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POWER BURST FACILITY - POWER OSCILLATION PROBLEM

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The Power Burst Facility (PBF) is an oxide fueled, epithermal reactor located at the Idaho National Engineering Laboratory near Idaho Falls, Idaho. It is designed to operate at steady-state power levels up to 40 MW and produce power bursts having reactor periods as short as 1.3 msec.

In late 1973 PBF achieved a power level of 15 MW. During this period of operation fluctuations in reactor power were observed. Many possible causes of these fluctuations were considered and a number of nuclear and non-nuclear tests were conducted. Initial instrumentation installed in the core showed coolant outlet temperature variations of $10^{o}F$ for several fuel cannisters and approximately 10% power variations at 15 MW. Power spectral density analysis showed a predominant frequency of 0.05 to 0.06 HZ.

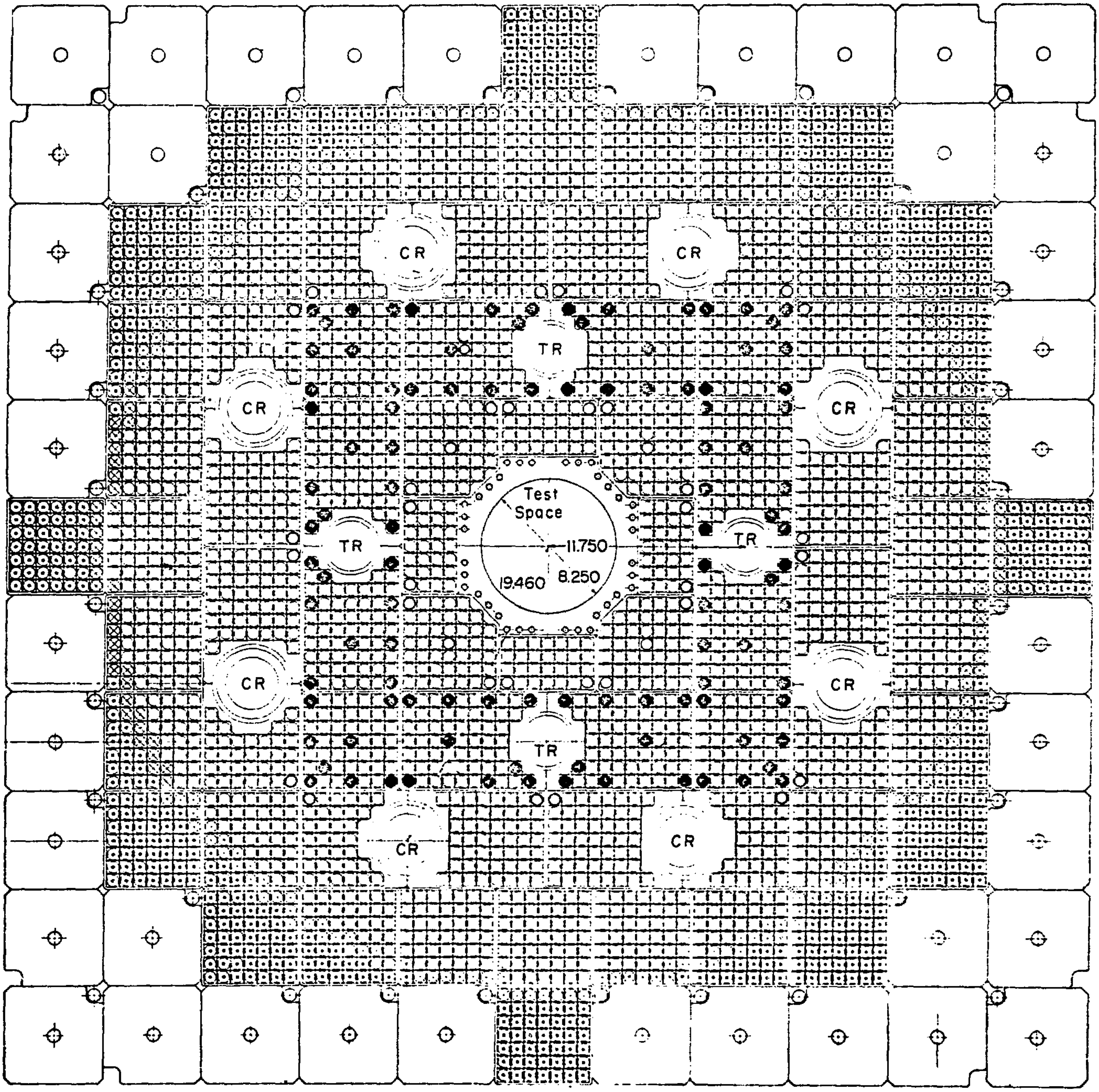
After elimination of a number of possible causes of the fluctuations an extensive instrumentation and analysis program was conducted. At this time the effort was centered on hydraulic problems (possible boiling) and fuel rod bowing. Analysis, temperature measurements and direct measurements showed that the fuel rods were bowing.

Figure 1 (a) shows the PBF core layout and Figure 1 (b) shows the unique fuel rod design used in the reactor. Temperature traces from two thermocouples located 180^{o} apart on a fuel rod which showed significant variations are plotted on Figure 1 (c). The temperature variations are essentially 180^{o} out of phase. From this temperature variation it was expected that there would be a significant amount of rod bowing and movement. This was later verified by attaching linear variable differential transducers to some of the rods to directly measure the motion of the free end of the rod.

It was postulated that the temperature fluctuations and resulting rod bowing were caused by the pellet stack (spring loaded inside the clad and insulator) moving back and forth and contacting the clad and insulator on different sides at different times. The resulting rod bowing and pellet stack temperature change contributed to further independent motion of the pellets.

A thermal model of a fuel rod was set up using the SINDA[1] code and the effects of possible pellet motion was studied. Figure 1 (d) shows a typical thermocouple temperature trace with a dotted overlay giving the results of a SINDA analysis for a sinusoidal pellet motion and for a sudden snapping of the pellet stack from side to side. The results tended to confirm this hypothesis.

To further verify the pellet movement hypothesis a fully instrumented fuel rod was irradiated in the PBF in-pile-tube. Operation at power levels high enough to cause fuel cracking resulted in suppression of the rod movement and temperature oscillations.



LEGEND

- Ternary Fuel Rod
- Stainless Steel Reflector Rod
- Aluminum Filler Rod
- Stainless Steel Shim Rod

FIGURE 1 (a)

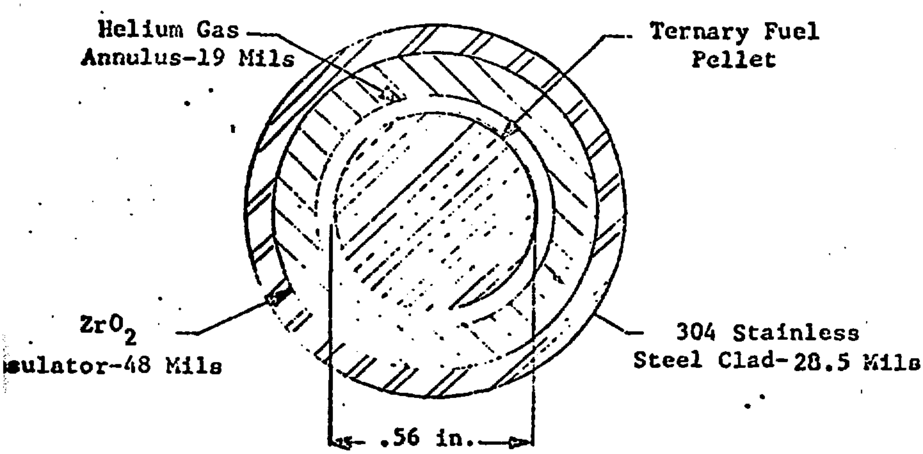

Helium Gas
Annulus-19 Mils
Ternary Fuel
Pellet
ZrO_2
Insulator-48 Mils
304 Stainless
Steel Clad-28.5 Mils
.56 in.

FIGURE 1(b)

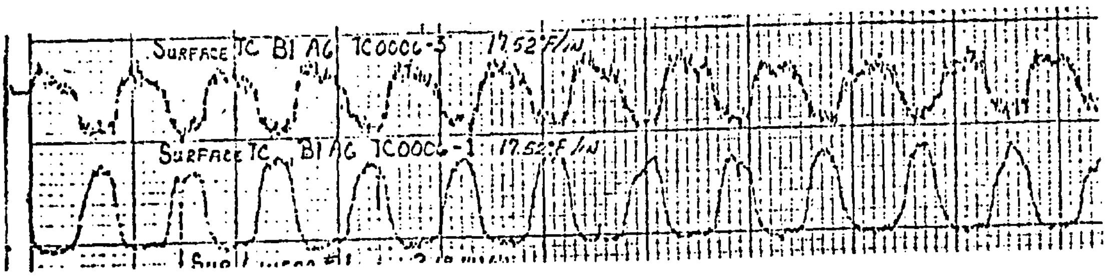


FIGURE 1 (c)

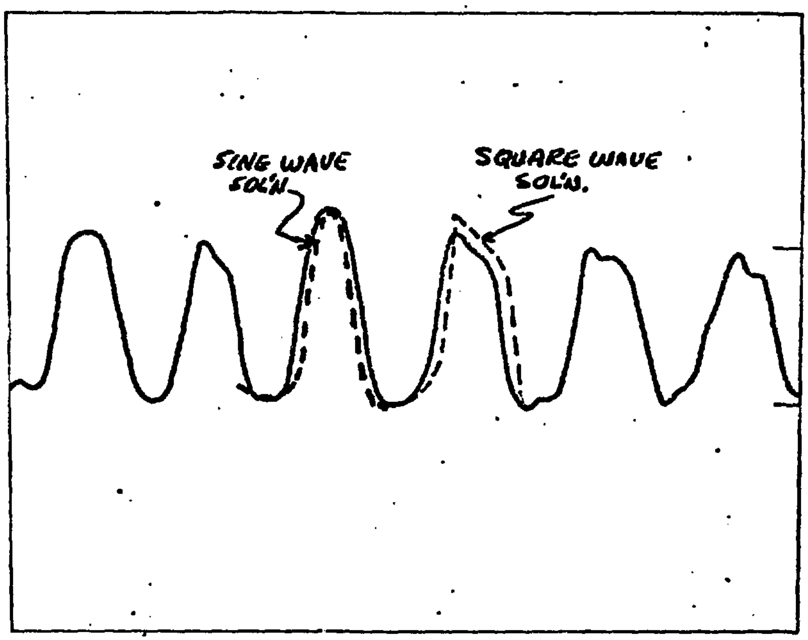


FIGURE 1 (d)

REFERENCES

1. D. R. Lewis, J. D. Gaski, and L. R. Thompson "Chrysler Improved Numberical Differencing Analyzer for Third Generation Computers", JN-AP-67-287, Space Division of Chrysler Corporation (Oct. 20, 1967)