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DUN-648 RD

UNUSUAL OPERATION - KE REACTOR
JANUARY 16 TO JANUARY 20, 1966

INTRODUCTION

Following the startup of the KE Reactor on January 16, 1966, a severe power oscillation, which was confined primarily to the top of the reactor, was experienced. The purpose of this report is to describe the transients which occurred and relate the control measures taken to dampen the oscillation.

SUMMARY

The cycle experienced at the KE Reactor after startup on January 16, 1966, was probably due primarily to the gross reactivity changes associated with the loss of helium a few hours after turnaround. The decrease in helium content of the reactor atmosphere at this crucial time agitated a normal condition that exists in the reactor during startup and turnaround.

Maximum graphite stringer temperature during the cycle was 964 C and the maximum rate of change of graphite temperature was about 100 C per hour. The reactor operated at full power (4400 KW) for all but a few hours of the cycle and the radial flattening during this time was above normal.

DISCUSSION

During a normal startup, the flux in the top half of the reactor is peaked to the rear at turnaround. This is a normal condition, since the rod insertion order calls for more front rod than rear rod in the normal turnaround configuration. The typical rod configuration in the top half of the reactor at turnaround is: 1 @ 40%, 2 full in, 3 @ 30%, 4 @ 20%, 5 @ 50%, 6 full in, 7 full in, 8 @ 70%, 9 @ 20%, 10 @ 10%.

Following turnaround during a normal startup, the power level is increased to slow the reactivity transients and allow time to balance the flux distribution. In general, the power level is increased in the low flux regions, while the power level in the high flux region is held constant. The ultimate goal is to reach equilibrium level with the ratio of front to rear rods balanced and the flux balanced. Once the flux distribution has been balanced and held balanced for a few hours, it becomes more stable and less susceptible to cycling.

- If the power level is held constant following turnaround, the reactivity transients are large and cause an excessive net loss of rod. More rods and splines have to be withdrawn from the high flux regions than from the low flux regions due to the increased rate of Xenon buildup in the high flux region. In the situation here, where the rear is the high flux region, more rear rod than front rod must be withdrawn. One soon finds that this is impossible due to the lack of rear rods, and a cycle is started. Once a

heat shift is started, if allowed to continue, it will tend to be self-magnifying for several hours and can be stopped prematurely only by applying a great deal of force (such as rods and splines). Since the splines go in from the front face, heat shifts can most easily be stopped when the increase is to the front.

Following turnaround on January 16, 1966, the amount of rod and the flux distribution in the top half of the reactor was normal. Then, about five hours after turnaround, the helium supply was lost for about two hours during which time the helium concentration dropped from 78 percent to 38 percent. Also, during this time, the power level increase was halted. These two incidents caused a great deal of rod to be pulled, and not enough rear rod was available to keep the heat from shifting to the front at a very fast rate.

When the heat shift was recognized, the power level was increased to full power, several splines were partially withdrawn, and several short splines were inserted. When the violent swing to the rear occurred on January 17, 1966, "half" splines were inserted and front splines were pulled out.

The "half" splines put in on January 17, 1966 applied a great deal of leverage; and, when the swing to the front occurred on January 18, 1966, it was not recognized soon enough. As a consequence, appropriate corrective action was not initiated at the proper time. By the time corrective action had been initiated, the swing was so violent that a power level cut and a "rod swap" was necessary. All the rear rods in the top half of the reactor were withdrawn and front rods were inserted. In addition, all the half splines, and all the full-in splines were removed, and short front splines were inserted. By noon on January 18, 1966, all the splines in the top half of the reactor were front splines, and only front rods were in for control.

As soon as the front was "turned," the power level was returned to normal and the rear rods were worked back in. A concerted effort was made to slowly bring the reactor to normal condition, but this was a tremendous task considering that the heat was now going to the rear again. Towards the end of day shift on January 19, the front to rear swing again got out of hand and a "rod swap" of the top two rods in the reactor was necessary.

After this "rod swap" was made, the front was allowed to increase freely until it reached its normal operating level. Then the top two rods were swapped back to their normal configuration and the cycle was stopped.

CONCLUSION

During the cycle the corrective action taken was in the proper direction in each instance; however, it is generally felt that the actions were not of great enough magnitude. The violent swing on January 18, 1966 could probably have been prevented.

The rear-to-front swing in the top half of the reactor following turnaround could be partially eliminated by a more determined effort to keep the heat from leaving the rear. Possible solutions would be to force the heat towards

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the front "before" turnaround or pull back on more splines after turnaround than is current practice. Also, putting in a few front splines during the power raising after turnaround would help if the heat wants to leave the rear.

As a rule, the rear octant readings should not be allowed to fall below their equilibrium values. Also, when an unusual situation that effects the reactivity status like this occurs, or when the flux distribution gets out of balance like this, a qualified reactor physicist should be consulted immediately; and an hourly plot of octant monitor readings and front and rear graphite temperatures should be started.

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APPENDIX A

DESCRIPTION OF CURVES:

Curve 1 shows a plot of the octant monitor signals at various locations. There are eight octant monitors on the reactors -- one at each corner of the reactor. The signal received from each chamber is directly proportional to the local power and can be used to control the front to rear flux distribution in that part of the reactor.

Curve 2 shows a plot of the front graphite temperatures on both sides of the top of the reactor. Hourly readings were not taken on rear graphite temperatures in these locations.

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