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AEC RESEARCH AND DEVELOPMENT REPORT

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Chief, Engineering Branch

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PILE DISCHARGE WATER MONITORING

FINAL REPORT ID3-19

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INTRODUCTION

One of the problems which confronted those who designed the 105 process units was the development of a satisfactory method of detecting the failure of slug jackets. Since it is possible to cripple the operation of these piles if a slug jacket breaks and the slug swells to such an extent as to become stuck in a process tube, considerable time has been spent on studying various methods of detecting such a condition before its effects are detrimental. During July 1944 work was started to develop equipment to detect failures by measuring the beta activity of the effluent pile water. One month later, investigation of another method, which depended upon delayed-neutron activity in the discharge water, was initiated. The latter method was installed in the 105B Building on an experimental basis (See Final Report ID3 41) while the former is incorporated in all 105 Buildings. This report reviews the development of the Beta system.

SUMMARY

In cooperation with the Design and Construction Divisions and the 105 Area Technical Section, a system was designed which monitors the pile discharge water for beta activity. The intensity of the activity is recorded and alarm lights in the pile control room indicate abnormally high activity. Monitors also record the activity in the two exit risers. Subsequent to the initial design, further improvement was obtained by additional developmental work. A stainless steel, betasensitive ion chamber has been designed. Methods of operating the system differentially to balance out backgrounds have been incorporated. Also equipment to determine the decay periods of the water activity has been provided so that the beta activity of heavy metal can be identified if and when a jacket failure occurs. The 105 Area Technical Section established techniques for using the equipment and aided in training operating personnel in its use. A simulated jacket failure produced in the

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PILE DISCHARGE WATER MONITORING

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105-B pile on January 17, 1945 showed the system to be capable of detecting a jacket failure which produces 6 sq' of exposed metal in an average central slug, thereby being superior to the delayed-neutron method.

EXPERIMENTAL DETAILS

The design of the Beta Jacket Failure Monitoring equipment is based upon work done at Clinton by W. D. Spata. Its basic principle is to detect beta activities in the process water which passes over the heavy metal slugs. When a failure occurs, the products within the slug are released into the water stream; therefore, an increase in the beta activity of the pile discharge water may indicate the presence of the failure.

A continuous sampling system has been devised which brings water from each discharge header into one of six sampling rooms. The water activity is allowed to decay for about four minutes enroute to the room so that a large portion of the oxygen and aluminum activities are eliminated. A cyclic valving system in each room delivers water from the header sampling lines within that room to a beta-sensitive ion chamber. Each line feeds into the chamber for one period, then it is diverted to the sewer while the other lines are monitored.

The overall design of the initial system is discussed in detail in the letter C. I. Bradford to R. F. Peterson, August 1, 1944. The original cycling system was controlled from a single timer in the control room. The timer not only operated solenoid valves to connect the sampling lines to the chambers but also provided one period in which the Micromax, which recorded the chamber ion current as indicated by a Beckman Amplifier, would index to a fixed voltage to provide a time reference in the cycle. Alarm controls on each Micromax turned on indicating lights in the control room if the beta activity in the water exceeded a pre-set limit.

The first installation of the system in 105-B incorporated the piping arrangement specified in the letters C. I. Bradford to V. F. Hanson, September 6, 1944, and B. L. Weller to V. F. Hanson, September 12, 1944. The ion chambers for the application were developed under Problem Assignment IDS-10. Provision was made in this installation for the addition of the differential connection of the Beckman amplifiers. It was found, after operating the system for a short time, that this change would be an improvement so the recorders were connected to indicate the difference between two beta monitoring chambers which were simultaneously monitoring headers of the same background activity. With this arrangement, three recorders showed the difference between pairs of beta monitors and either high or low deviation of the beta activity operated the alarm lights. The basic wiring of the system is given in W76210 and W76311. Operating experience further showed that it was not necessary to index the Micromaxes to provide a time reference so that this detail of the system was deleted before the start-up of 105-B.

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The monitoring equipment was improved in 105-D and F as a result of experience at 105-B. The sampling lines were changed from 1/4 inch to 1/2 inch so that the flow rates would remain more constant. The arrangement in these areas is given in the letter, C. I. Bradford to R. F. Peterson, October 28, 1944. Somewhat later the 100 Area Technical Section found that the system could be made more immune from control rod configuration if adjacent headers were bused in the differential system rather than headers which were geometrically opposite each other. The letter, W. E. Jordan to C. I. Bradford, January 5, 1945, gives this arrangement. These piping connections have been very successful in 105-D and will probably be incorporated in 105-F and 105-B shortly.

The operating techniques for using this equipment have been very thoroughly studied by the 100 Area Technical Section. A recommended method of operating the equipment is presented in a letter W. E. Jordan to file, November 25, 1944. The procedure for locating the particular tube in which a failure has occurred is of particular importance. It involves studying the decay periods of the water by using a water monitoring device, in which a G.M. tube is immersed in the water sample within a vertical lead shield. Proposals on the particular use of these monitoring units to find active process tubes are made by W. E. Jordan in two letters to M. H. Smith, January 4, 1945 and February 13, 1945.

The most recent change which is now under consideration, is to provide additional recorders which give information to make the differential monitoring records more significant. It has been found that the most common variation in the monitoring system is for the flow rate of the water in the sampling lines to decrease. This results in a longer hold-up of the water and hence, a lower background. The differential record does not identify this decrease of background since it might be interpreted to be an increase in the accompanying monitor. To make it possible to identify all variations in the differential records, provision is being made for the output of one of the Beckman amplifiers in each differential pair to record directly. By comparing this individual record with the differential record, all changes can be interpreted.

A simulated slug jacket failure was created in a process tube in 105-B on January 17, 1945. This test, reported in detail by W. D. Spatz and M. H. Wilkening in their report of February 9, 1945 on IDS-70, made it possible to calculate the sensitivity of the system. It was found that the region in which the monitor is most sensitive is at the pile center where it will show a break of 6 mm^2 . Its sensitivity at the pile edge allows it to detect 230 mm^2 at that point. This sensitivity has been shown to be better than that of the delayed-neutron method; hence, the Beta system has been adopted in preference to the delayed-neutron.

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