UNCLASSIFIED

OAK RIDGE NATIONAL LABORATORY

 Operated By
 UNION CARBIDE NUCLEAR COMPANY

UIC

 POST OFFICE BOX P
 OAK RIDGE, TENNESSEE

 ORNL
 CENTRAL FILES NUMBER

CF-57-7-25

 EXTERNAL TRANSMITTAL AUTHORIZED
 COPY NO. 123

DATE: July 3, 1957

SUBJECT: RADIATION LEVEL IN THE STATOR REGION
OF THE HRT FUEL CIRCULATING PUMP

TO: S. E. Beall

FROM: J. R. Engel

DISTRIBUTION

1. HRP Director's Office	28. D. F. Frech
2. G. M. Adamson, Jr.	29. C. H. Gabbard
3. W. L. Albrecht	30. W. R. Gall
4. H. F. Bauman	31. E. H. Gift
5. S. E. Beall	32. T. H. Gladney
6. A. M. Billings	33. H. E. Goeller
7. E. G. Bohlmann	34. A. T. Gresky
8. J. C. Bolger	35. J. C. Griess
9. N. C. Bradley	36. J. D. Grimes
10. J. C. Bresee	37. R. H. Guymon
11. N. A. Brown	38. P. A. Haas
12. F. R. Bruce	39. J. P. Hammond
13. J. R. Buchanan	40. P. H. Harley
14. W. D. Burch	41. R. J. Harvey
15. C. A. Burchsted	42. P. N. Haubenreich
16. G. H. Cartledge	43. J. W. Hill, Jr.
17. R. D. Chumerton	44. J. P. Jarvis
18. C. J. Claffey	45. S. Jaye
19. H. C. Claiborne	46. G. H. Jenks
20. C. W. Collins	47. R. W. Jurgensen
21. E. L. Compere	48. S. I. Kaplan
22. J. S. Culver	49. P. R. Kasten
23. R. J. Davis	50. J. O. Kolb
24. J. R. Engel	51. R. B. Korsmeyer
25. H. L. Falkenberry	52. U. Koskela
26. D. E. Ferguson	53. K. A. Kraus
27. J. D. Flynn	54. J. A. Lane

NOTICE

This document contains information of a preliminary nature and was prepared primarily for internal use at the Oak Ridge National Laboratory. It is subject to revision or correction and therefore does not represent a final report.

Continued on page 1a

UNCLASSIFIED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission to the extent that such employee or contractor prepares, handles or distributes, or provides access to, any information pursuant to his employment or contract with the Commission.

DISTRIBUTION (Continued)

55. R. E. Leuze	104. A. M. Weinberg
56. R. B. Lindauer	105. K. W. West
57. M. I. Lundin	106. J. C. Wilson
58. R. W. Lyon	107. R. H. Winget
59. R. O. Maak	108. C. E. Winters
60. E. A. Mason	109. W. L. Wright
61. J. P. McBride	110. F. C. Zapp
62. H. F. McDuffie	111. D. O. Campbell
63. H. A. McLain	112. ORNL Doc. Reference Library, Y-12
64. E. M. McLeod	113. Central Research Library
65. R. A. McNees	114-115. REED Library
66. J. R. McWherter	116-118. Laboratory Records
67. O. Mepis	119. ORNL-RC
68. E. C. Miller	120. R. L. Clark
69. B. L. Moore	<u>NON-PROJECT</u>
70. R. C. Moren	
71. C. W. Nestor	121. F. C. Moesel, AEC
72. L. F. Parsly	122. M. J. Skinner
73. M. L. Picklesimer	123-137. TISE, AEC
74. R. G. Pitkin	138-144. Westinghouse PAR Project
75. L. R. Quarles	
76. W. D. Reel	
77. D. M. Richardson	
78. G. W. Rivenbark	
79. R. C. Robertson	
80. J. N. Robinson	
81. A. M. Rom	
82. M. W. Rosenthal	
83. H. C. Savage	
84. W. F. Schaffer	
85. R. E. Schappel	
86. H. K. Search	
87. C. H. Secoy	
88. C. L. Segaser	
89. E. M. Shank	
90. I. Spiewak	
91. R. W. Stoughton	
92. C. D. Susano	
93. J. A. Swartout	
94. E. H. Taylor	
95. D. G. Thomas	
96. P. F. Thomason	
97. M. Tobias	
98. D. S. Toomb	
99. W. E. Unger	
100. R. Van Winkle	
101. B. S. Weaver	
102. B. H. Webster	
103. H. O. Weeren	

SUMMARY

The gamma dose rate in the motor region of the HRT fuel circulating pump was measured with the pump scroll full of radioactive solution. Extrapolation of the data to the solution activity expected in the pump under normal operation gives a dose rate well below that which would result in excessive gas production in the stator can within the life of the pump.

The above dose rate does not include the effects of fast neutrons from the fuel solution or of the general cell radiation level in the vicinity of the pump. It appears that the possibility of gas production in the stator from the cell background radiation is sufficiently great to warrant the installation of a shield around the outside of the motor end of the fuel circulating pump.

INTRODUCTION

The stator windings in the Westinghouse circulating pumps are insulated with glass tape and silicone varnish, which evolve hydrogen gas under intense irradiation. It is possible to generate enough gas pressure in this manner to cause buckling of the stator can when the system pressure in the pump is reduced to atmospheric. It has been suggested by Gift (ORNL-CT 57-4-80)¹ that the gas production rate by gamma radiation from the HRT fuel solution in the pump scroll might be great enough to seriously limit the useful life of the pump unless some means of relieving the pressure is provided.

DESCRIPTION OF TEST

An experiment was performed to measure the actual gamma dose rate in the stator region with a distributed source in the scroll case. The activity used was Cs^{137} which has a gamma energy of 0.66 Mev to approximate the average fission product gamma energy of 0.7 Mev as used by Gift¹ in his calculations. The dose rates were measured with photographic film which was provided and interpreted by the Health Physics Division.

Approximately 100 millicuries of Cs_2SO_4 was added to 5.05 liters of water in the scroll of the fuel circulating pump. The pump discharge line was plugged off at the inside of the scroll and the suction line was plugged 2 in. below the inside surface. All of the parts which are normally in the scroll were in place.

Individual photographic films (radiation badge type) were attached to the pump rotor along its length. The rotor was then placed inside the stator, positioning the film directly against the inside of the stator can, and the impeller attached at the lower end. The motor end of the pump was placed over the scroll in its normal operating position. The radioactive solution filled the pump up to the lower face of the thermal

barrier. The back of the pump which, under normal operation, is full of condensate was left dry to protect the film.

Some difficulty was encountered in keeping the film protected from light so that two exposures, one of 24-hr and one of 145-hr duration, were made. Following each exposure, the pump was disassembled and the films removed, developed, and read. The results from the usable films are shown in Table I. Only one exposure value was taken from each film. The locations of the data points are given in terms of distance along the axis of the pump. The reference point is the face of the Kingsbury thrust bearing, which is below the stator windings.

Table I

Distance From Bearing Face (cm)	Exposure Time (hr)	Total Exposure (mr)	Exposure Rate (mr/hr)
1.9	24	70	2.9
9.8	145	130	0.9
14.3	145	35	0.24
18.0	145	~15	~0.1
21.9	145	<15	<0.1

The film readings have an accuracy of 5% for total exposures of 30 mr or greater, while 15 mr represents the lowest detectable exposure.

After the final exposure, a sample of the solution was taken from the pump scroll for counting. The activity was determined to be 2.2×10^{-5} curies/cc. Gift¹ calculated the activity of the HRT fuel solution in the pump to be 42.2 curies/cc with the reactor operating at 5 Mw. Using these figures, the experimental dose rates were scaled up by a factor of 1.92×10^6 and plotted as a function of position to show the exposures under HRT operating conditions.

DISCUSSION

Figure 1 is a graphical presentation of the gamma dose rate in the pump with the HRT at 5-Mw core power. A sketch of a half-section of the stator winding is included for position reference. Also, included is the dose rate assumed by Gift in calculating the gas production rate reported in ORNL-CF 57-4-80. The experimental exposure curve was conservatively approximated by a simple exponential to fit the linear portion. This equation was then integrated over the length of the stator

windings and divided by the length to obtain an average dose rate of 1.7×10^3 R/hr. Direct, graphical integration of the experimental curve gives an average dose rate of 1.05×10^3 R/hr. These numbers were then applied to the data for gas production used by Gift¹ and gas buildup rates were calculated. The rates of pressure rise corresponding to the above dose rates were estimated to be only 0.7 psi/yr and 0.5 psi/yr. The previously reported value was about 30 psi/yr. The stator can collapsing pressure was calculated previously to be no less than 5.9 psi.

It may be readily seen that the earlier calculation was conservative by at least an order of magnitude. It may thus be concluded that gamma radiation from the scroll is not likely to contribute significantly to the gas buildup in the stator can during the expected life of the pump.

It should be emphasized that no consideration has yet been given to the general cell background radiation level and its effect on gas production in the stator windings. Cardwell² calculated the radiation level near the fuel circulating pump to be 9.2×10^4 rad/hr. Extrapolation of data taken during the operation of HRE-1 and reported in ORNL-1839³ gives a radiation level of 3.4×10^5 R/hr. Even the lower of these two figures is well within the range of radiation that could cause significant gas production in the stator region of the pump.

Based on these figures, either a gas vent for the stator can or a unit shield would be required for the protection of the motor end of the fuel circulating pump. However, a more thorough study of the background radiation level would be desirable. If the protection is required, it appears that a unit shield designed for remote placement and removal from around the pump offers a simpler solution to the problem than a gas venting system.

J. R. Engel
J. R. Engel

JRE:be

REFERENCES

1. E. H. Gift, Possible Radiation Damage to the Stator Windings of the HRT Circulating Pump, ORNL-CF 57-4-80 (Apr. 17, 1957).
2. C. C. Cardwell and P. N. Haubenreich, Radiation Level at HRT Air Line Disconnects, Letter to S. E. Beall, February 24, 1956.
3. D. O. Campbell, Decontamination of the Homogeneous Reactor Experiment, ORNL-1839 (May 22, 1956).

0-6