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SUGGESTED STARTUP PLAN WITH HIGH CO₂

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November 12, 1963

C. E. Bowers, Supervisor
Pile Physics Unit
Operational Physics Subsection
Research and Engineering Section

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SUGGESTED STARTUP PLAN WITH HIGH CO₂

Following the startup of 11-6-63 at 105-B there ensued an operating period in which graphite stringer temperatures were above those allowed by process standards, and a PCA was authorized to enable continuity of operation. The highest temperature recorded was 35° above the standards limit and occurred approximately 44 hours after first indication. As per your request, I have investigated the matter to clarify certain areas of Pile Physics concern.

There are at least three possible reasons for the occurrence:

1. A large and unscheduled outage was just completed and as a result reactivity was lower than for previous startups due to the rather severe samarium dip. This reduced the amount of control available for such requirements as distribution control early in the startup.

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2. Power was raised rather quickly to the equilibrium power level.
3. CO₂ composition was rather rapidly increased to a level somewhat higher than that customary following startup.

Looking at each possible cause of the event:

1. Although reactivity was steadily decreasing due to the samarium effect during the high temperature operation, the reactivity in rods was never below 730 c-mk until limits were re-attained. This is a total excess reactivity of at least 1000 c-mk at all times during the high temperature operation. Previous operating history shows that recently the old type reactors have survived samarium dips with less than 800 c-mk in rods, splines, and PCCF. This seems to indicate that reactivity was not too low.
2. Equilibrium was attained in about 29 hours on this startup while it required 48 hours on the startup of 10-27-63. (This was a fairly fast startup, although on the hot startup of 10-11-63 equilibrium was attained within 26 hours and no apparent difficulties were noted. A normal time for cold startups is 32-36 hours.)
3. The per cent CO₂ in the reactor is recorded below:

<u>Hours After Startup</u>	<u>% CO₂</u>
9.5	42
11.5	45
13.5	46
17.5	49
19.5	52
27.5	52
31.5	56
35.5	60
43.5	64
45.5	66
51.5	67

The composition stayed at about 67 per cent for the next two days. (These readings were from the Orsat, however, and the chromatograph had been reading close to 72 per cent when the Orsat indicated 67 per cent.)

It is probable that the combined effects of raising the CO₂ rapidly and to a high level in conjunction with the relatively fast approach to full power level caused the temperature effects noted. During previous operating periods the CO₂ usually ranged from 55 per cent to 60 per cent, rarely if ever going above 60 per cent. The fact that there was at least 67 per cent in this case was probably the major contribution to the high temperatures noted. There was a very minimal amount of cycling, showing no instability of operation beyond high temperature.

It was difficult to increase the helium once equilibrium power levels were attained, since all available control was then being used in hot regions and could not be withdrawn. This merely reduced the rate at which operation within temperature limits could be re-attained, since the high CO₂ composition slowed the graphite cooling considerably even after power was reduced in the hot regions.

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Occasional localized graphite temperature problems are not new, but their frequency has been minimized by adopting operating procedures to compensate unusually large discharges, water leaks, prediction errors, etc. An increase in graphite temperature limits, as under the current program, results in a larger block of reactivity being "tied up" in temperature coefficient effects. In addition, due to the relatively low heat transfer coefficient of CO₂, localized effects respond slowly to corrective efforts; the net effect is that once trouble spots develop, they are difficult to eliminate.

The high CO₂ program is planned for uniform application, and similar situations are possible at each reactor; however, it is expected that optimum procedures will be developed to prevent or minimize future occurrences of this type. Such procedures will be developed cooperatively by Pile Physics and Processing personnel, and will reflect each reactor's particular needs.

As an interim step, until the best approach has been developed at each reactor, it is suggested that startup CO₂ additions be tailored to level off at 5-10 per cent below the level intended at equilibrium, and that resulting graphite temperatures limit the power level accordingly. This restriction should apply from first indication until approximately 48 hours after the normal nonequilibrium cutoff power level has been attained. The CO₂ concentration may then be slowly raised to within the limits established by the PITA on high CO₂ operation.

Peter Gross

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Research and Engineering Section

PD Gross:gs

Concurrence with above conclusions:

C. J. Bowers

Supervisor, Pile Physics
Operational Physics Subsection
Research and Engineering Section

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