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DATE 2/20/94
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HIGH RADIATION LEVELS AT THE DISCHARGE FACES OF THE REACTORS

Jan. 4, 1955

Introduction

Undesirably high radiation dosage rates are being encountered in the discharge areas during reactor outages. This is costly to Operations in terms of burn-out time, extra work crews, and extended outages required to complete scheduled work. Significant savings in operating costs would be realized if the rear face radiation levels could be reduced during shutdowns. As a first step towards this some measurements have been made to identify and locate the major sources of this radiation. These results are given in this report. It is suggested that this information may be of use in devising a water treatment or purge technique which could reduce the rear face contamination problem encountered during outages.

Summary

An analysis of the radioactivity on several perfs obtained from process tubes at the piles and on a nozzle and pigtail assembly from 105-H shows that approximately 80-90% of the activity present after a few hours decay is due to 250 day Zinc-65 (1.12 Mev. gamma). Small amounts of 27 day Chromium-51 (0.32 Mev. gamma) and other lower energy gamma emitters were present. These activities were found both inside and outside the nozzle and pigtail assembly; however, the amounts on the outside were very small. The observed dosage rate is therefore primarily due

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to gamma activities, as verified by RMU measurements. This activity is spread fairly uniformly on the inner surfaces of the nozzle and pigtail and on the surfaces of the perfs in a brown film which was present on all of the pieces. The source of this zinc is not definitely known at present but it seems probable that a considerable amount comes from corrosion of the 72 S aluminum liners in the process tubes which have a zinc content of approximately 1%. Gamma spectrometer measurements made on the rear face at 105-H soon after shutdown verify this predominant zinc activity and also indicate a slow decay rate for gamma activity. Data obtained from RMU indicate that the rear face dosage rate may drop by as much as 50% during the first 24 hours of an outage and after the first day or so decreases quite slowly if at all. It is not known if this is due to radioactive decay or to some of the contaminants being washed out of the rear face piping.

Discussion

To analyze and identify the radioactivity present on the 105 area discharge faces, several perfs were obtained from B, C, D and F areas and a nozzle and pigtail assembly was obtained from H area. The perfs obtained were the furthest downstream in each case and had been in the pile for times varying from about one month to two years. The surfaces of the perfs and inner surfaces of the nozzle and pigtail were coated with a brown film. This film was removed from the perfs by washing them with a nitric acid solution. The solution was evaporated and the gamma activity in the residue was analyzed using a NaI (Tl) crystal scintillation spectrometer. The nitric acid solution removed all of the activity from the perfs confirming that the activity is in the surface film. Figure I shows a typical gamma ray spectrum of the activity removed from the perfs and also a spectrum from a pure Zn^{65} source of comparison. The response of the NaI (Tl) crystal used is such that its efficiency for capturing the Cr^{51} 0.32 Mev. gammas is nearly eleven times greater than its efficiency for 1.12 Mev. gammas. A differential spectrum of the gamma activity in the pigtail and nozzle is given in Figure II. Here again the activity is mainly Zn^{65} although the peak at 0.9 Mev. indicates that there may also be a small amount of Sc^{46} (1.12 Mev. and 0.9 Mev. gammas) present.

The outer surface of the pigtail was cleaned by washing with nitric acid and very little activity was removed indicating most of the activity is internal. This is supported by the low beta activity measurements obtained on the outer surface of the nozzle and also by the fact that the rear face dosage readings as measured by RMU are for the most part due to gamma radiation.

At 105-F the near side process water pH is the normal 7.65 and the far side water pH is 7.3. To see what effect this might have, perfs were obtained from tubes 1955 and 1894 which are in the same orifice zone and operate within one or two degrees of each other. Both tubes were charged 8-18-54 and discharged 11-11-54. Both perfs showed predominately Zn^{65} activity but there was approximately 40% less activity on the far side perf. It is understood⁽¹⁾ that the lower pH water appears to result in a 50% reduction in aluminum corrosion rate.

(1) Personal communication from W. R. Conley

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This would infer that most of the zinc is coming from corrosion. However, RMU at 105-F reports that the far side dosage reading is about double the near side reading when the initial entry to the rear face is made, and that the far side continues to read somewhat higher throughout the outage. This effect is not yet explained.

Earlier work done on the rear face at 105-H immediately after shutdown where gamma ray spectra and decay curves of the gamma activity were obtained⁽²⁾ indicate the predominance of the 1.12 Mev. Zn^{65} activity and show little if any decay. Data obtained from RMU at the 100 areas indicate that the dosage rate 24 hours after shutdown may decrease as much as 50% below the dosage rate immediately after shutdown. This decrease is probably due in part to washing away of activity in the rear face piping.

Typical dosage rate reading encountered on the rear face at the 105 areas immediately after shutdown and 24 hours later are given below. These readings are for the center of the unit.

Area	Dosage Rate	Dosage Rate 24 Hours
	Immediately after Shutdown	after Shutdown
B	300 (110 $\frac{1}{2}$) Mr/hr	110 Mr/hr
C	40	25
D	100-150	100-150
DR	150-200	100
F	200-250	100
H	175-250	100

The rates for C pile apply since the pigtails were changed; changing the pig-tails cut the rate in half.

Data accumulated to this date indicate the zinc activity is likely more or less uniformly deposited on the inner surfaces of the discharge face piping. A number of rear face measurements with a highly directional portable radiation detector (the Bazooka⁽³⁾) showed no evidence of localized concentrations of activity. Also if one assumes that the activity concentration as measured on the perfs is uniformly distributed in the piping, the estimated discharge area reading is in reasonable agreement with the observed reading. Some attempt was made to separate the contributions of the nozzle and pigtail from H. This was hampered by stuck fittings, but it was apparent that the surface contamination was less in the end cap of the nozzle where the water is somewhat stagnant.

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(2) HW-32761, pp. 11-12 - Portable Detector for Reactor Discharge Face Use in Isolating the Process Tube Containing a Ruptured Fuel Element - R.S. Paul and M.C. Greene, 8-16-54 - Secret

(3) HW-32761

Figure I - Typical differential spectrum of the gamma activity removed from a perf. A differential spectrum of Zinc-65 gamma activity is included for comparison.

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