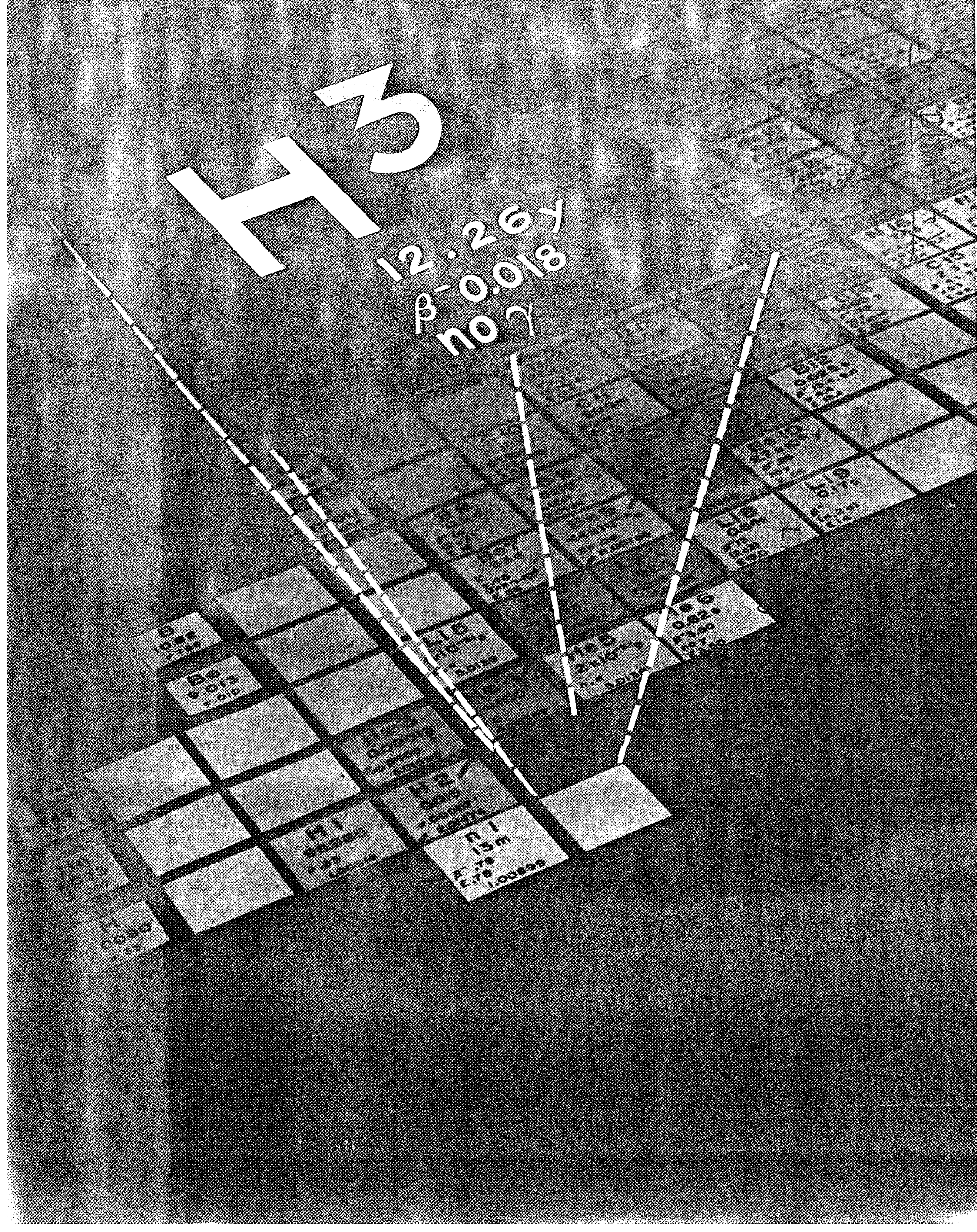
NUCLEONICS

POWER • NUCLEAR ENGINEERING • APPLIED RADIATION



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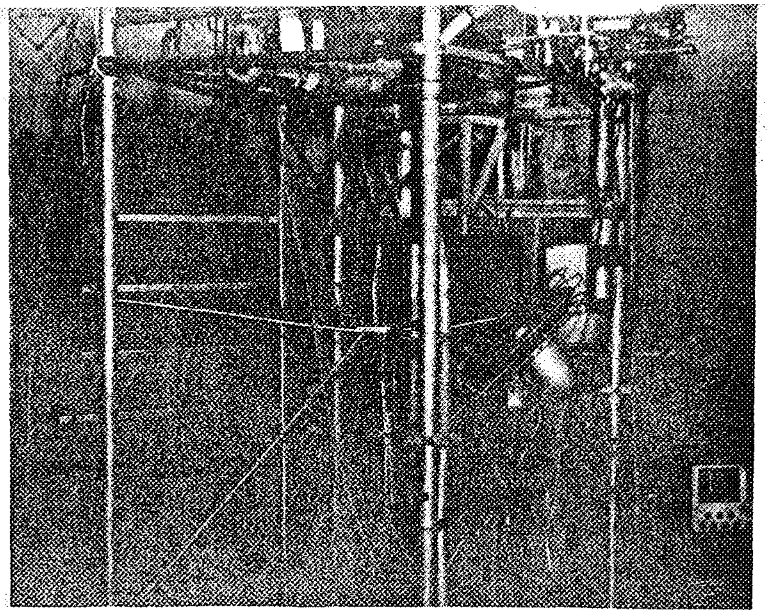
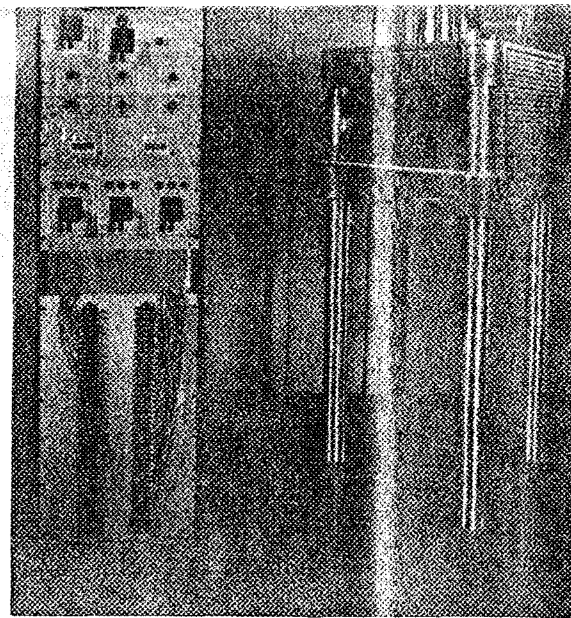


Between this (Godiva I, after accident) . . .



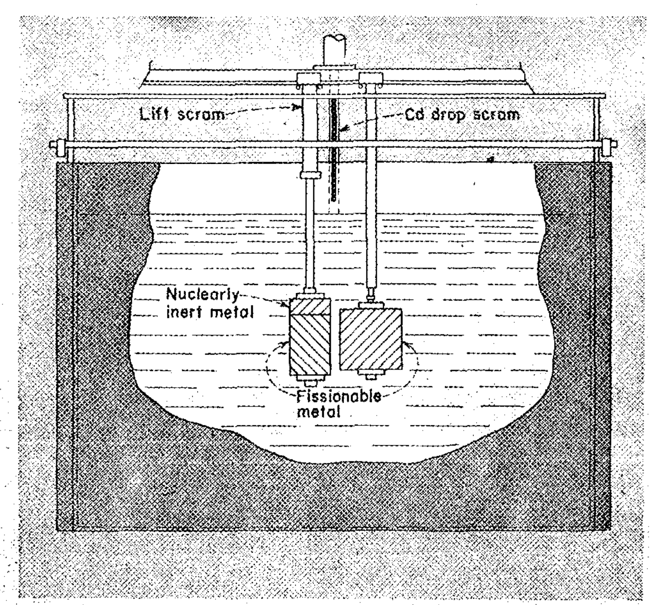
and this (Godiva II), lie many . . .

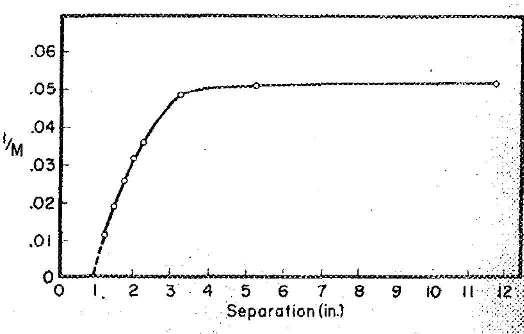
Critical-Assembly Booby Traps

By HUGH C. PAXTON *Los Alamos Scientific Laboratory, Los Alamos, N. M.*

1. Unanticipated motions in scram can cause burst

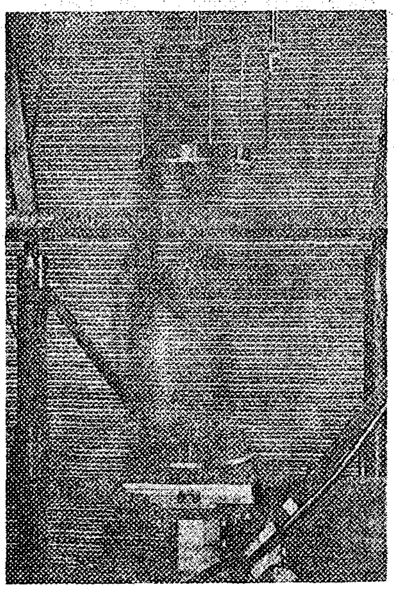
A modification to our water-reflected oralloy assembly The Aquarium (below, left) resulted in our first remote, accidental burst. Designed originally for determining the neutron multiplication of a single piece of fissionable metal in water, it included, as one scram, a pneumatic cylinder that raised the unit out of the water. A traveling support and a second unit was added, so that distances between two units could be determined, and a dropping Cd screen was provided as an additional scram. When scrammed, local radiation detectors went off scale and a cloud of steam showed on the monitoring television screen. Reconstruction showed that the pneumatic scram was the first to be effective and led to two types of difficulty: (a) the center of reactivity of the left hand cylinder was below that of the stationary cylinder, and (b) the rapid lift through the water brought the two cylinders together. The total burst of $\sim 10^{17}$ fissions probably came from several independent bursts separated by bubbling. The well-known sensitivity of systems like this to separation as the critical value is approached makes it easy to be misled by extrapolation of the reciprocal multiplication curve (below, right) in evaluating the safety of a next step.

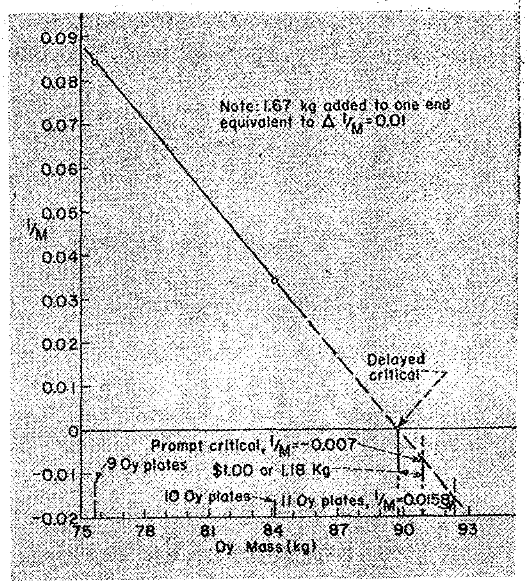




2. Human error in calculating criticality

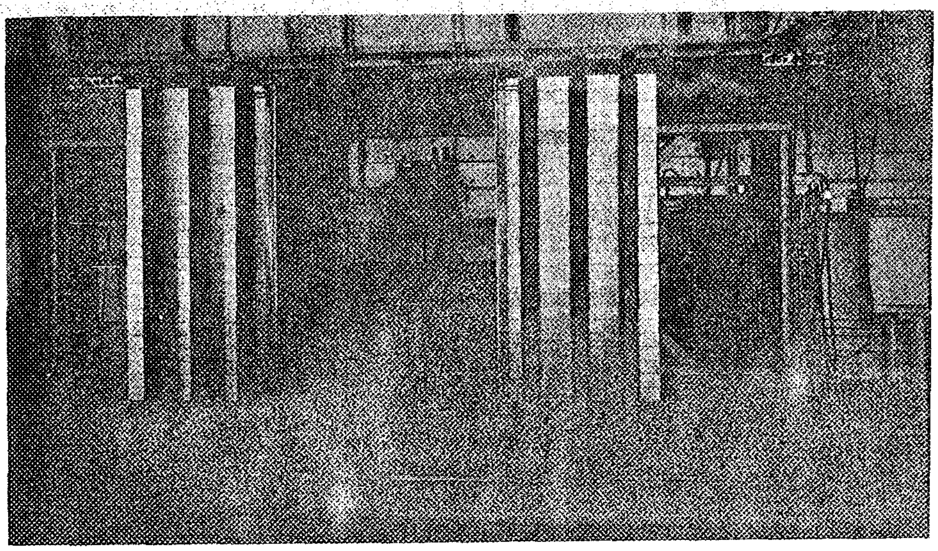
At right is Jemima, another assembly with which we had trouble—this time arithmetic. During buildup to delayed critical, indication that an added plate of enriched uranium would make the system supercritical by a certain margin was erroneously interpreted as meaning that it was subcritical by that same margin. A too-rapid assembly (even though controlled increments were available) led to a burst of 7×10^{16} fissions but no damage. A plot of the data (far right), omitted in this case even though called for by our operating regulations, could hardly have been misinterpreted, but sure enough it was.





3. Too-rapid approach to criticality

In our Honeycomb assembly (right), we had a burst for which we still can find no clear stopping mechanism other than the relatively sluggish [illegible]. Here, the active region was formed by long sandwiches of enriched-uranium foil (0.005 in. thick) and graphite that slipped into [illegible] matrix tubes. Too large a [illegible] in the core, and incautious assembly, led to a burst of 3×10^{16} fissions. The initial part of the assembly motion was fast, the final part slow, and the system became critical before the slow range was reached—but the foils were not damaged.



4. A near miss—"safeties" weren't safe

Apparently innocuous changes in an assembly can have very surprising effects. In another Honeycomb assembly (lower right), a potentially [illegible] situation could easily have [illegible] had we not been feeling our way carefully and deliberately. [illegible] had led from an assembly [illegible] than Be islands, in which [illegible] of Be and fuel proved [illegible] safeties, to this assembly [illegible] which the first 6 in. of [illegible] (simultaneous withdrawal of Be and fuel rods) gave a 30-[illegible] reactivity *gain*. Within this [illegible] fuel rods were ineffective and the Be made a positive reactivity contribution.