U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: REGULATIONS, CODES, AND STANDARDS FOR CASK DESIGN

PRESENTER: MARILYN WARRANT

PRESENTER'S TITLE AND ORGANIZATION:
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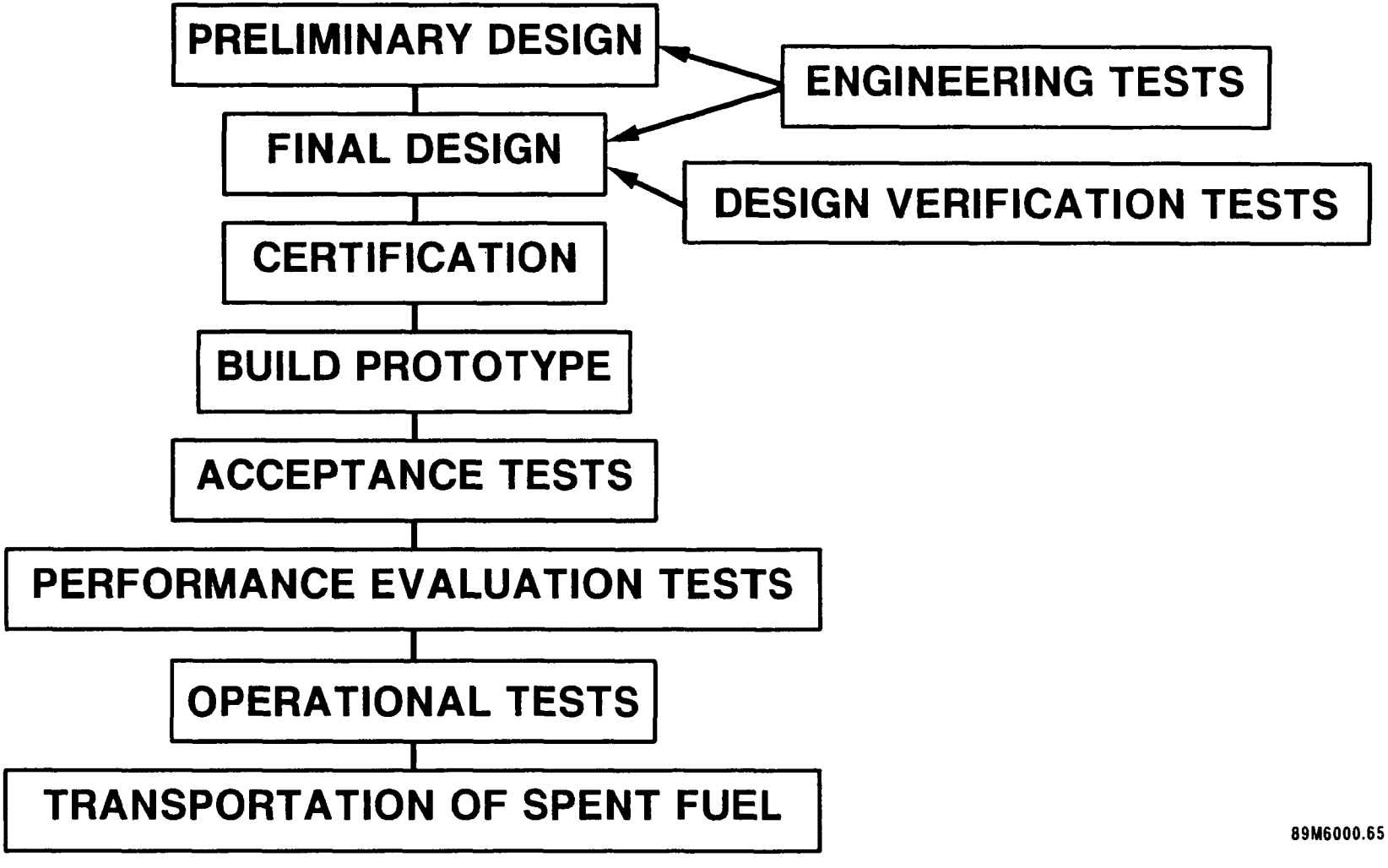
AUGUST 21, 1989

PROCESS FOR DEVELOPING A SPENT FUEL CASK



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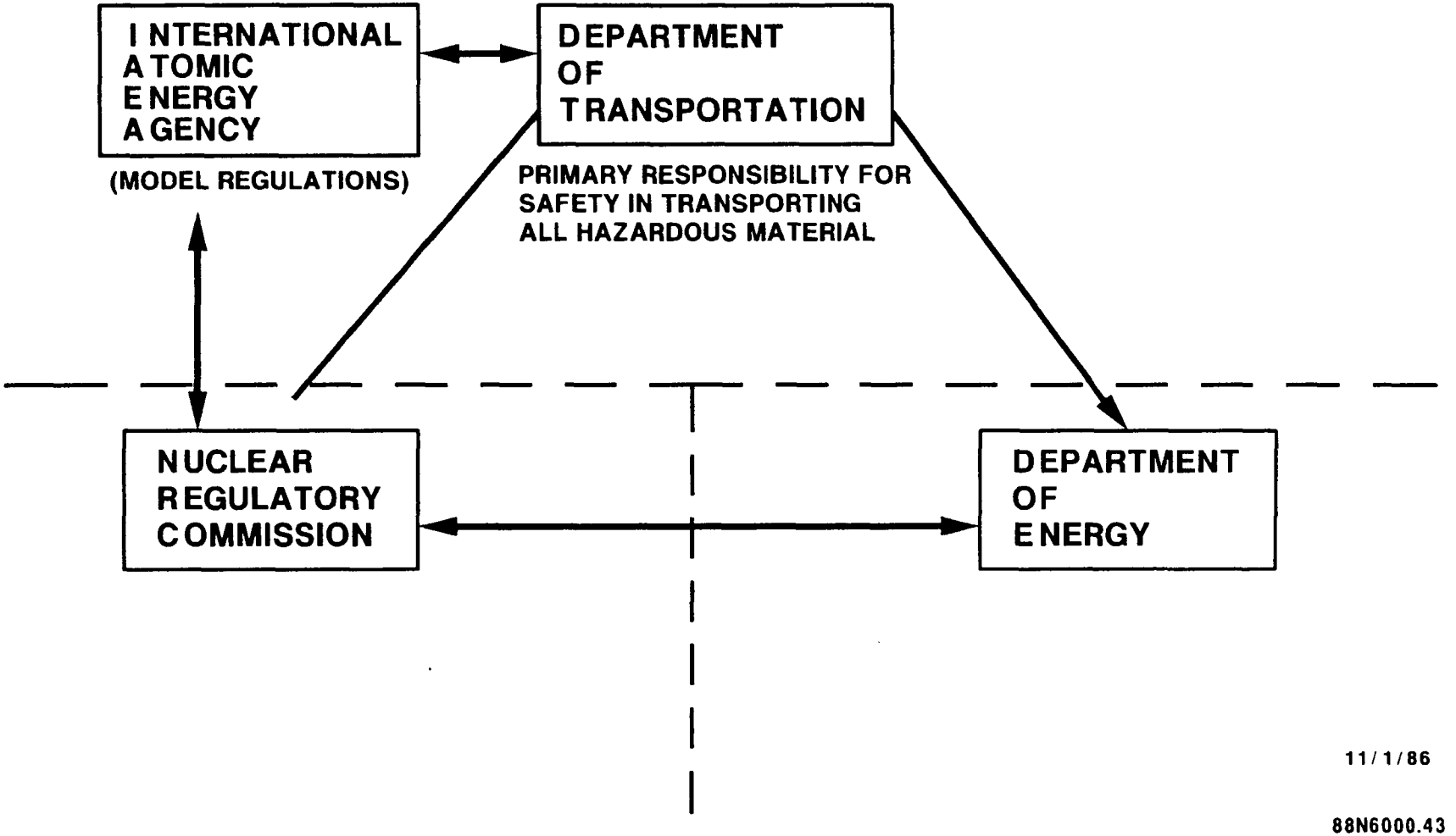
SAFE TRANSPORTATION REGULATION



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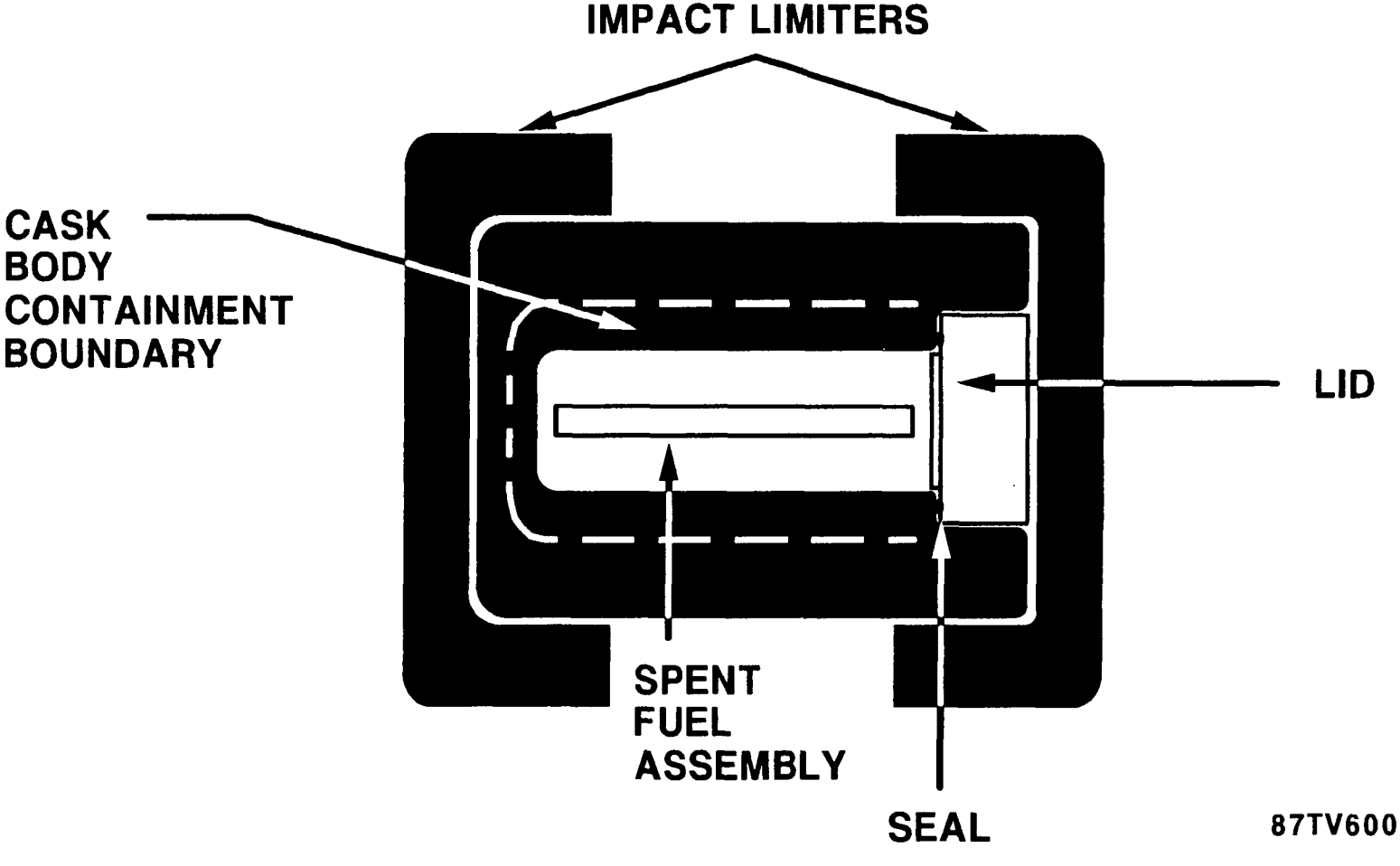
REGULATORY PHILOSOPHY

- GOAL IS TO MAINTAIN LOW RISK REGARDLESS OF CONTENTS
- PACKAGING PROVIDES PRIMARY PROTECTION
- REGULATIONS SPECIFY PERFORMANCE FOR PACKAGINGS
- ENGINEERING CRITERIA REQUIREMENTS ARE USED TO SIMULATE DAMAGE OF TRANSPORTATION ACCIDENTS
- PACKAGE PERFORMANCE IS DEMONSTRATED BY ANALYSIS OR TESTING

CONTAINMENT



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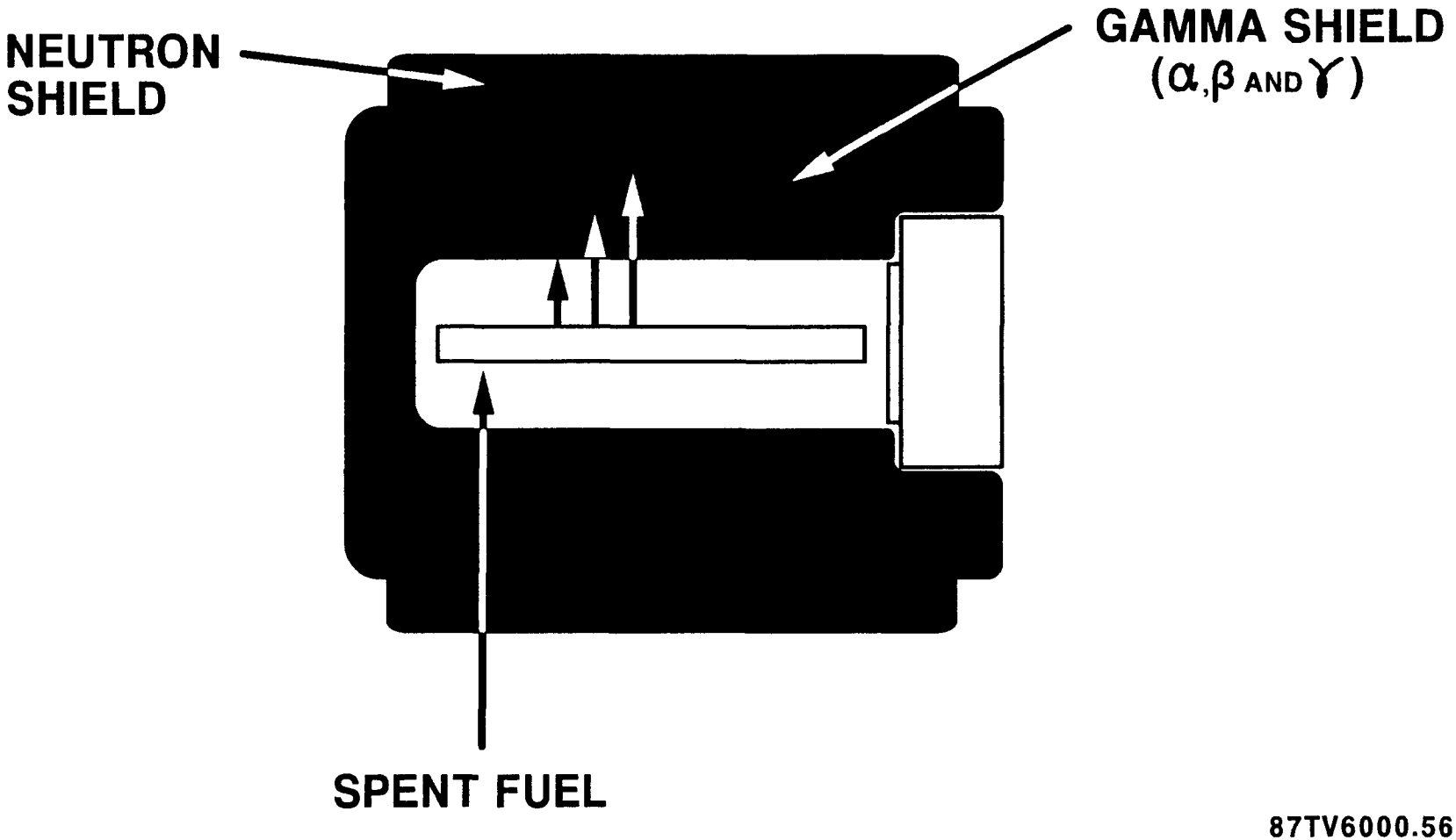
CONTAINMENT

- NO RELEASE OF MATERIAL UNDER NORMAL TRANSPORT CONDITIONS MEASURED TO A SENSITIVITY OF $A_2 \times 10^{-6}$/HR
- LIMITED RELEASE UNDER HYPOTHETICAL ACCIDENT CONDITIONS (A_2 / WEEK)

SHIELDING



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SHIELDING

- LIMITED EXTERNAL EXPOSURE
- LIMIT FOR NORMAL CONDITIONS OF TRANSPORT
  - $\leq$ 200 MILLIREM/HR AT SURFACE
  - $\leq$ 10 MILLIREM/HR AT 2 METER
- LIMIT FOR ACCIDENT CONDITIONS
  - $\leq$ 1 REM/HR AT 1 METER

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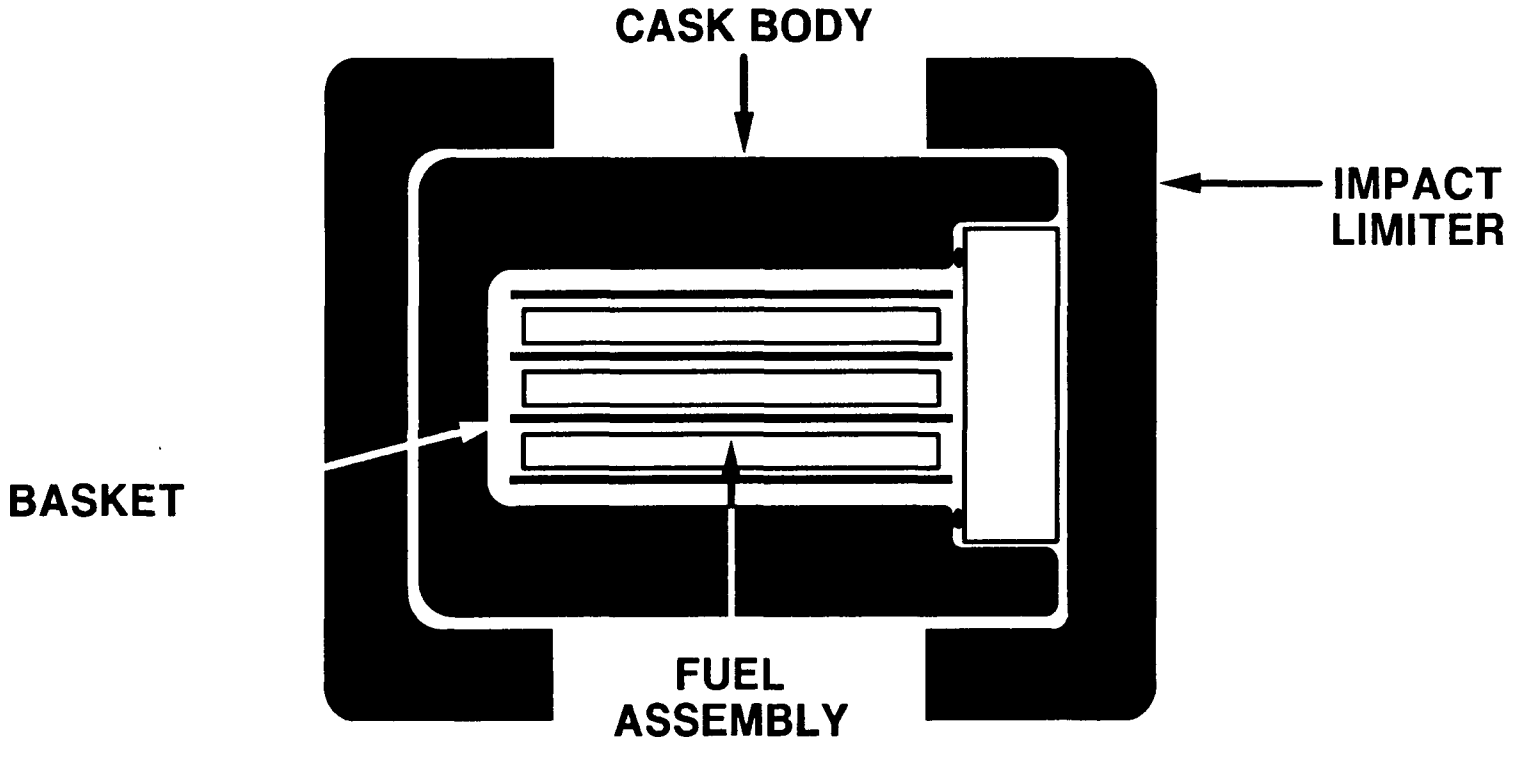
PREVENTING A SUSTAINED NUCLEAR CHAIN REACTION



OPTIONS:

- MAINTAIN ACCEPTABLE GEOMETRY WITH BASKET
- USE "POISONS" IN BASKET TO ABSORB NEUTRONS
- EXCLUDE MODERATOR FROM CASK CAVITY

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CRITICALITY

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CASK PERFORMANCE REQUIREMENTS

- CONTAINMENT OF RADIOACTIVE MATERIAL
- CONTROL OF RADIATION EMITTED FROM THE MATERIAL
- DISSIPATION OF ANY HEAT GENERATED BY THE MATERIAL
- MAINTENANCE OF A "SUB-CRITICAL" CONDITION

NORMAL CONDITIONS OF TRANSPORT

(1) HEAT

(2) COLD

(3) REDUCED PRESSURE

(4) INCREASED PRESSURE

(5) VIBRATION

(6) WATER SPRAY

(7) FREE DROP

(8) CORNER DROP

(9) COMPRESSION

(10) PENETRATION

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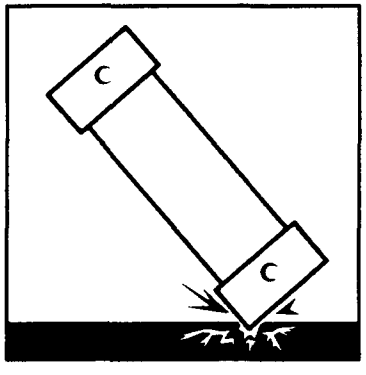
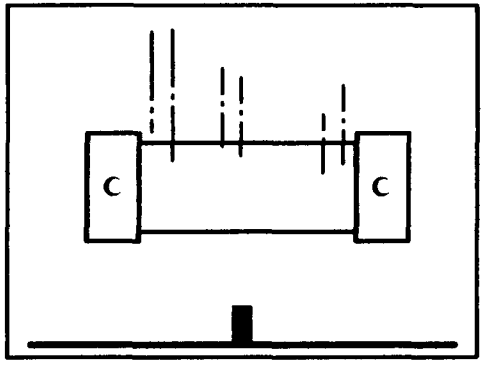
NRC DESIGN PERFORMANCE STANDARDS

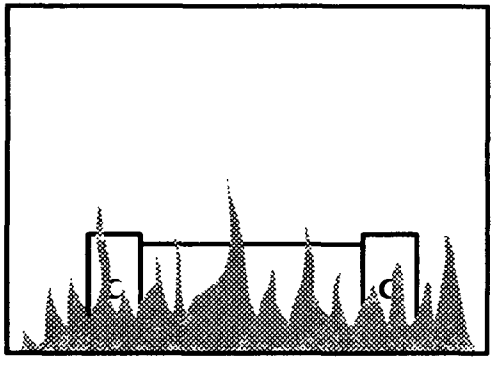
10 CFR 71 HYPOTHETICAL ACCIDENT CONDITIONS



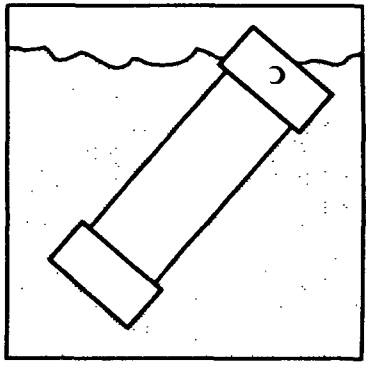
IMPACT



PUNCTURE



FIRE (1475°F)



IMMERSION

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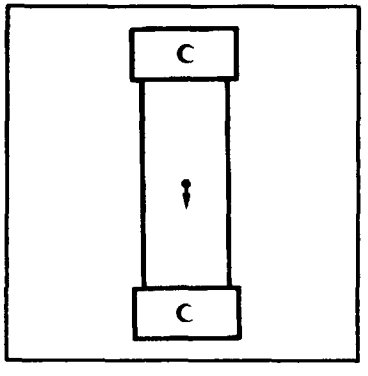
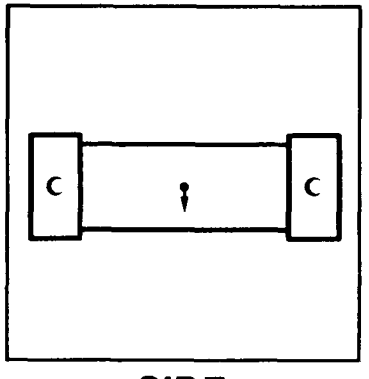
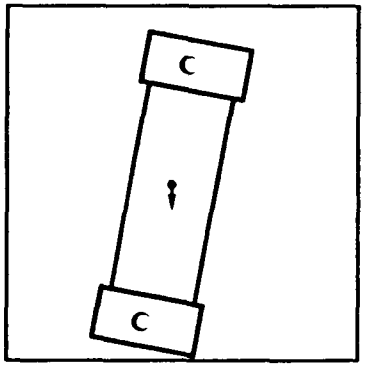
VARIOUS ORIENTATIONS ARE CONSIDERED FOR THE FREE DROP TEST



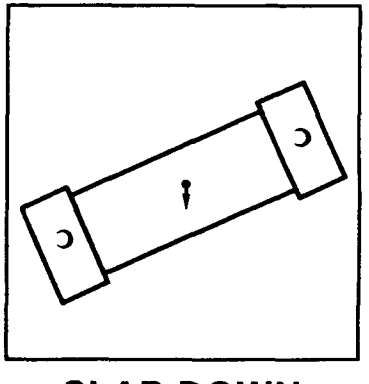
END



SIDE



CENTER OF GRAVITY OVER CORNER



SLAP DOWN

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TESTS
HYPOTHETICAL ACCIDENT CONDITIONS

- SEQUENTIAL TESTS
  - FREE DROP - 30 FEET ONTO AN UNYIELDING SURFACE
  - PUNCTURE DROP - 40 INCHES ONTO A 6 INCH DIAMETER, MILD STEEL, PUNCTURE BAR
  - THERMAL - 30 MINUTE EXPOSURE TO 1475°F FULLY ENGULFING THERMAL ENVIRONMENT
  - IMMERSION - 50 FEET BELOW SURFACE FOR 8 HOURS

QUESTIONS CONCERNING CURRENT REGULATORY PERFORMANCE TESTS

- IS THERE A TECHNICAL CONNECTION TO ACTUAL ACCIDENT CONDITIONS?
- ARE THE REGULATIONS REPRESENTATIVE OF EXTREMELY SEVERE REAL-WORLD ACCIDENTS?
- DO THE REGULATIONS ADDRESS POTENTIAL HIGH CONSEQUENCE - LOW PROBABILITY TRANSPORTATION ACCIDENT EVENTS?

NRC ASSESSMENTS OF SAFETY PROVIDED BY TRANSPORT REGULATIONS

- 10CFR51.52 -- "ENVIRONMENTAL EFFECTS OF TRANSPORTATION OF SPENT FUEL AND WASTE -- TABLE S-4"

- WASH-1238 -- "ENVIRONMENTAL SURVEY OF TRANSPORTATION OF RADIOACTIVE MATERIALS TO AND FROM NUCLEAR POWER PLANTS" (12/72); SUPPL. 1, NUREG-75/038 (4/75)

- NUREG-0170 -- "FINAL ENVIRONMENTAL STATEMENT ON THE TRANSPORTATION OF RADIOACTIVE MATERIAL BY AIR AND OTHER MODES" (12/77)

- NUREG/CR-4829 -- "SHIPPING CONTAINER RESPONSE TO SEVERE HIGHWAY AND RAILWAY ACCIDENT CONDITIONS" (2/87)

DOE/OCRWM VIEW OF SAFETY PROVIDED BY REGULATIONS

- NRC REGULATIONS ARE GENERALLY CONSISTENT WITH IAEA REGULATIONS
- REGULATIONS ARE INTEGRAL PART OF OCRWM's EFFORTS TO DEVELOP SAFE CASKS
- DOE/OCRWM PERFORMS INDEPENDENT TECHNICAL ASSESSMENTS OF CASK SAFETY

NRC REGULATORY PRACTICE ESTABLISHED BY

- REGULATIONS
- REGULATORY GUIDES
- NUREG DOCUMENTS
- PRECEDENTS
- STANDARDS (ASTM, ANSI)
- REVIEWS OF ANALYSES AND TESTS

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USE OF ANALYSES IN DESIGN

- PRELIMINARY ANALYSES TO DETERMINE CASK PARAMETERS
  - WALL THICKNESS
  - IMPACT LIMITER STRENGTH
  - BOLT SIZE
- DETAILED CONFIRMATORY ANALYSES TO SIMULATE CASK RESPONSE TO NORMAL AND HYPOTHETICAL ACCIDENT CONDITIONS

IMPLEMENTATION OF REGULATIONS IN CASK DESIGN

- USE OF DESIGN GUIDELINES INCORPORATED IN NATIONALLY ACCEPTED REGULATORY GUIDES, DESIGN CODES, AND STANDARDS
- ANALYSIS OF THE DESIGN BY VALIDATED COMPUTER CODES
- VERIFICATION OF DESIGN ANALYSES WITH TEST DATA

ASTM SPECIFICATIONS

- PROVIDE ASSURANCE OF A STATED LEVEL OF MATERIAL QUALITY
  - LIST FABRICATION GUIDELINES
  - ESTABLISH MINIMUM PHYSICAL AND MECHANICAL PROPERTY VALUES
  - REQUIRE TESTING TO DEMONSTRATE MINIMUM PROPERTIES ARE MET

ASME BOILER AND PRESSURE VESSEL CODE SECTION III

- PROVIDES GENERAL DESIGN GUIDELINES FOR CONTAINMENT VESSELS
- SPECIFIES MAXIMUM ALLOWABLE STRESSES FOR MATERIALS ACCORDING TO THEIR USE
- DEFINES QUALIFICATION TESTS OF FABRICATED MATERIALS

ANSI N14 STANDARDS

PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIALS

EQUIPMENT

- TIEDOWNS
- TRAILERS
- ANCILLIARY EQUIPMENT

TESTING

- LEAKAGE TESTING

ENVIRONMENT

- SHOCK AND VIBRATION

GEOMETRIC REPRESENTATION OF A MATHEMATICAL MODEL

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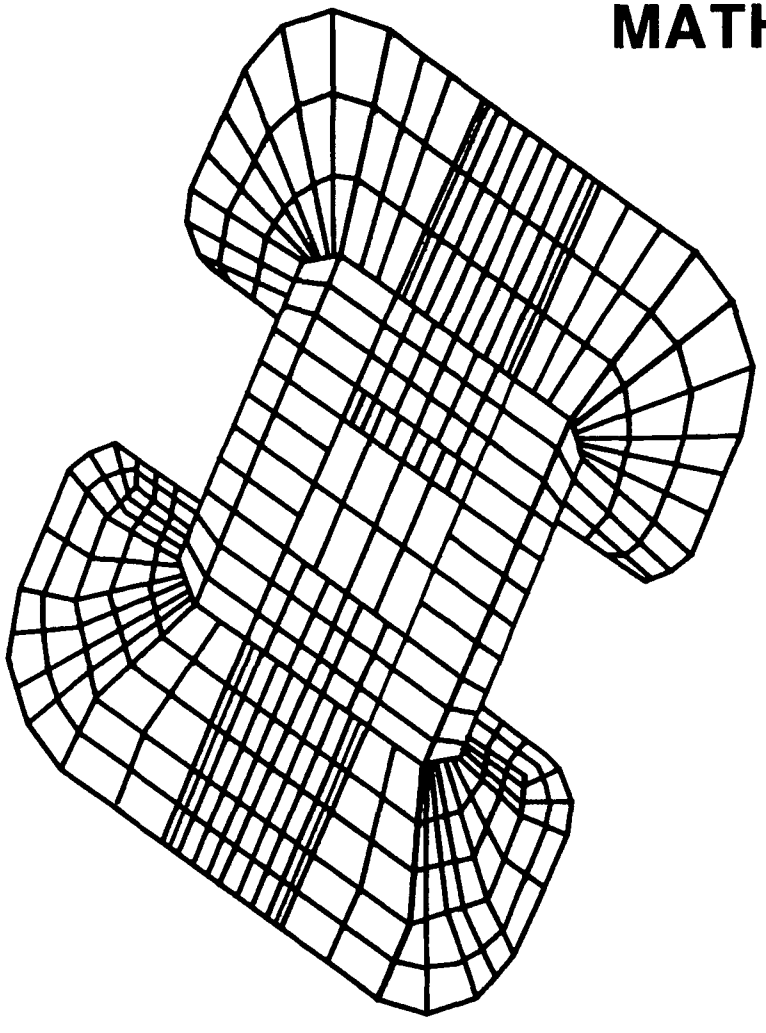
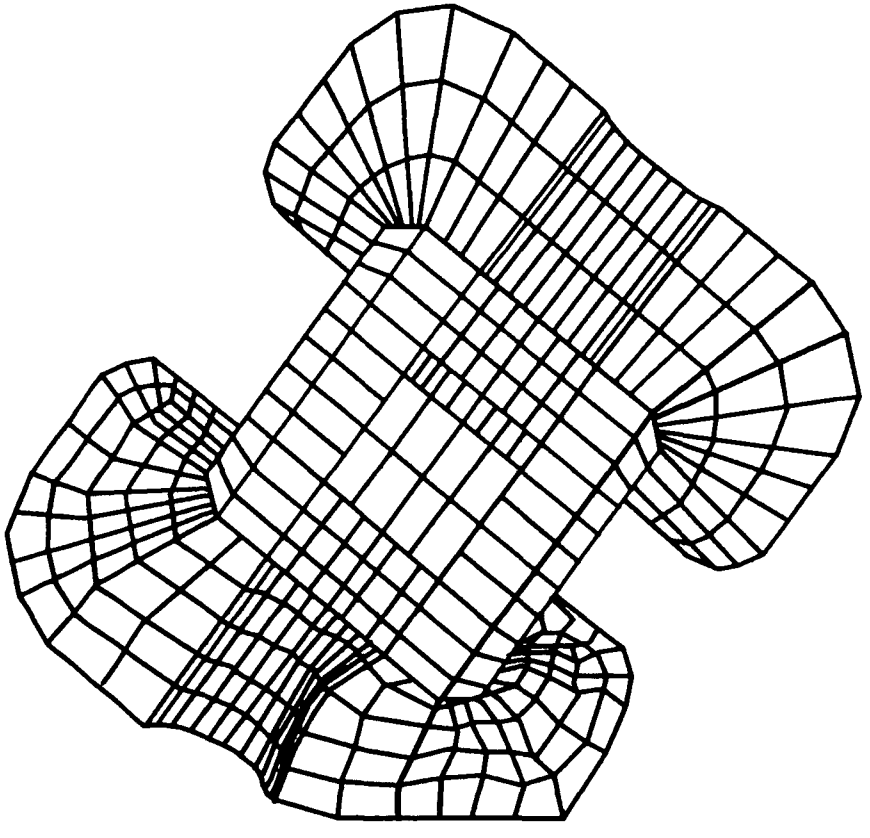


FINITE ELEMENT MESH FOR CASK CORNER DROP



DEFORMED SHAPE FOR CASK CORNER DROP

CODE VALIDATION (BENCHMARKING)

- CLOSED FORM ANALYTICAL SOLUTIONS
- EXPERIMENTAL DATA
- CONSENSUS OF NUMERICAL SOLUTIONS
- TESTS USER OF CODE ALSO

SAFETY ANALYSIS REPORT FOR PACKAGING CONTENTS

- PACKAGE DESCRIPTION
- ANALYSES AND TEST DATA
  (STRUCTURAL, THERMAL, CONTAINMENT SHIELDING, CRICALITY)
- ACCEPTANCE TESTS AND MAINTENANCE PROGRAM
- QUALITY ASSURANCE