VIEW GRAPHS

ACCOMPANYING PRESENTATIONS

BY R. LIPINSKI AND

W. MURFIN

SANDIA LABORATORIES

ON

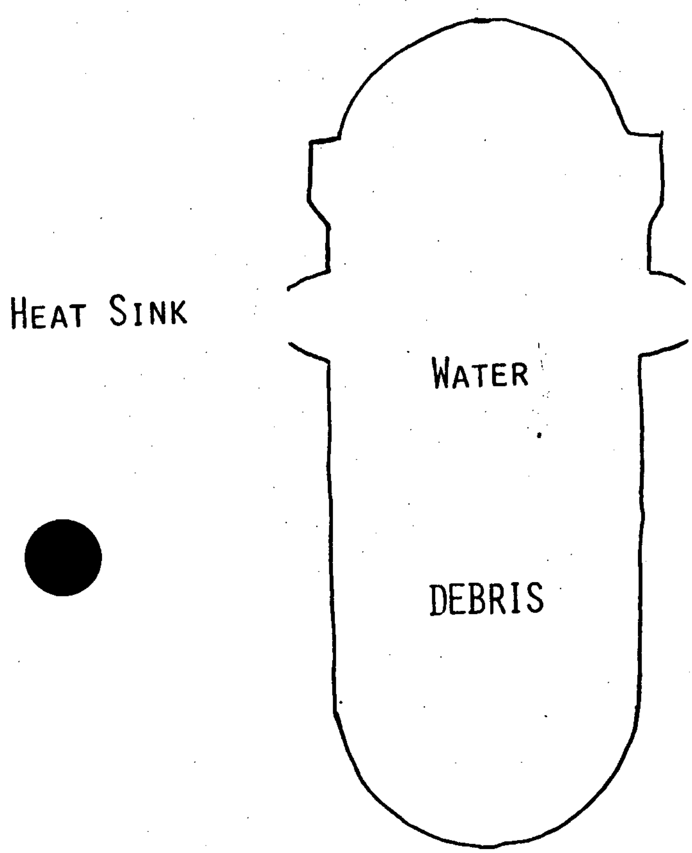
IN-VESSEL AND
EX-VESSEL DEBRIS BED
COOLABILITY

AND

BASE MAT PENETRATION
ASSUMPTIONS

MAY 7, 1930

IN-VESSEL DEBRIS BED COOLING



HEAT SINK

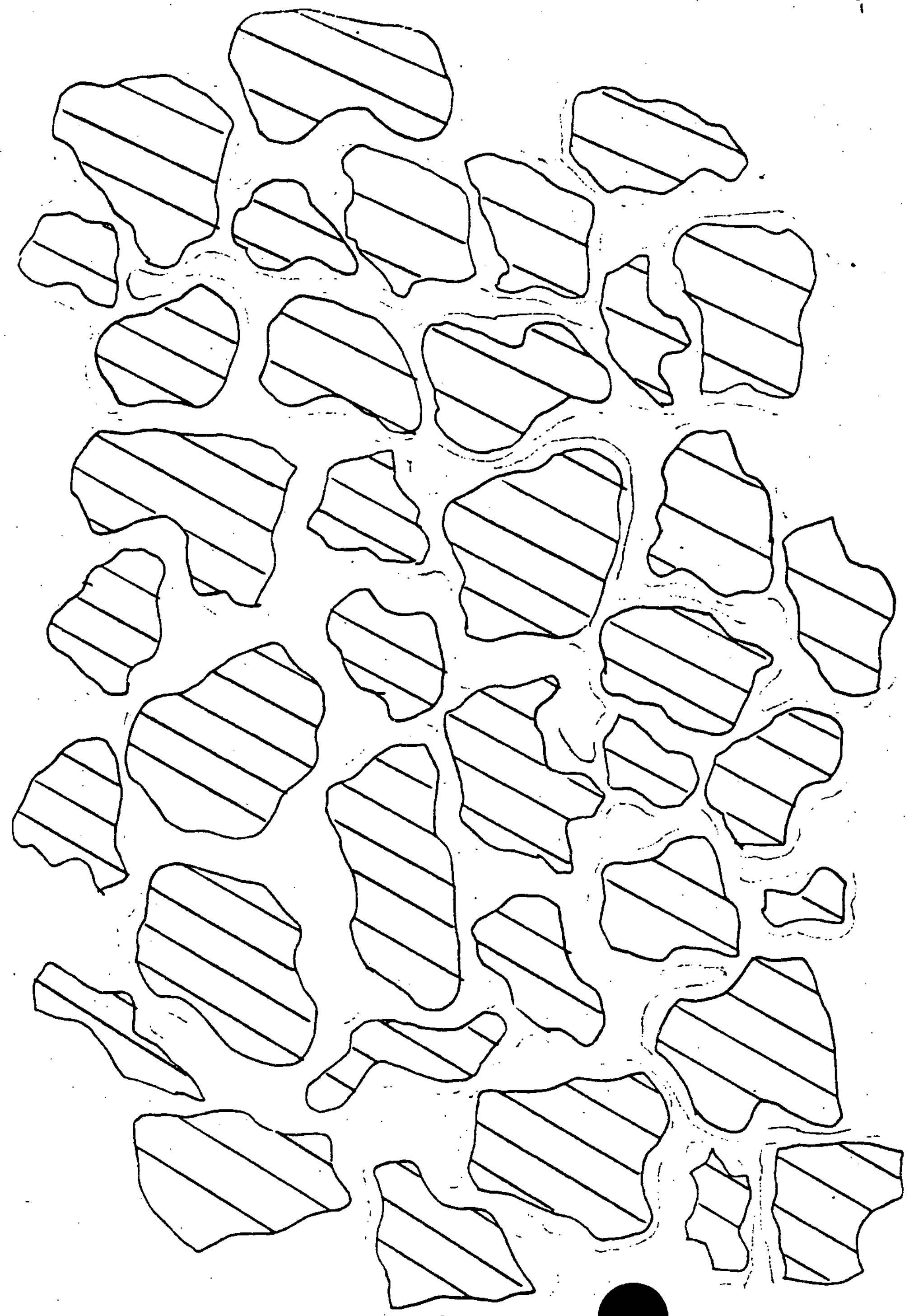
WATER

PARTICLE BED

IMPERMEABLE SUPPORT PLATE

BOILING

LIPINSKI
SNL

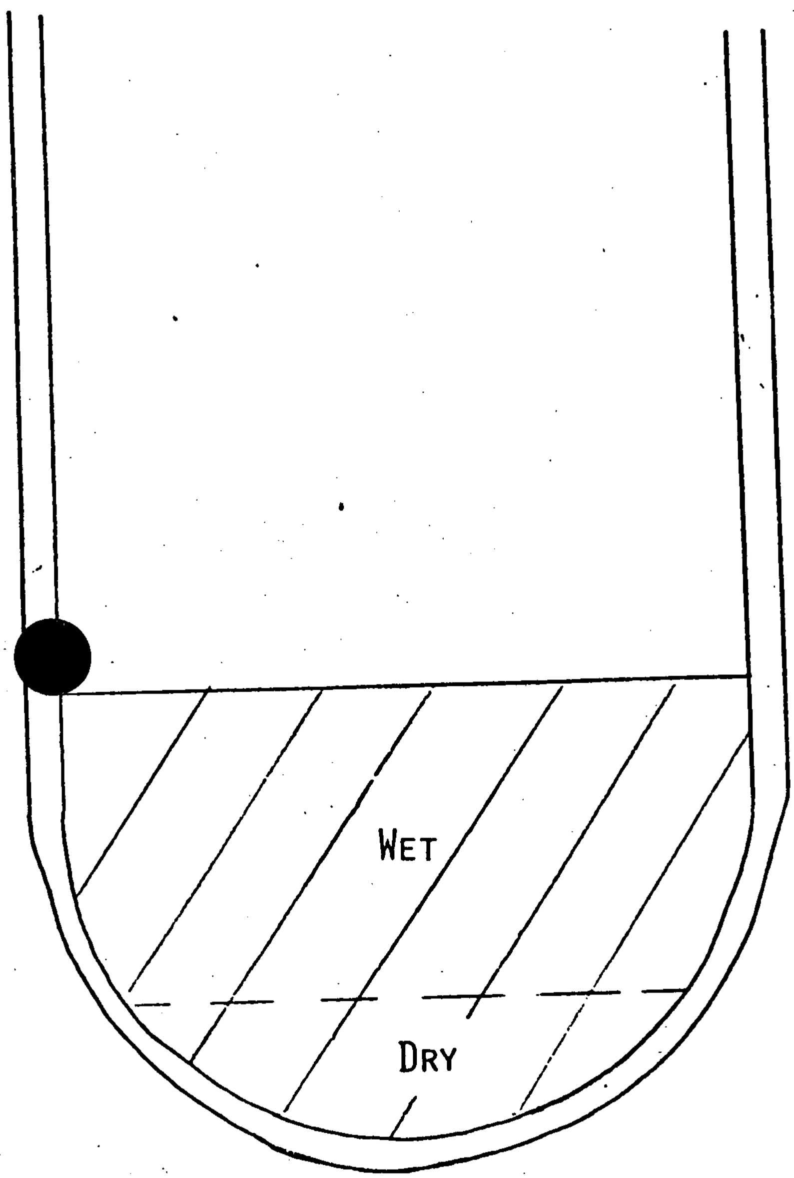


HEAT REMOVAL BY BOILING WATER

ONE LIMIT IS

$$d < \sqrt{24\, k\, \Delta T / S}$$

$$d < 10 \text{ INCHES}$$



SMALL PARTICLES YIELD DRYOUT

DRYOUT LEADS TO HIGH TEMPERATURE

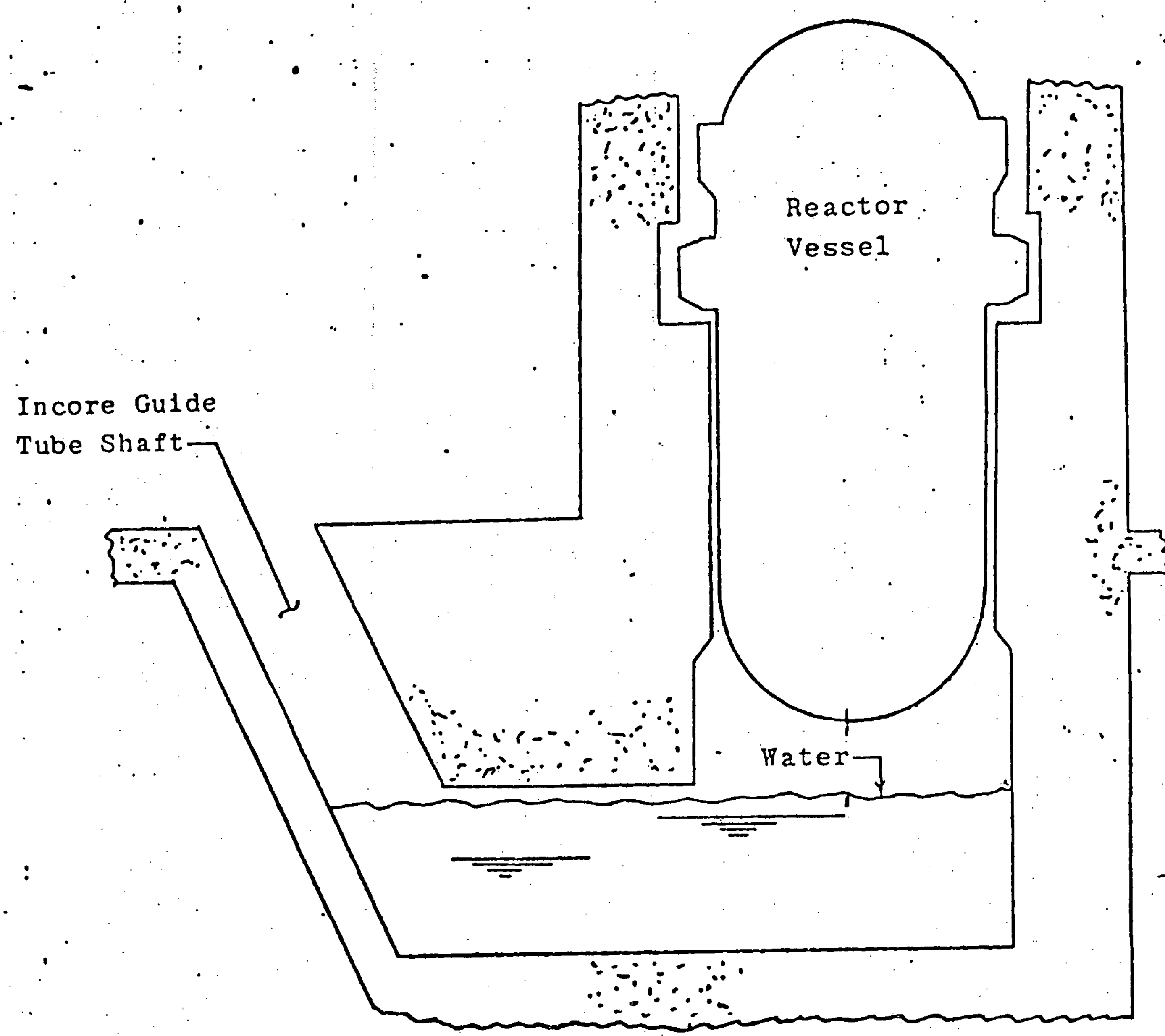
FUEL MELT WITH A 3.5 INCH DRY ZONE

DRYOUT IS PRINCIPAL CONCERN OF

PARTICLE BED STUDIES

OTHER LIMIT IS

$d > ?$



Reactor
Vessel
Incore Guide
Tube Shaft
Water

EFFECTS OF WATER IN THE CAVITY
ASSUMPTIONS

- At Least 300,000 Pounds of Water in the Cavity (7 Feet Deep)
  - Amount Can Vary Widely
- The Water is Initially at the Atmospheric Boiling Point
  - Could be Cooler But Effect is Small
- Amount and Temperature of Core Melt Determined by MARCH
  - All UO_2 and Zr Plus More than Equal Mass of Structure
  - 2550 K (4130°F) Molten
- All of Debris is Quenched by the Water in a Short Time (Dictated by Condensation Rate)
  - Sudden Vessel Failure and Core Dump
  - Thorough Mixing
  - No Dispersal onto Dry Surfaces

BASE PENETRATION - ASSUMPTIONS - INITIAL CONDITIONS

* DEBRIS COMPOSITION -
  - ALL UO_2
  - ALL Zr AS ZrO_2
  - BOTTOM HEAD
  - IN-CORE STEEL
  - PART CORE BARREL AND SUPPORT STRUCTURE
* INITIAL TEMPERATURES AS CALCULATED BY MARCH
* DEBRIS FALLS INTO DRY CAVITY, OR IF WATER IS PRESENT, DEBRIS IS NOT PERMANENTLY COOLED, DRIES OUT, AND REMELTS
* INITIAL CONTACT AREA = 29.2-45.4 m^2
* INITIAL CAVITY IS FLAT BOTTOMED

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* AS A CONSEQUENCE OF THE ASSUMPTION ON COOLING OF DEBRIS, MELT INTERACTS WITH CONCRETE. IF DEBRIS IS PERMANENTLY COOLED, NO INTERACTION TAKES PLACE

BASE PENETRATION - ASSUMPTIONS - CONCRETE

* GRANITIC, LIMESTONE, OR CRBR CONCRETE
* INITIALLY 20° C
* REBAR 13.5 WT. PERCENT
* NO SPALLATION OR CRACKING
* QUASI-STEADY STATE ABLATION
* EFFECTIVE HEAT OF ABLATION INCLUDES DECOMPOSITION REACTIONS
* ALL CONCRETE TYPES ASSUMED TO HAVE 4% INITIAL FREE WATER

BASE PENETRATION - ASSUMPTIONS - DECAY POWER

* POWER AND NUCLIDES BY ORIGEN - "AVERAGE" PWR FUEL MANAGEMENT
* FISSION PRODUCT RELEASE PER WASH1400
* MOST FISSION PRODUCTS IN OXIDE PHASE. METALLIC PHASE HAS ONLY NOBLE METALS, PLUS METALLIC ACTIVATION PRODUCTS, PLUS RU, PLUS PART TE
* OXIDATION OF METALLIC FISSION PRODUCTS BY GASES NOT ACCOUNTED FOR

BASE PENETRATION - ASSUMPTIONS - POOL THERMO-HYDRAULICS

* DENSITY DRIVEN SEPARATION OF METALLIC AND OXIDE PHASES
* ISOTHERMAL LAYERS
* GAS BUBBLE DRIVEN CIRCULATION
* HEAT TRANSFER TO CONCRETE ACROSS GAS FILM
* LIQUID CONCRETE CONSTITUENTS INCORPORATED INTO OXIDE PHASE
* LIQUID REBAR INCORPORATED INTO METALLIC PHASE
* PERCOLATING GASES REACT WITH MELT
* PROPERTIES ARE FUNCTIONS OF TEMPERATURE AND COMPOSITION
* UPPER SURFACE HEAT TRANSFER VIA:

  1. RADIATION TO REACTOR REMNANTS INITIALLY 500° C PLUS CONCRETE INITIALLY 100° C; HEAT TO MELTING POINTS; MOLTEN MATERIALS DRIP INTO POOL

     -OR-

  2. CONSTANT 500° C SURROUNDINGS

     -OR-

  3. QUIESCENT WATER POOL

* EMPIRICAL AEROSOL GENERATION MODEL

BASE PENETRATION - ASSUMPTIONS - SOLIDIFICATION BEHAVIOR

* EACH PHASE SOLIDIFIES INDEPENDENTLY
* SOLIDUS TEMPERATURE OF EACH PHASE IS DETERMINED BY COMPOSITION
* INSTANTANEOUS SOLIDIFICATION OF AN ENTIRE PHASE
* POST-SOLIDIFICATION PENETRATION RATE = 2-3 CM/HR
* NO DEFINITION OF CAVITY SHAPE AFTER SOLIDIFICATION