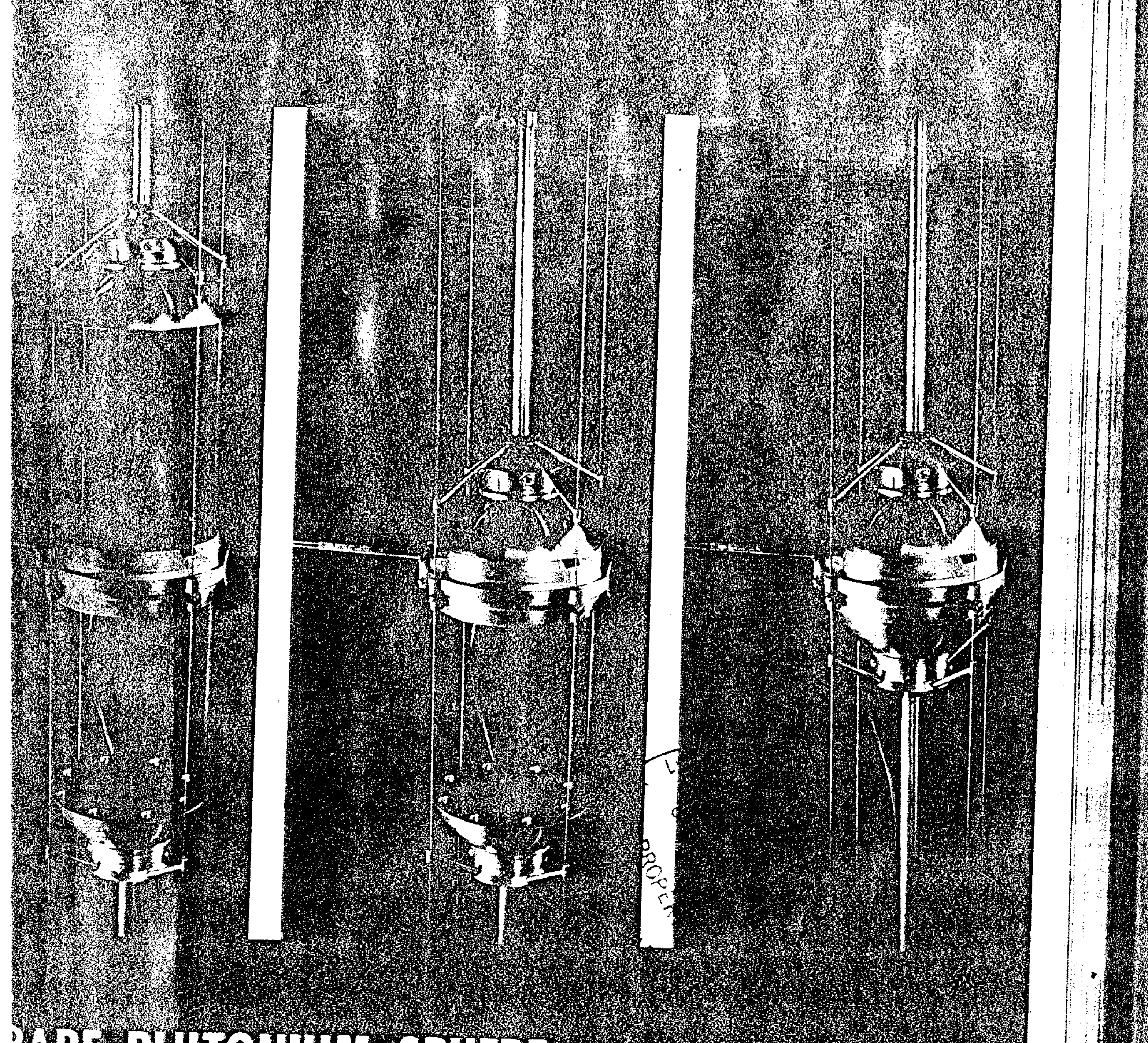
NUCLEONICS



BARE PLUTONIUM SPHERE

CLEONICS

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which is consolidated "Atomic Engineering") October, 1955, published monthly by the McGraw-Hill Co., Inc., Executive, Editorial, Advertising Offices: McGraw-Hill Building, Street, N. Y. 36, N. Y. Publication York St., York, Pa. Entered as sec- December 17, 1947, in the Post under the act of March 3, 1879. McGraw-Hill Publishing Company, reserved. Donald C. McGraw, President; Chevalier, Executive Vice President; Vice President and Treasurer; John Paul Montgomery, Executive Vice Division; Ralph B. Smith, Vice Editorial Director; Nelson Bond, Vice Director of Advertising; J. E. Black- President and Director of Circulation. write to Nucleonics-Subscrip- West 42nd Street, New York 36, must indicate company and position. change of address. Price per subscription rates: United States and 1 year, $12 for 2 years, $16 Canada $10 for 1 year, $16 for 2 years. Other Western Hemisphere Philippines $15 for 1 year, $25 for 3 years. All other countries for 2 years, $40 for 3 years. Member of ABP.

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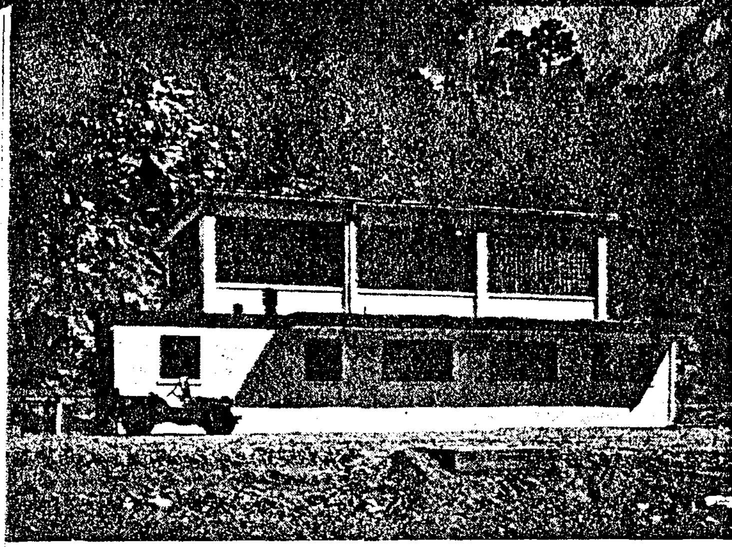
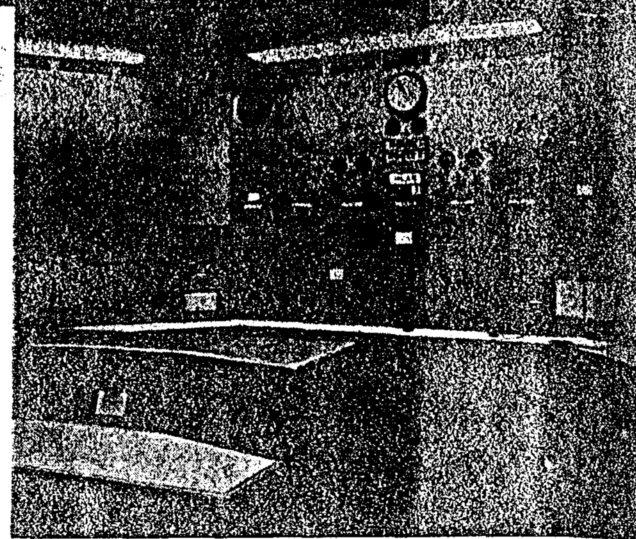


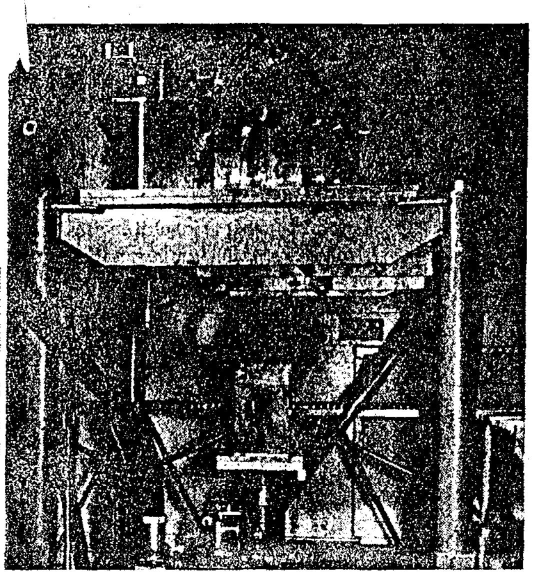
TWO LABORATORIES that contain remotely controlled assemblies are called Kivas after ceremonial chambers of Pueblos



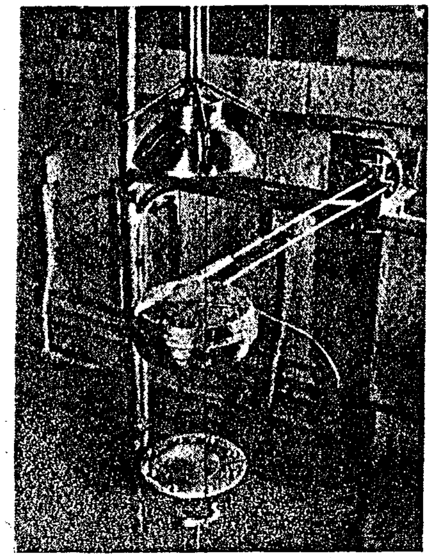
CONTROL ROOM is in main laboratory building located about one-quarter mile from each Kiva. Note use of television

Godiva,

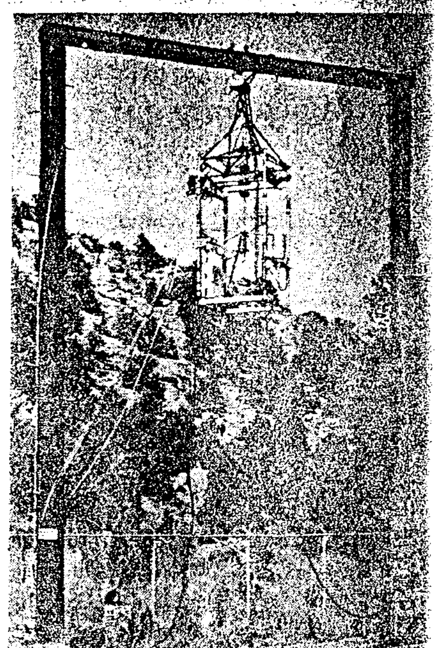
By H. C. PAXTON
Los Alamos Scientific Laboratory
University of California
Los Alamos, New Mexico



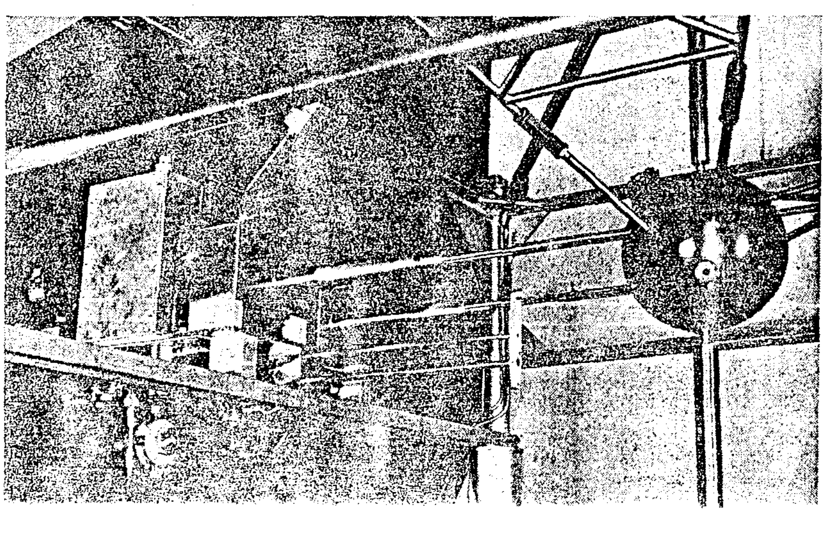
"TOPSY," IS OLDEST critical assembly, a small U^{235} metal core surrounded by a thick reflector of normal U metal. Safeties drop a section of core and reflector and shift another large block of reflector away from its normal operating position to make system safe to approach. Control rods of normal U move in channels through reflector. Topsy has been operated with Pu core



"JEZEBEL," IS NEWEST critical assembly, bare Pu without a reflector. Under operating conditions sections are brought together to form smallest, simplest critical system there is. A Pu control rod rides in channel through sphere. After its characteristics are determined as completely as is practicable, it is expected that this assembly will be dismantled



GODIVA OUTDOORS and hoisted about 25 ft to minimize room-scattered neutrons



"GODIVA," IS WORKHORSE of Los Alamos critical assemblies, bare U^{235}. It is much like bare Pu system. It is shown here [illegible]

Delayed Neutrons from Fast-Neutron Fission of U^{235}, U^{238}, Pu^{239} and Th^{232}

U^{235} (99.9%)		U^{238} (99.97%)		Pu^{239}		Th^{232}	
Period, $\tau_{1/2}$ (sec)	Relative abundance, a_i/a	Period, $\tau_{1/2}$ (sec)	Relative abundance, a_i/a	Period, $\tau_{1/2}$ (sec)	Relative abundance, a_i/a	Period, $\tau_{1/2}$ (sec)	Relative abundance, a_i/a
[illegible] ± 0.9	0.036 ± 0.006	53.0 ± 1.7	0.011 ± 0.003	53.7 ± 3.6	0.037 ± 0.016	54.0 ± 1.0	0.033 ± 0.003
[illegible] ± 0.8	0.210 ± 0.019	22.0 ± 0.6	0.128 ± 0.013	22.9 ± 1.1	0.265 ± 0.037	22.0 ± 0.5	0.133 ± 0.015
[illegible] ± 0.17	0.192 ± 0.027	4.94 ± 0.10	0.182 ± 0.018	6.11 ± 0.24	0.193 ± 0.019	6.2 ± 1.0	0.172 ± 0.050
2.18 ± 0.07	0.409 ± 0.022	1.77 ± 0.04	0.405 ± 0.017	2.14 ± 0.06	0.378 ± 0.013	2.1 ± 0.4	0.458 ± 0.055
0.46 ± 0.03	0.135 ± 0.008	0.39 ± 0.03	0.240 ± 0.015	0.40 ± 0.03	0.120 ± 0.007	0.52 ± 0.1	0.169 ± 0.025
0.126 ± 0.018	0.018 ± 0.004	0.117 ± 0.015	0.034 ± 0.008	0.15 ± 0.05	0.007 ± 0.004	0.18 ± 0.02	0.035 ± 0.010
Absolute yield (neutrons/fission)							
0.0173 ± 0.0007		0.044 ± 0.003		0.0067 ± 0.0003		0.063 ± 0.006	

Topsy, Jezebel . . .

Critical Assemblies at Los Alamos*

Systems of bare fissionable metal made critical by remote assembly provide valuable information basic to fast-reactor design. Results of studies of delayed neutrons from fission are also given here

[illegible] CRITICAL ASSEMBLIES used at Los Alamos have provided valuable information about fast-neutron systems. They've also served as a source of 50-μsec bursts of $\sim 10^{16}$ neutrons for instantaneous irradiations in studies of delayed neutrons from fission.

Critical Assemblies

The Los Alamos critical-assemblies group is located a few miles from the town of Los Alamos in Pajarito Canyon. The laboratories, control room, and one of the critical assemblies are shown in the photographs on p. 48.

The remotely-controlled assembly machines are of two types: simple but [illegible] machines for nuclear safety tests, and more specialized, but still simple, machines for the operation of semipermanent critical assemblies.

The over-all reason for our interest in the characteristics of elementary, fast-neutron critical assemblies is to check results of detailed calculations by modern high-speed computers. If discrepancies between predictions and observations can be eliminated, there will be increased confidence in calculated characteristics that are not readily observable in the laboratory (*1*).

The experimental quantities that are useful for checking calculations include critical masses, and results of traverses by threshold neutron detectors. For uranium assemblies, experiment and theory agree except in a few extreme cases (*e.g.*, at low U^{235} concentration). For plutonium systems, however, small but significant discrepancies call for a revision of the plutonium parameters which are used in calculation.

Reactivity Booster

Godiva, the bare U^{235} semipermanent assembly, has been equipped with a reactivity booster that takes it rapidly from slightly above delayed critical to slightly above prompt critical.

A U^{235} slug is shot into the assembly and stopped near its most effective location. When system is a bit above prompt critical, the fission rate rises extremely rapidly, the uranium heats, expands, thus dropping the reactivity enough to terminate the fission burst. Thus, a potentially run-away burst is stopped by thermal expansion. With a typical Godiva burst the initial rise in fission rate is exponential with a period of about 15 μsec and continues to a maximum power level of nearly 10^9 watts, then falls off in a manner similar to the buildup. The burst is about 50-μsec wide at half-height, and the energy developed is that of 10^{16} fissions or about 100 watt-hrs. Typical bursts are shown in Fig. 1.

Godiva bursts show a curious effect due to room-scattered neutrons. The

* Based on a talk presented at the June, [illegible] meeting of the American Nuclear Society.

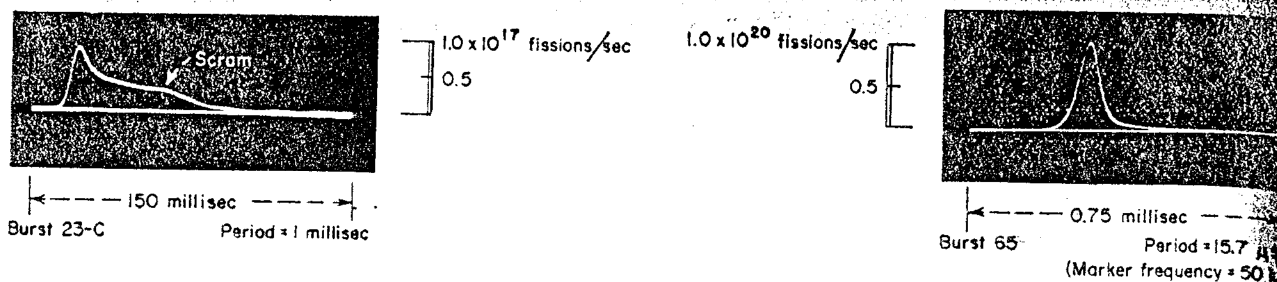


FIG. 1. Typical bursts from Godiva used with reactivity booster

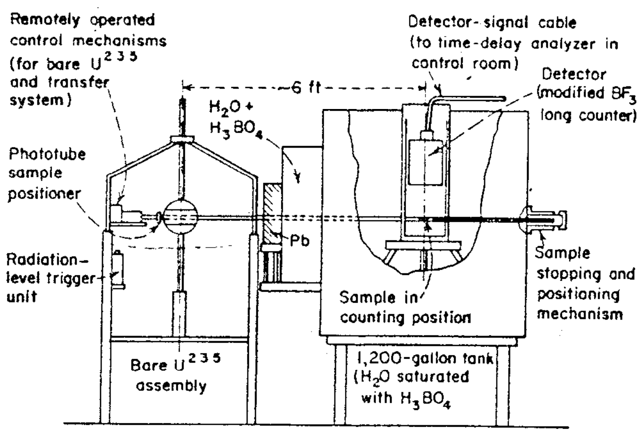


FIG. 2. Fissionable specimens are transferred from point of irradiation within Godiva to heavily shielded counter in 0.05 sec. Multichannel time-delay analyzer (2) gives delayed-neutron activity versus time as shown in Fig. 3

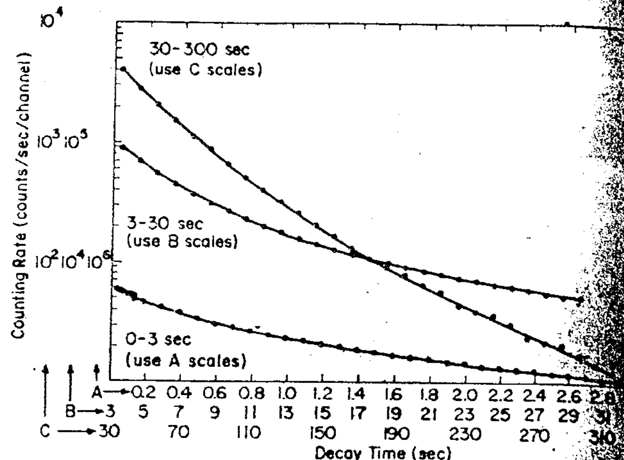


FIG. 3. Delayed neutron decay following prompt-burst irradiation of 99.9% U^{235}. These are the cumulative data from irradiations of 3-gm sample. Least-squares fit to data (curves) gives U^{235} delayed-neutron groups listed in table on p. 49

shape of the trailing edge of a burst should be sensitive to short-period delayed neutrons, and, in fact, bursts obtained with Godiva indoors do appear to be influenced by neutrons delayed the order of a millisecond. As this effect disappears with Godiva suspended outdoors, it can be attributed to neutrons scattered back from the laboratory walls.

Delayed-Neutron Studies

An example of the use of Godiva bursts is a study of the periods and relative abundances of delayed neutrons from various fissionable materials conducted by G. R. Keepin and T. F. Wimett. See Figs. 2 and 3.

Figure 3, supplemented by data from a long steady irradiation, may be resolved into a set of delayed neutron periods and relative abundances.

Periods and abundances of delayed neutrons from fast-neutron fission of the principle fissionable elements as determined by Keepin and Wimett are given in the table on p. 49. These do not include ultra-low-yield groups that have been reported with half-lives of 3, 12, and 125 minutes and yields per fission of 5.8×10^{-8}, 5.6×10^{-10}, and 2.9×10^{-10} (3).

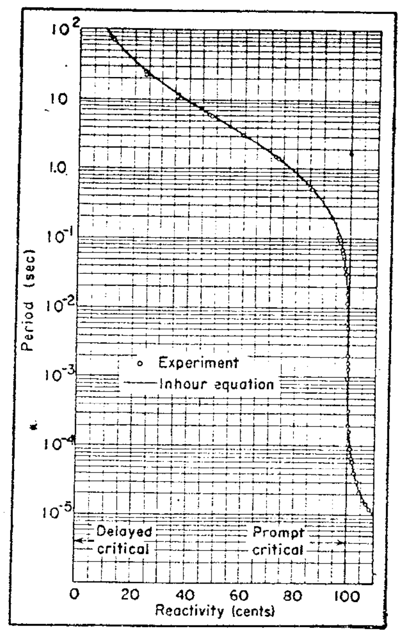


FIG. 4. Godiva period as a function of reactivity in cents

Results of Godiva reactor-period measurement show a spectacular decrease in period near prompt critical as the influence of delayed neutrons drops out. (See Fig. 4.) This is evidence against the existence of a delayed neutron period in the few millisecond range.

Briefly, the data for U^{235} and Th are similar to the periods and relative abundances reported for U^{235} by Hughes and his co-workers (4), and for U^{238} the shorter periods are more predominant. Data of this type are basic to the problem of reactor control.

* * *

Some of the people responsible for the work to which I have referred—people whose names I hope you will see on an increasing number of declassified publications are: Leon Brown, Glen Graves, Jim Grundl, Gordon Hansen, George Jarvis, Grant Koontz, Gus Linenberger, John Orndoff, Rolf Peterson, and Roger White.

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