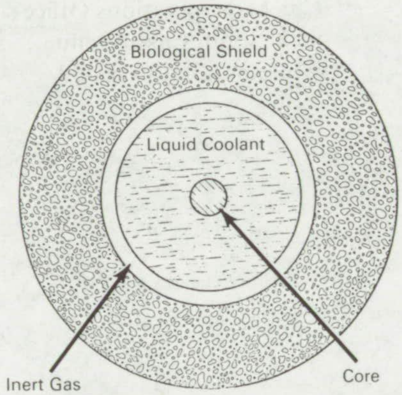
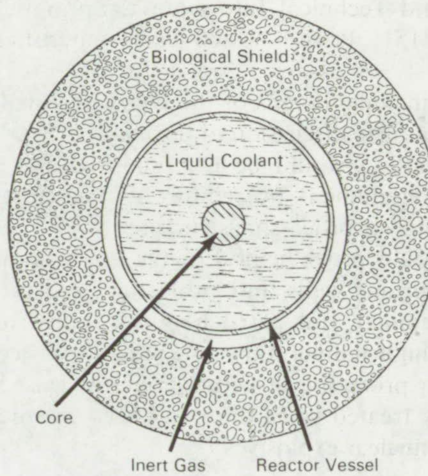
AEC-NASA TECH BRIEF

Hydrodynamics of a New Concept of Primary Containment by Energy Absorption





To determine the effect the destructive component of a nuclear accident produces on a primary containment structure, a fluid dynamical analysis has been made for an idealized reactor system having spherical symmetry.

To reduce the cost of primary nuclear containment and to provide reliable safety factors for credible nuclear accidents, a new approach for primary containment by energy absorption is proposed. High-strength steel strands are placed in the biological shield to form a basketlike configuration around the reactor cavity. The strands are placed in conduits to prevent bond with the concrete. The energy-absorbing process is accomplished by the plastic deformation that the strands are capable of exhibiting. This approach eliminates the expensive multiple steel cylinders in the reactor cavity and extends the primary containment system to include the concrete biological shield.

The purpose of the investigation is to make a fluid dynamical analysis of the energy release of a nuclear accident in order to (1) obtain general information on how the destructive component propagates and changes with time, and (2) determine the effect of the destructive component on the concrete primary-containment structure so that the rate of strain for the strands can be calculated. The destructive component is separated into three elements: (1) The shock wave; (2) The fluid momentum due to passage of the shock wave; and (3) The expanding gas bubble at high temperature and pressure pushing on the fluid.

Two solutions for an example problem are given. Part I presents the solution for an ideal reactor system (left figure) that does not include the reactor vessel. Part II gives the solution for the same ideal reactor system but with the reactor vessel included (right figure). In each case, the effect the destructive component produces on the concrete containment

(continued overleaf)

structure is determined from computer results and is discussed. The results of the two solutions are then compared.

The partial differential equations describing the fluid motion of the destructive component are based upon the von Neumann–Richtmeyer artificial-viscosity technique and are presented in Lagrangean form. A numerical solution based upon finite-difference approximations of these equations is obtained by the use of a CDC-3600 digital computer.

Notes:

1. This information, conducted by H. C. Sorensen and S. H. Fistedis of Argonne National Laboratory, has been reported in "Hydrodynamics of a New Concept of Primary Containment by Energy Absorption," ANL-7214, December 1966. This report is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; Price – $3.00 each (microfiche $0.65).
2. The report includes details of the computer analysis and a complete discussion of the results.
3. This information would be helpful in studies of explosion containment by reinforced-concrete explosive storage or processing structures.
4. The work could prove helpful in the analysis and design of curtain walls and protective structures for the chemical and petrochemical industries. Vessels for high temperature and pressure processes and their protective structure could at least be qualitatively treated since the code uses chemical rather than nuclear explosives.
5. Inquiries concerning this report may be directed to:

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   Argonne National Laboratory
   9700 South Cass Avenue
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   Reference: B69-10046
   Source: H. C. Sorensen **and** S. H. Fistedis
   Reactor Engineering Division
   of Argonne National Laboratory
   (ARG-10242)

Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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