that a pile will stay down until the total water content decreases to 300 gallons, about \$26,000 worth of increased production can be realized by the use of the gas refrigeration for one 1000 gallon leak. Assuming that, from reactivity considerations, a pile must stay down a minimum of 24 hours or until the total water content decreases to 600 gallons, about \$14,000 worth of increased production can be attributed to gas refrigeration for one 1000 gallon leak. (Ref. III)

The total installed cost of the system was estimated to be \$43,000 using major construction forces. With the present rate of leak occurrences as a basis, this cost can be amortized in from one to three years. No additional engineering work or material procurement is required at this time because the design is complete and the refrigeration equipment, valued at \$12,000 and originally purchased for this installation, is on hand. There are space and equipment provisions in the building and gas system for this installation.

CONCLUSION:

It has been shown in the references that the following conclusions can be drawn, and form a basis for this recommendation.

- A. That the original intent of the design of the hot water recirculation system necessarily includes installation of the refrigerated condenser.
- B. That proper economic justification cannot be made without consideration of the rapid deterioration of the process tubes due to the graphite-aluminum corrosion couple.
- C. Based on information in the references (Ref. II) and (Ref. III) if the condition of the tube corrosion is regarded as being critical, and that the reactor is operated in a way to reduce the water to a minimum by avoiding wet start-ups, the cost of the refrigeration can be amortized by two rapid drying cycles. This is expected to occur in less than two years based on the present rate of leak occurrences.
- D. That the bare ability to start the reactor under wet conditions (not practical with leaks over 600 to 1000 gallons due to insufficient reactivity) is not by itself suitable evidence of the best operating procedure especially if tube corrosion, poison redistribution and integrated losses in production from operating at lower powers for extended periods are considered. (Ref. II, pp. 11 thru 14.)
- E. That the limitation on reactor drying rate should not be the capacity of the dryers but the limit at which the water can be driven from the unit. Reference II

DECLASSIFIED

DECLASSIFIED

Page -4-

• H. A. Carlberg

March 5, 1953

• CONCLUSION: (continued)

clearly shows that the drying capacity of 115-C system is undersized, considering the effects of hot water recirculation, and that this capacity can be doubled for the installed investment of \$43,000. (The estimated cost of the condenser-refrigeration system.) This capacity then exceeds the estimated rate of water evolution by only 30-1/3 percent. No other method of making a material increase in capacity is possible for an equivalent cost.

DISCUSSION:

It is apparent that the magnitude of the leak problem indicates that every reasonable method should be used to decrease these losses. Based on the nominal operation levels of 500 MW, over 75 days or 37,500 MWD of production were lost in a period of 7 months in the past 3 quarters of 1952. Using an amortization value of \$20,000 a day for the older units, this totals \$1,500,000 in losses over this period.

The history of reactor drying has been largely parallel to that of the ruptured slug problem. The first leak of any magnitude occurred at 105-F in November, 1948, allowing 1200 gallons of water to enter the unit and causing the loss of 17 1/2 days of production (4250 MWD). Various expedients have been attempted since that time to shorten this very long delay, none of which produced outstanding success until May, 1952, when the hot water recirculation system was first used at 105-H.

In the data collected at F Area, evidence was noted that velocity of gas flow had some effect on the over-all drying rate where some free water exists in the passages. • New design for H and C took account of this effect by including extra blower capacity • (up to 5 times normal flow). The over-all rate of drying was still not anticipated to be above 5 gallons per hour even taking into account the possibility of reaching graphite temperatures as high as 50° C which might be obtained by fission product heating.

Early in the C program, studies were initiated to determine what actual limits could be used for the design of a highly efficient moisture removal system. Contracts let with the University of Washington and some local work produced sufficient data to recognize that the graphite temperature was a controlling element in the drying process. The results of these studies and the successful operation of the hot water recirculation system at 100-H were used as a basis for installing the hot water recirculation system and designing the gas refrigeration system.

At this point, it was recognized that the dryer capacity was limiting even in the C installation. There were three possible ways to increase this capacity, either increase the dryer size, add more units, or produce an equivalent effect through refrigeration. Since the first two possibilities were not practicable, both schedule and cost wise, the latter solution of condensing the excess moisture was proposed. The cost was a small part of the over-all cost of improved drying.

DECLASSIFIED

DECLASSIFIED

Page -5-

H. A. Carlberg

March 5, 1953

DISCUSSION: (continued)

already provided in the form of hot water recirculation, and higher gas flow. The design was prepared accordingly and is now complete, provisions having been made in the building design.

No discussion of this problem of drying is complete without considering the effects and causes of tube corrosion. Briefly, Document HW-23342 can be reviewed and the following information obtained. In this report, the corrosion resulting when 28 aluminum is coupled to graphite in tap water at both room and elevated temperatures is outlined. At elevated temperatures (99° C) the corrosion is as follows:

<u>Time</u>	<u>Uniform Corrosion</u>	<u>Pitting Depth</u>
24 hours	0.16 mils	None
48 hours	0.27 mils	None
72 hours	0.36 mils	None
120 hours	0.46 mils	None

At 25° C the uniform corrosion is less, but the pitting is severe.

<u>Time</u>	<u>Uniform Corrosion</u>	<u>Pitting Depth</u>
24 hours	0.06 mils	1 mils
68 hours	0.12 mils	1.5 mils
94 hours	0.16 mils	2 mils
139 hours	0.26 mils	6.8 mils
168 hours	0.36 mils	7.1 mils
216 hours	0.44 mils	7.3 mils

On the basis of the above figures and other conformatory results later obtained, it is apparent that both uniform corrosion and pit depth are a definite function of time and any action that will result in a lesser time of reactor core drying is very desirable.

In order to demonstrate the magnitude of the problem at hand, a list of process tube leaks and the MWD production loss is listed below. This list covers only the period from January 1, 1952 to October 7, 1952.

<u>Date</u>	<u>Tube No.</u>	<u>Water Gallons</u>	<u>MWD Prod. Loss</u>
1-11-52	3763-DR	957	6537
2-2-52	2180-H	601	1039
2-11-52	0285-F		
	0386-F		
	0486-F	126	3658
	0690-F		
	0990-F		
	1251-F		

DECLASSIFIED

DECLASSIFIED

HW-27318
Page -6-

H. A. Carlberg

March 5, 1953

DISCUSSION: (continued)

<u>Date</u>	<u>Tube No.</u>	<u>Water Gallons</u>	<u>MWD Prod. Loss</u>
3-27-52	3565-H	320	1084
4-13-52	3088-H	58	124
4-25-52	0463-F	112	1694
	0885-F		
5-4-52	2062-B	0	1048
5-16-52	3261-H	1031	4286
6-5-52	3573-B	150	1957
6-6-52	2683-H	864	2413
6-10-52	1170-H		
6-23-52	0887-F	44	1524
7-5-52	3189-H	185	959
7-8-52	0867-F	101	1263
7-12-52	3670-F	532	1509
7-19-52	1475-F		
	3668-B	335	1988
	3883-F		
8-6-52	4068-F	171	2714
8-8-52	3175-D	153	1243
8-15-52	3293-B		
	0569-B	378	1364
	2252-B		
	2660-B		
8-26-52	1692-D	125	1525
9-19-52	4376-H	None	50
10-7-52	0585-F	None	550

H. J. Wells
Contact Engineering
REACTOR SECTION

HT Wells:vjm

DECLASSIFIED

**DATE
FILMED
01/08/93**