1 of 1

DECLASSIFIED

SERIES AND COPY NO.

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

DATE _____

January 30, 1964

RESTRICTED

THIS DOCUMENT CONTAINS UNCLASSIFIED DATA AS
DEFINED BY THE NATIONAL ENERGY ACT OF 1954.
ITS TRANSMISSION IN ANY MANNER TO ANY OTHER
PERSON IS PROHIBITED.

TITLE

EFFECTS OF CORROSION UPON THE ADEQUACY OF THE
105-KE and 105-KW EMERGENCY COOLANT BACKUP
SYSTEM

AUTHOR

D. F. Watson

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.

CIRCULATING COPY
RECEIVED 100 D AREA
MAR 4 1964
RETURN TO
TECHNICAL INFORMATION FILES

THIS DOCUMENT MUST NOT BE LEFT UNATTENDED OR WHERE AN UNAUTHORIZED PERSON MAY HAVE ACCESS TO IT. WHEN NOT IN USE, IT MUST BE STORED IN AN APPROVED LOCKED REPOSITORY OR IN AN APPROVED GUARDED AREA. WHEN IT IS YOUR POSSESSION, UNTIL YOU HAVE OBTAINED A WRITTEN RECEIPT FROM THE CLASSIFICATION OFFICE, IT IS YOUR RESPONSIBILITY TO KEEP IT AND ITS CONTENTS WITHIN THE LIMITS OF THIS OBJECT AND FROM ANY UNAUTHORIZED PERSON. ITS TRANSMISSION, AND STORAGE AT YOUR PLACE OF RESIDENCE IS PROHIBITED. IT IS NOT TO BE DUPLICATED. ADDITIONAL COPIES, IF REQUIRED, OBTAIN THEM FROM THE CLASSIFICATION ISSUING FILE. ALL PERSONS READING THIS DOCUMENT ARE REQUESTED TO SIGN IN THE SPACE PROVIDED BELOW.

ROUTE TO:

PAYROLL NO.

LOCATION

FILE	ROUTE	DATE
100-443888-100	100-443888-100	100-443888-100

SIGNATURE AND DATE

R. T. Jessen
A. P. Larrick

1445	1704 H
21424	1704

MAR 4 1964

MAY 12

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DECLASSIFIED

(CLASSIFICATION)

HW-80626

This document classified

by D.M. Diehler

This document consists of
12 pages.

EFFECTS OF CORROSION UPON THE ADEQUACY OF THE 105-KE
AND 105-KW EMERGENCY COOLANT BACKUP SYSTEM

Classification Cancelled and Changed To

DECLASSIFIED

By Authority of D.S. Lewis

CG-PR-2 4-5-94

By J.E. Savely 4-17-94

Verified By Jessie Maley 4-18-94

by

D. F. Watson

Plant Design Operation
Design Engineering Operation
FACILITIES ENGINEERING SECTION

January 30, 1964

DISTRIBUTION

1. TW Ambrose	13. SS Jones
2. ER Astley	14. AR McGuire
3. JW Ballowe	15. JC McLaughlin
4. RG Clough	16. GE Peck
5. RF Corlett	17. WH Radtke
6. DM Diediker	18. RW Reid
7. ML Faught	19. GJ Rogers
8. OH Greager	20. W Seeburger
9. CN Gross	21. FW Van Wormer
10. HW Heacock	22. Records Center
11. RD Hickman	23. 300 Area Files
12. RT Jessen	24-28. Extras

This document contains Restricted information. Disclosure of its
contents to an unauthorized person is prohibited.

GROUP 1

and

DECLASSIFIED

EFFECTS OF CORROSION UPON THE ADEQUACY OF THE 105-KE
AND 105-KW EMERGENCY COOLANT BACKUP SYSTEM

INTRODUCTION

When final system acceptance tests were performed on Project CGI-844, 100-K Coolant Backup System, it became evident that less than the design flow of 32,000 gpm was being achieved. Since the tests indicated that only 28,200 gpm was being supplied to KW and 26,700 gpm was being supplied to KE, it was obvious that the cross-tie lines had higher friction losses than anticipated. A study was therefore made to determine the effects of crosstie line cleaning to remove corrosion nodules. Calculations showed that with the lines cleaned, flows of 31,800 gpm to KW and 30,800 gpm to KE would result.

The lines were subsequently cleaned, and on February 16, 1963, flow tests were conducted. The resultant flows were 31,500 to KW and 30,900 to KE. On November 1, 1963, flow tests were again conducted to determine if corrosion buildup in the cross-tie line was affecting the flow capacity of the system. While the flow data has not been issued by the test engineers, initial indications are that the present capacity of the system is approximately 29,500 gpm to KE and 30,000 gpm to KW, or a loss of approximately 1500 gpm on each side.

The purpose of this document is to review the actual flow requirements of the coolant backup system for the various reactor operating conditions to determine when decisive steps should be taken to increase the capacity of the system to prevent any reduction of operating levels, and to point out the possible solutions being considered if a capacity increase is required.

SUMMARY AND CONCLUSION

The diesel pump emergency coolant backup system for the KE and KW Reactors is presently adequate for the following operating conditions:

1. 208,000 gpm flow (hot)
2. 95 C bulk outlet limit
3. 20 C maximum inlet.
4. Three emergency pumps operating at the non-stricken reactor.
5. Two diesel pumps supplying flow to the stricken reactor.
6. Gravity flow to 182-KE diesel pump house from 183-KW only.

The system capacity is marginal for the above set of conditions if only two emergency pumps are in operation at the non-stricken reactor. The future operating philosophy must be resolved and documented to permit a program to be established to provide adequate coolant supplies for all foreseeable operating conditions and power levels if such is required.

Last ditch and secondary system capacity will gradually decrease unless corrosion in the diesel pump supply lines and in the steam turbine pump supply lines is arrested. It is suggested that deaerated water combined with chemical inhibitor be used for this purpose. If additional flow is required, the lines must be cleaned and inhibited or provided with a corrosion resistant coating.

DECLASSIFIED

Elevated water temperatures in the 182-KE pump well and in the clearwells or a "down" reactor will reduce the adequacy of the coolant backup system. It is suggested that baffles be installed in the clearwells to prevent sand accumulation in front of the sluice gates which supply the 182-KE diesel pump house. This will permit both gates to be opened as originally designed. It is further suggested that a model study be initiated to determine the optimum baffle location.

DISCUSSION

Flow Adequacy

For the purposes of CGI-844 design, a flow of 32,000 gpm was established as being required 68 seconds after loss of primary power. This design flow was based upon a measured pump decay curve for a prototype modified 190-K pump set, extrapolated to five pump sets with a K-3 reactor loading; and upon a calculated demand curve (1) decaying from 4500 megawatts with an assumed 90 C bulk outlet temperature limit and a 20 C inlet temperature. These curves are shown in Figure 1. In actual practice, the five pump or six pump decay curve is flattened by the early introduction of secondary or last-ditch flows, thus stretching the critical time to approximately 110 seconds. At this time the actual demand for the design case is about 28,000 gpm.

It is impossible, of course, to achieve a 4500 mw power level with 20 C inlet conditions and a bulk outlet limit of 95 C even with six pumps operating. These thermodynamic limitations and present process operating limits are shown on Figure 2. Although Normal bulk outlet temperatures are approximately 95 C, for the purpose of emergency coolant requirements, 90 C is used as a conservative measure to prevent tube boiling.

To provide an indication of the actual shut down cooling requirements for various conditions of operation, Figures 3 through 6 have been prepared. These graphs indicate a conservative reactor demand for various power levels and inlet temperatures. As an example, for an inlet condition of 15 C, Figure 2 indicates that the bulk outlet temperature limit governs and the maximum power level that can be achieved with six pumps operating is approximately 4375 mw. From the 4400 mw curves on Figure 5, the demand curve for an inlet temperature of 15 C indicates that the flow provided to 105-KE prior to line cleaning was marginal. For an extreme condition of 22 C inlet water, the maximum power level that can be attained is 4000 mw and from Figure 3, it can be seen that again the flow provided to 105-KE prior to line cleaning would be marginal. Conversely, however, if the 4400 mw AEC limit was not in effect, Figure 6 indicates that 4600 mw could be achieved during 10 C or less inlet conditions even with the restrictive flows provided prior to line cleaning.

The actual diesel pump flow rates supplied to each reactor are based upon the original CGI-844 design assumption that three pumps remain in operation at the non-stricken reactor, thus establishing the necessary back-pressure which "valves" the emergency coolant flows to the stricken reactor. If a

(1) HW-58614, "K Reactor Water Plant Analysis", by R. L. Dickeman, dated December 22, 1958 (Secret).

DECLASSIFIED

new philosophy is adopted which assumes that only two pumps may be considered to be available at the non-stricken reactor, then five per cent less flow is received at the stricken reactor because of the greater diversion to the non-stricken reactor. In this case, the November 1, 1963, tests indicate the 105-KE flows approach those recorded prior to line cleaning and are marginal.

Other considerations enter into the determination of flow adequacy. These are the possibility of filter sand plugging the crossheader screens, and the effects of stagnant storage in the clearwells, pumpwell and emergency supply line on the inlet temperature of the emergency coolant supply. Filter sand carry-through at the KE clearwell is still severe enough to require that the 182-KE diesel pumphouse supply is valved to KW only. The possibility of crossheader screen plugging, however, has been alleviated by the removal of the 30 mesh screens and retaining the eight mesh. This should permit most of the fine sand to pass through the reactor.

The problem of increased inlet water temperatures from stagnant storage in the cross-tie line and to a lesser extent in the 182-KE pumpwell is reduced by continuous circulation of water by circulating lines and a pump provided for this service. In this case, however, when KW is down, and reactor flows are reduced to a minimum, the KW clearwell has low throughput and temperatures in the cross-tie increase as much as 5 C during the summer. (2) This has the effect of reducing the adequacy of the diesel pumping last-ditch system, and is probably as serious as reduced lows through corrosion.

The temperature of the water in the cross-tie line is closely monitored by Process Engineering during the summer months, and steps have been taken to monitor the flow capacity of the diesel pumping system by routine testing. This is done by measuring the pump discharge pressures when flushing the corss-tie system at a given flow rate.

Reduction of corrosion in the cross-tie line was attempted after the line was cleaned in early 1963 by the addition and circulation of sodium silicate in the cross-tie line as well as the discharge line from the steam turbine driven emergency pumps in the 190 Buildings. Current evidence, however, indicates that the inhibiting properties of the silicate at the concentration used in the installation has been less than adequate.

Corrective Action

Corrective action that may be taken in the event that the present emergency flows at the K Reactors are deemed to be inadequate will, of course, depend upon the degree of inadequacy. If the philosophy is adopted that only two emergency pumps can be considered to be operating at the non-stricken reactor, then for the present power levels the system must be restored to a clean condition and maintained in that condition. In addition, action must be taken to assure that the temperature in the supply lines and reservoir be maintained at a minimum. If the three pump philosophy is retained, then further flow loss through corrosion must be arrested and the temperature of the emergency supply maintained at a minimum.

(2) Personal Communication - W.H. Radtke, Process Engineering.

DECLASSIFIED

The suggested corrective action is as follows:

Corrosion: Studies are presently underway to determine the effectiveness of various chemical inhibitors in the high tanks. (3) (4) The results of these tests will not be known for at least six months, and may or may not be directly relational to the 100-K cross-tie line system. Dr. E.L. Knoedler, of Sheppard T. Powell and Associates, a consultant retained by N Area for water treatment advice, was requested to investigate the use of sodium silicate for the coolant backup systems at Hanford and to recommend other types of inhibitors if feasible. Dr. Knoedler suggests that the most advantageous method of corrosion control in the coolant backup system would be to remove the oxygen from the 100 gpm flow used to maintain minimum temperatures by vacuum deaeration at atmospheric temperatures. He estimates that the cost of a commercial unit for this purpose would be approximately \$7000, plus installation costs. To further reduce the oxygen content in the system and as a measure of added protection, he suggests that two pounds per day of sodium sulfite be fed to the deaerated water at an estimated cost of 35¢ per day.

The deaerator could be easily installed in the 182-KE diesel pump house so no freezing problems would arise. The present sodium silicate tank and feed arrangement could be used for the sodium sulfite.

Temperature Control: To provide maximum utilization of emergency coolant flows, the emergency water supply should be at least at the operating reactor inlet water temperature. This is normally done by circulating water through the diesel pump discharge system and the steam turbine pump system with a 100 gpm pump installed in the 182-KE pump house. This likewise draws water from the clearwells into the 182 Building pump well. The KE clearwell sluice gate, however, is normally closed due to sand accumulation near the gate. When KW is down, and circulating flow is from the KW clearwell, cross-tie line temperatures increase as much as 5 C. This would be alleviated if the KE gate was open.

K Power Operations is considering the installation of baffles near the gates in both clearwells. (5) This should solve the temperature problem and the problem of filter sand being drawn into the emergency diesel pumps. It is suggested, however, that model tests be made to determine the optimum baffle configuration.

-
- (3) HW-79612, "Program for Testing of Sodium Silicate as a Corrosion Inhibitor in 100-D and 100-DR High Tanks," L.D. Gustafson, dated November 12, 1963.
 - (4) HW-79625, "Production Test PT-IP-635-S, Testing of Corrosion Inhibitors in Reactor High Tank Coolant Backup Systems," R.G. Gier and L.D. Gustafson, dated November 13, 1963.
 - (5) Personal communication, K. W. McKay, K Power Operation.

DECLASSIFIED

Increased Emergency Coolant Flows

Flow increases above those attainable after the line has been cleaned and adequately inhibited can be obtained by either of the following measures depending on the flow requirements and the desired coolant backup philosophy.

1. Increased reactor flow at the non-stricken reactor to increase A-B Riser pressure thus decreasing diesel pump "bleed" to the non-stricken reactor.
2. Provision for the automatic closure of the V-72 valve at the non-stricken reactor.
3. Provision of automatic restricting devices to increase the apparent back pressure at the non-stricken reactor thus reducing "bleed" to non-stricken reactor. This type of device could be detrimental, however because it could lessen the effects of early introduction of diesel pump flow on the rate of primary pump decay.
4. Increasing the capacity of the diesel pumps by increasing the diesel engine speed and power output.
5. Additional installed pumping in the 182-KE pump house. This would require expansion of the existing pumpwell to accomodate the new pump.
6. Provision of a separate diesel pumping station at the KW reactor and complete isolation of the two systems.

A study of alternate methods for obtaining increased coolant backup flows will be made by the Design Engineering Sub-section. This study, currently underway, will include the items listed above and any others which may be appropriate. It is very important; however, that the basic coolant backup philosophy be resolved and documented so that design efforts can have a fixed goal.

DECLASSIFIED

DECLASSIFIED

K-E 10X 10 TO THE CM. 358-14
KEUFFEL & ESSER CO. MADE IN U.S.A.

FIGURE 2

DECLASSIFIED

FIGURE 3

DECLASSIFIED

DECLASSIFIED

DECLASSIFIED

DECLASSIFIED

FIGURE 6

DATE

FILMED

8/10/94

END