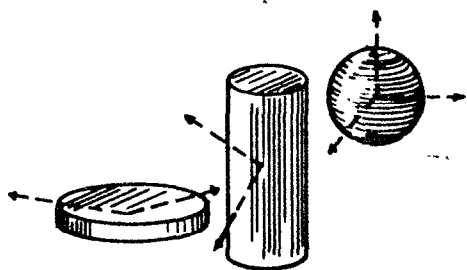


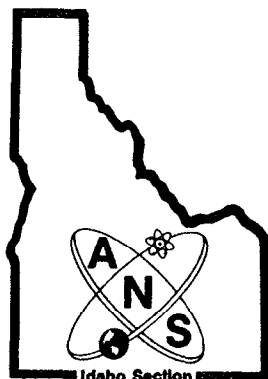
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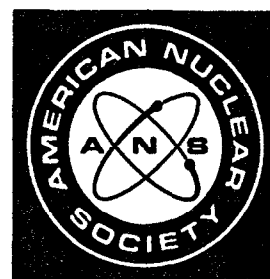
# CRITICALITY SAFETY IN THE STORAGE OF FISSILE MATERIAL

## PROCEEDINGS OF A TOPICAL MEETING

Jackson, Wyoming  
September 8-11, 1985



American Nuclear Society  
Idaho Section  
Nuclear Criticality Safety Division



## HISTORY OF DENSITY-ANALOG STORAGE CRITERIA

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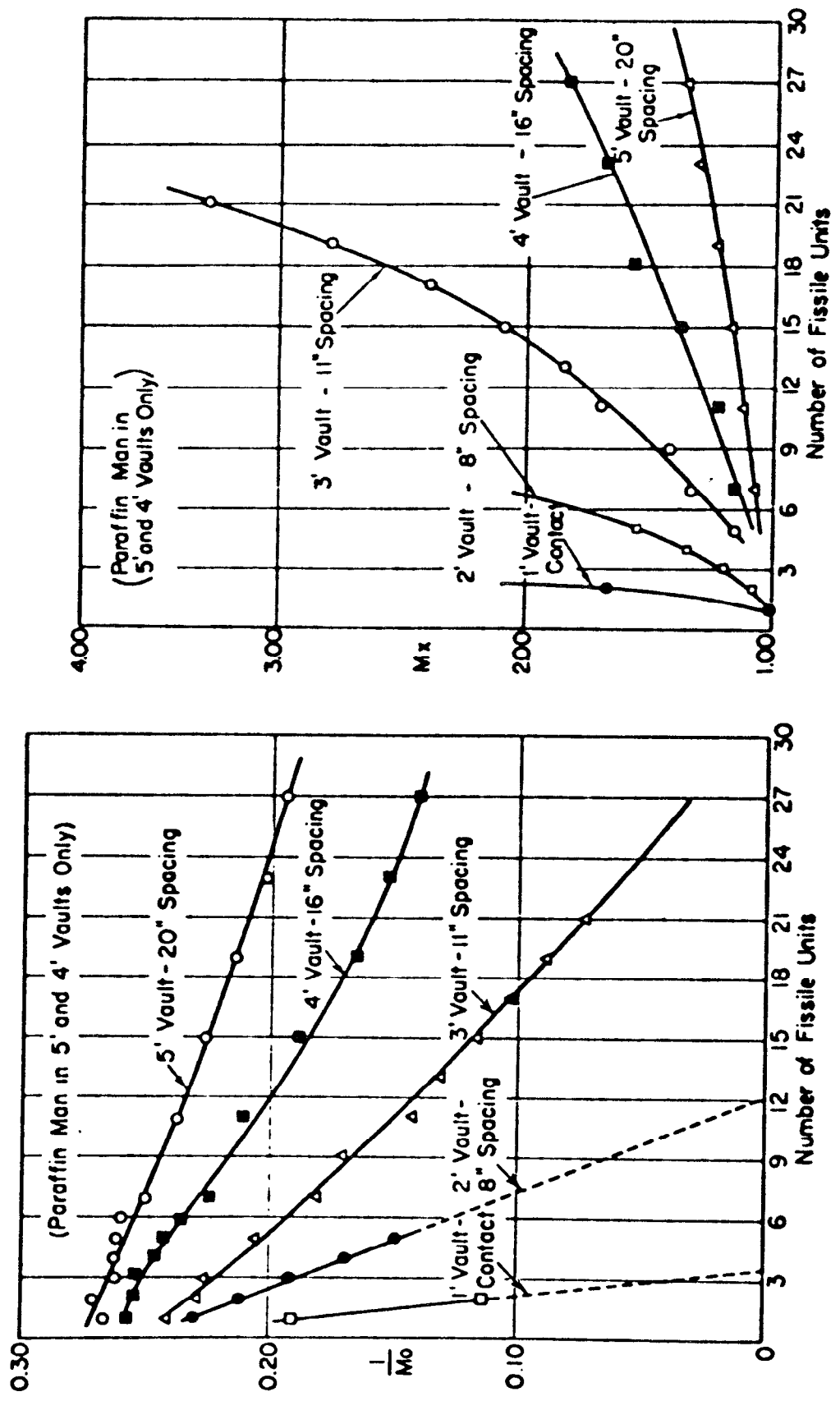
In 1947 there were neutron-multiplication measurements at Los Alamos on cubic arrays of massive weapon capsules. Up to 27 capsules (all that were available) were in a close-fitting concrete enclosure of adjustable size (Fig. 1). The purpose of these so-called "vault tests" was to provide criticality safety guidance for the design of structures for storing large numbers of capsules.

The density-analog scheme for storage resulted from a misguided attempt to generalize results of the vault tests (Fig. 2). If concrete walls were ignored, extrapolation of the reciprocal-multiplication curves of Fig. 2 to zero resulted in the main curve of Fig. 3, which was recognized as too flat, extrapolating to an impossibly large lattice density for a single critical unit.

Before this attempt at generalization, Los Alamos critical data on single uranium-reflected spheres at reduced density gave the exponential relationship of Fig. 4. Also shown is the known  $(\rho/\rho_0)^{-2}$  dependence of critical mass for an unreflected sphere (or a reflected sphere in which the density is changed throughout). In the attempt at generalization, it was assumed that a reflected array would behave somewhat like a single reflected unit at reduced density, hence the density-analog designation. This implied a constant density exponent (shown ultimately to be correct), extrapolation to density  $\rho_0$  for a single critical unit (which proved to be incorrect), and, as suggested by the vault test, a strong dependence of density exponent on reactivity of a unit (which also proved incorrect).

The density-analog model was adequate for specifying the storage of large numbers of weapon capsules in structures intended for the purpose, and I made the mistake of trying to promote it for general use. The elegant Oak Ridge experiments with critical arrays of highly enriched uranium metal units eventually showed how seriously in error was my density-analog formulation (Fig. 5). Instead of abandoning the term "density-analog", Joe Thomas saved it by means of the modification shown in Fig. 6. So, with this modern modification, Joe made the density-analog model generally useful.

Fig. 1. Arrangement of Weapon Capsules in the Los Alamos Vault Tests.



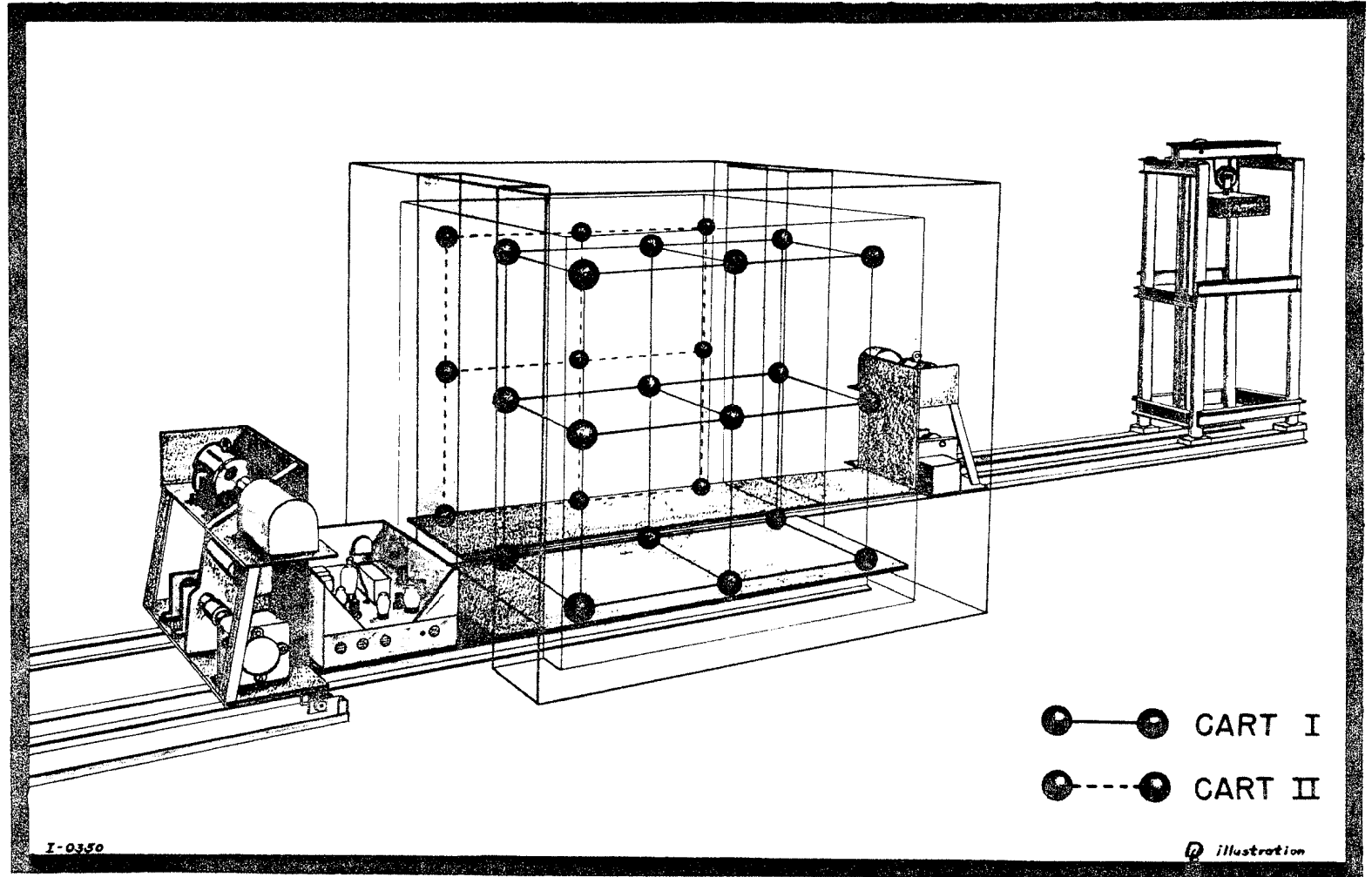


Fig. 2. Neutron-multiplication Data (and Their Reciprocal) From the Vault Tests.

Fig. 3. Results of Extrapolating Vault-test Reciprocal Multiplication Curves to Zero.

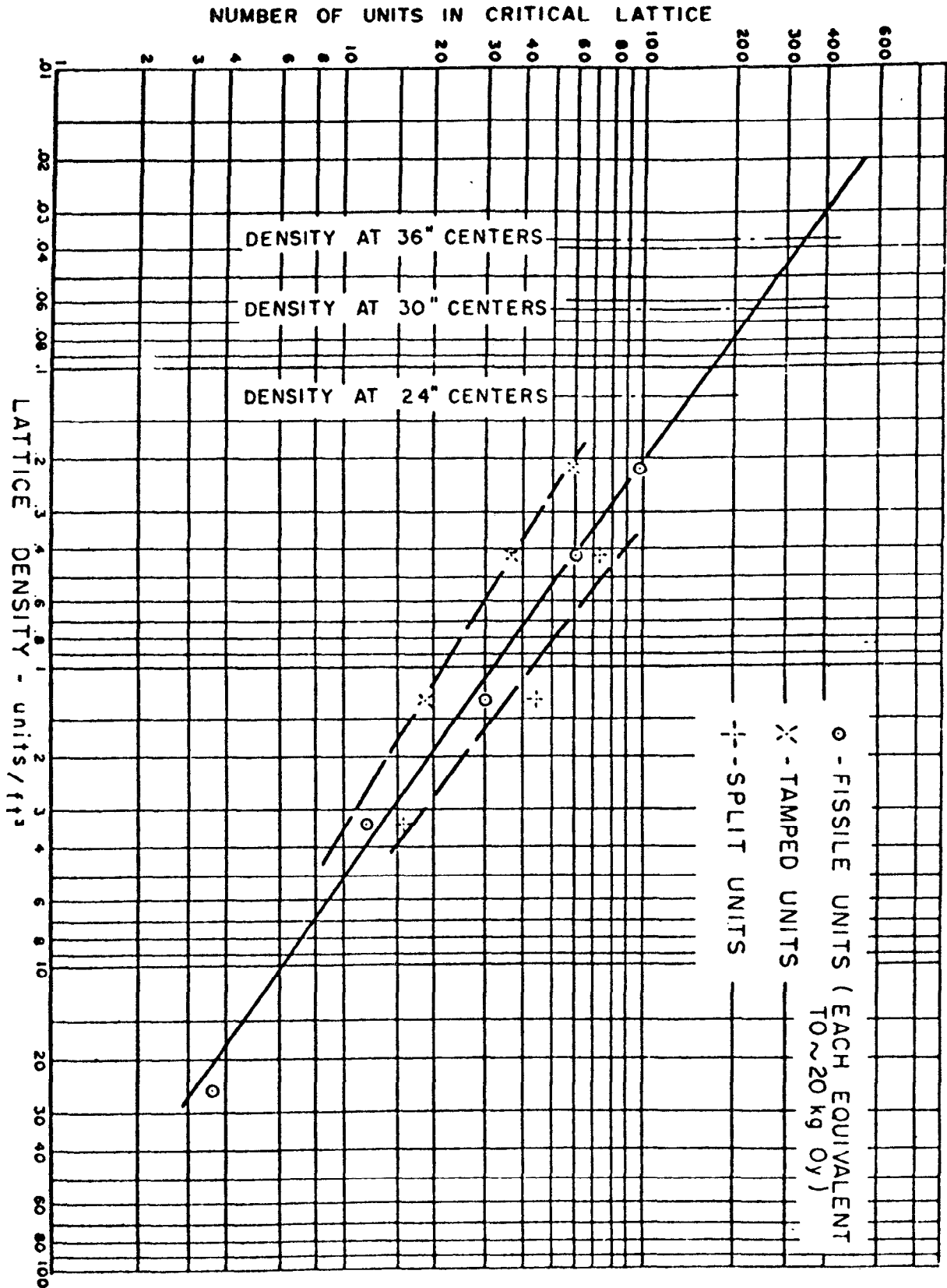


Fig. 4. Dependence of Critical Mass on Density for Single Units, with Assumed Density-analog Relation for a Storage Array.

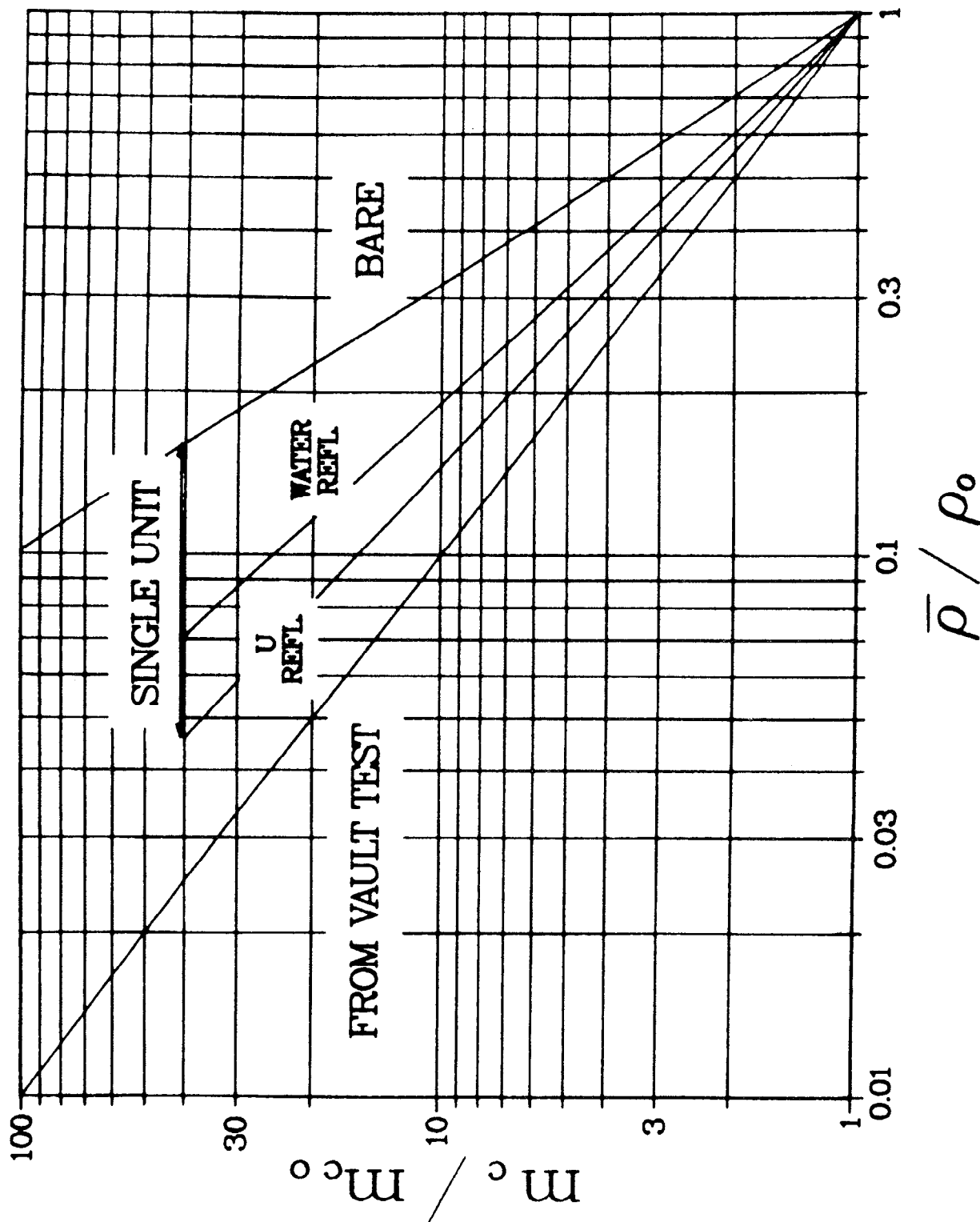


Fig. 5. Oak Ridge Data for Metal Arrays Show the Error of the Original Density-analog Formulation.

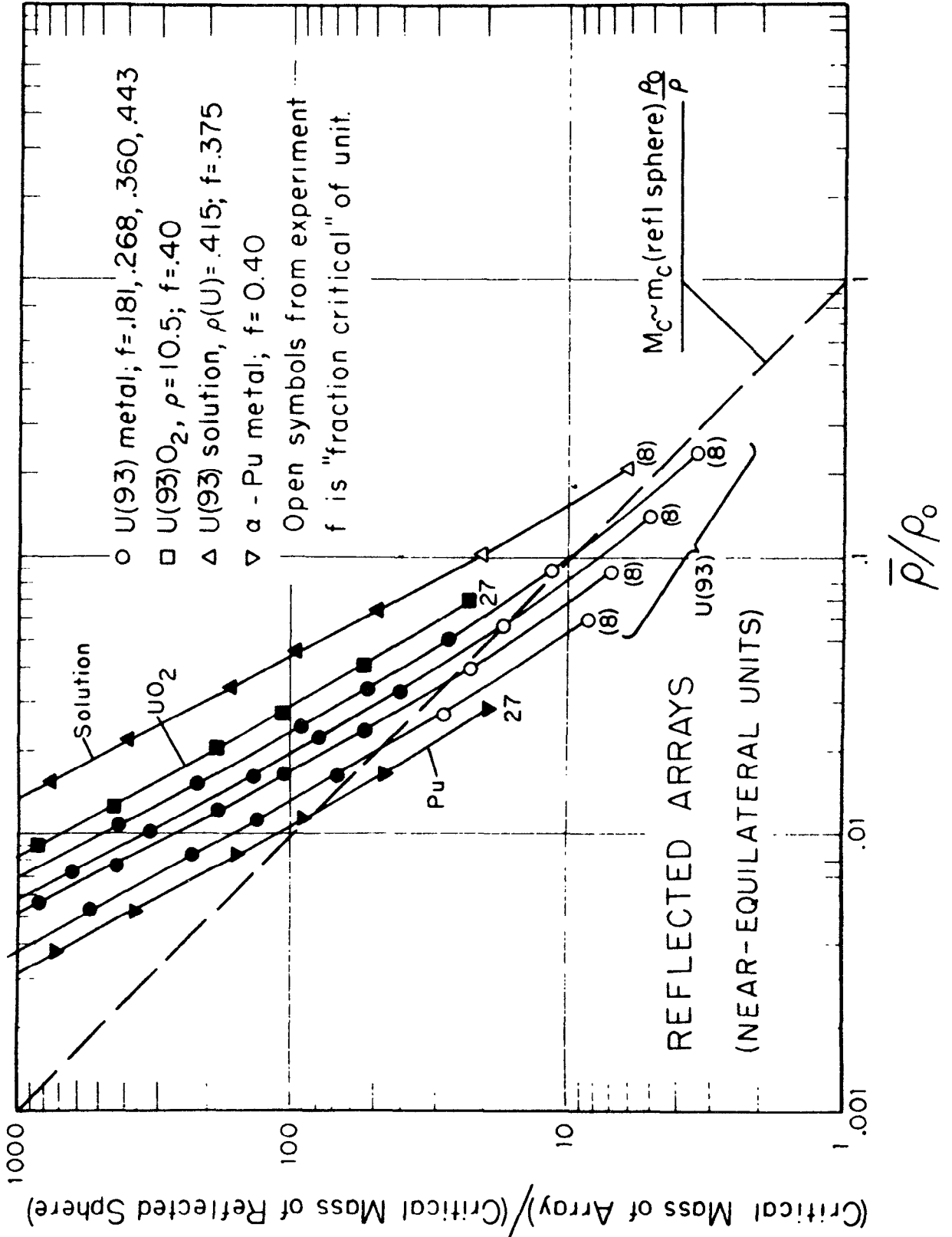


Fig. 6. Joe Thomas' Density Analog Modification Compared With Oak Ridge Array Data. The Curve Shown is for Extremely Reactive Units.

