

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

**PRESENTATION TO  
THE NUCLEAR WASTE TECHNICAL REVIEW BOARD**

**SUBJECT: CASK TESTING**

**PRESENTER: MARILYN WARRANT**

**PRESENTER'S TITLE  
AND ORGANIZATION:**

**SUPERVISOR  
TRANSPORTATION SYSTEMS DEVELOPMENT DIVISION  
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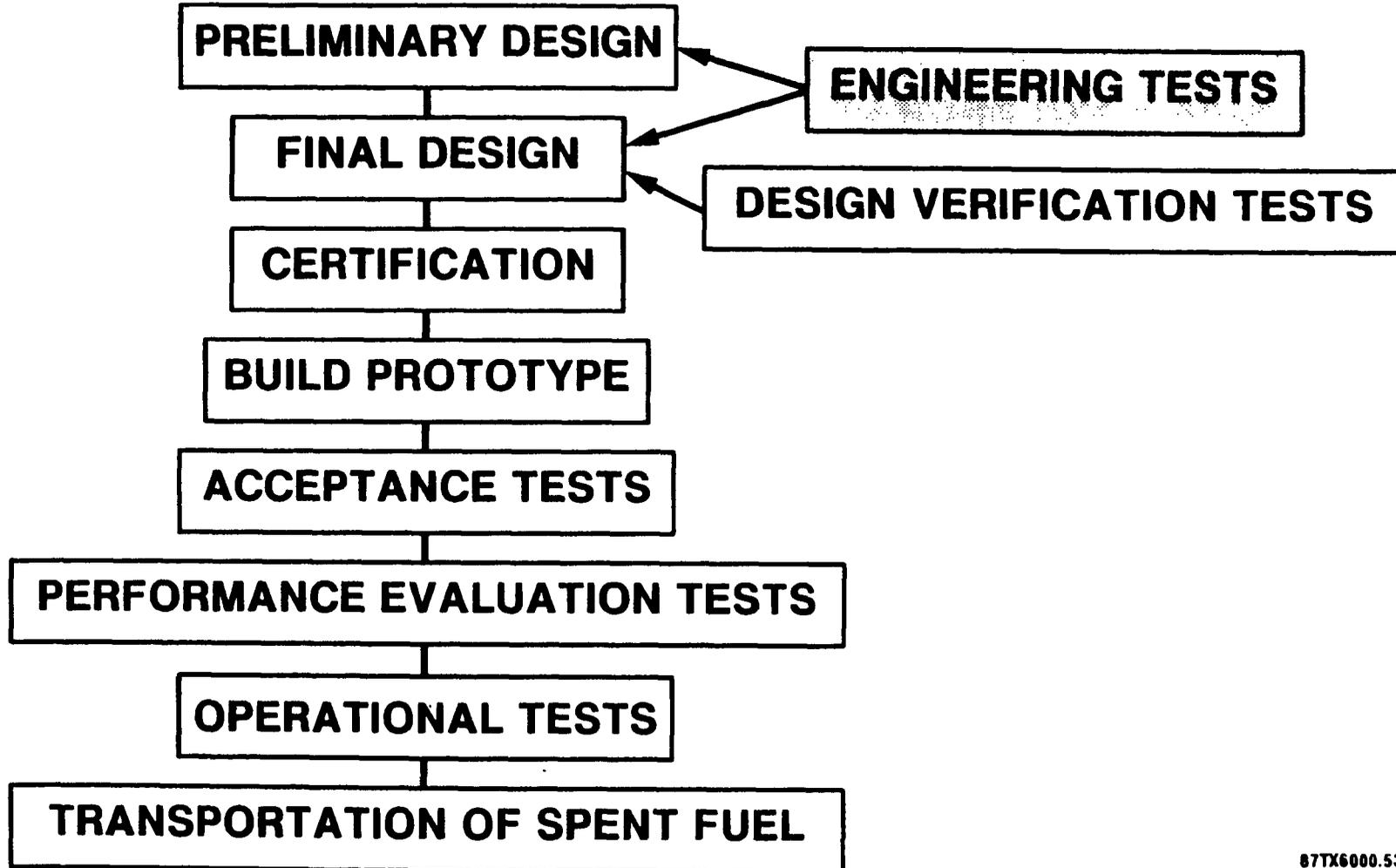
**PRESENTER'S  
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**AUGUST 21, 1989**

**89N6000.06**

# PROCESS FOR DEVELOPING A SPENT FUEL CASK



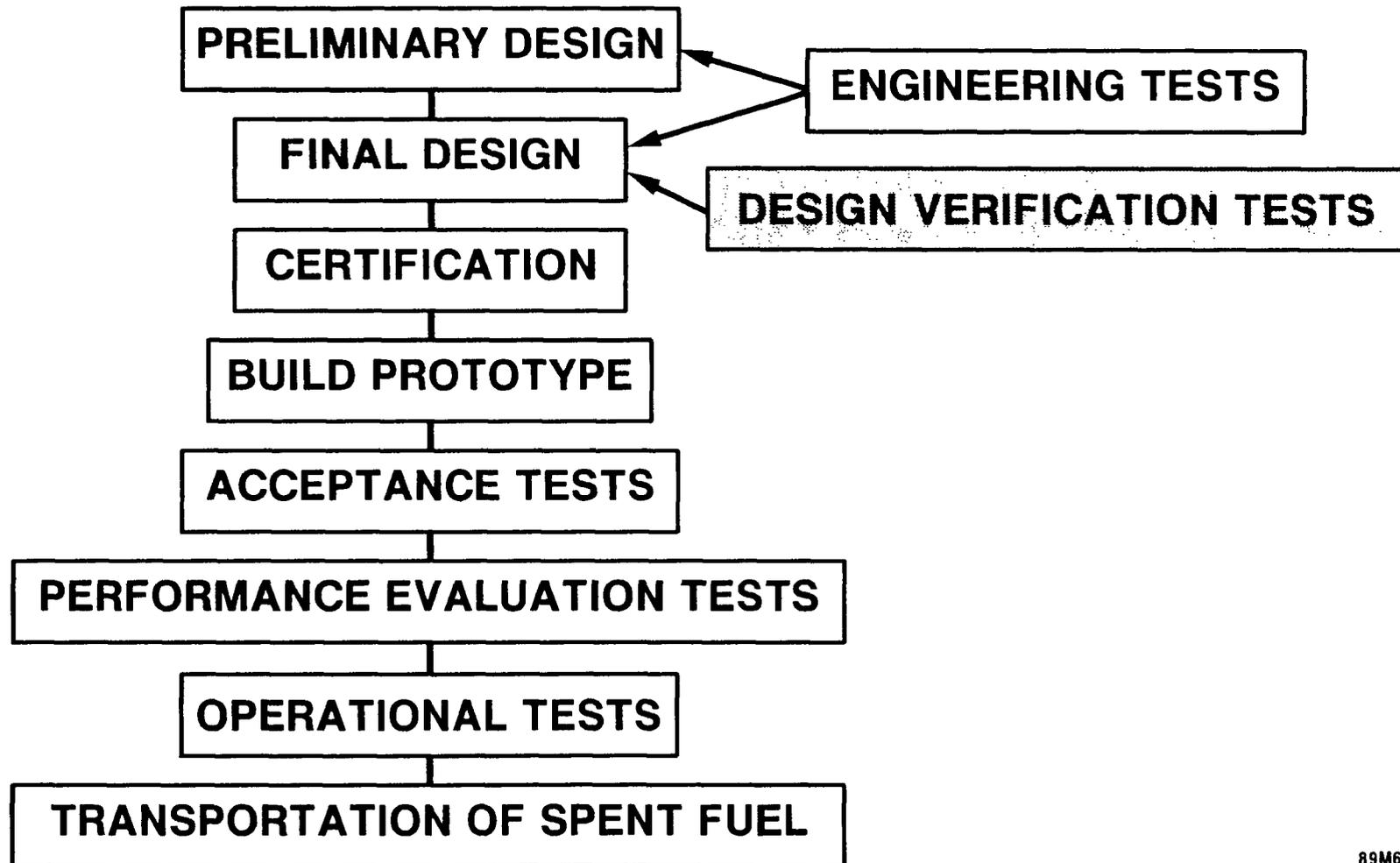
# **ENGINEERING TESTING**

**ENGINEERING TESTING YIELDS DATA ON COMPLEX BEHAVIOR OF MATERIALS AND COMPONENTS.**

**EXAMPLES ARE:**

- TEMPERATURE PERFORMANCE OF A SEAL**
- ENERGY ABSORPTION OF AN IMPACT LIMITER**
- MATERIAL PROPERTIES**

# PROCESS FOR DEVELOPING A SPENT FUEL CASK



# **INTEGRATION OF ANALYSIS AND SCALE MODEL TESTING**

- **ANALYTIC ASSUMPTIONS VERIFIED**
  - MATERIAL MODELS
  - BOUNDARY CONDITIONS
- **ANALYTICAL MODELS MODIFIED TO CORRESPOND WITH OBSERVED BEHAVIOR OF SCALE MODELS**
- **PACKAGE RESPONSE ANALYZED FOR NORMAL AND HYPOTHETICAL ACCIDENT ENVIRONMENTS NOT TESTED**

# SCALING RELATIONSHIPS FOR STRUCTURAL TESTS

**DISPLACEMENT:**  $L_{\text{model}} = 1/n \cdot L_{\text{full-scale}}$

**ACCELERATION:**  $a_{\text{model}} = n \cdot a_{\text{full-scale}}$

**FORCE:**  $F_{\text{model}} = (1/n)^2 \cdot F_{\text{full-scale}}$

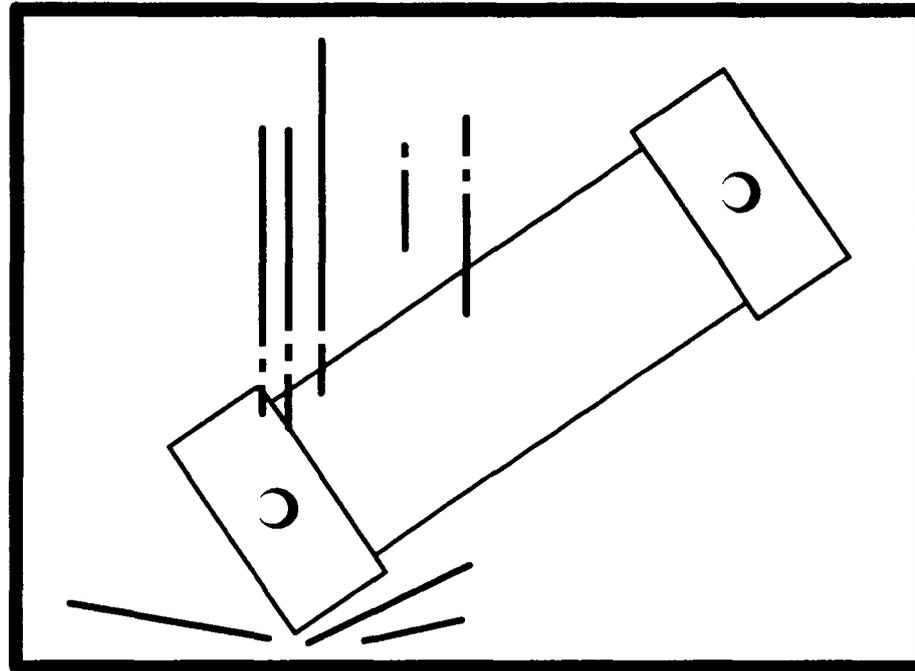
**VELOCITY:**  $V_{\text{model}} = V_{\text{full-scale}}$

**STRESS:**  $\sigma_{\text{model}} = \sigma_{\text{full-scale}}$

**STRAIN:**  $\epsilon_{\text{model}} = \epsilon_{\text{full-scale}}$

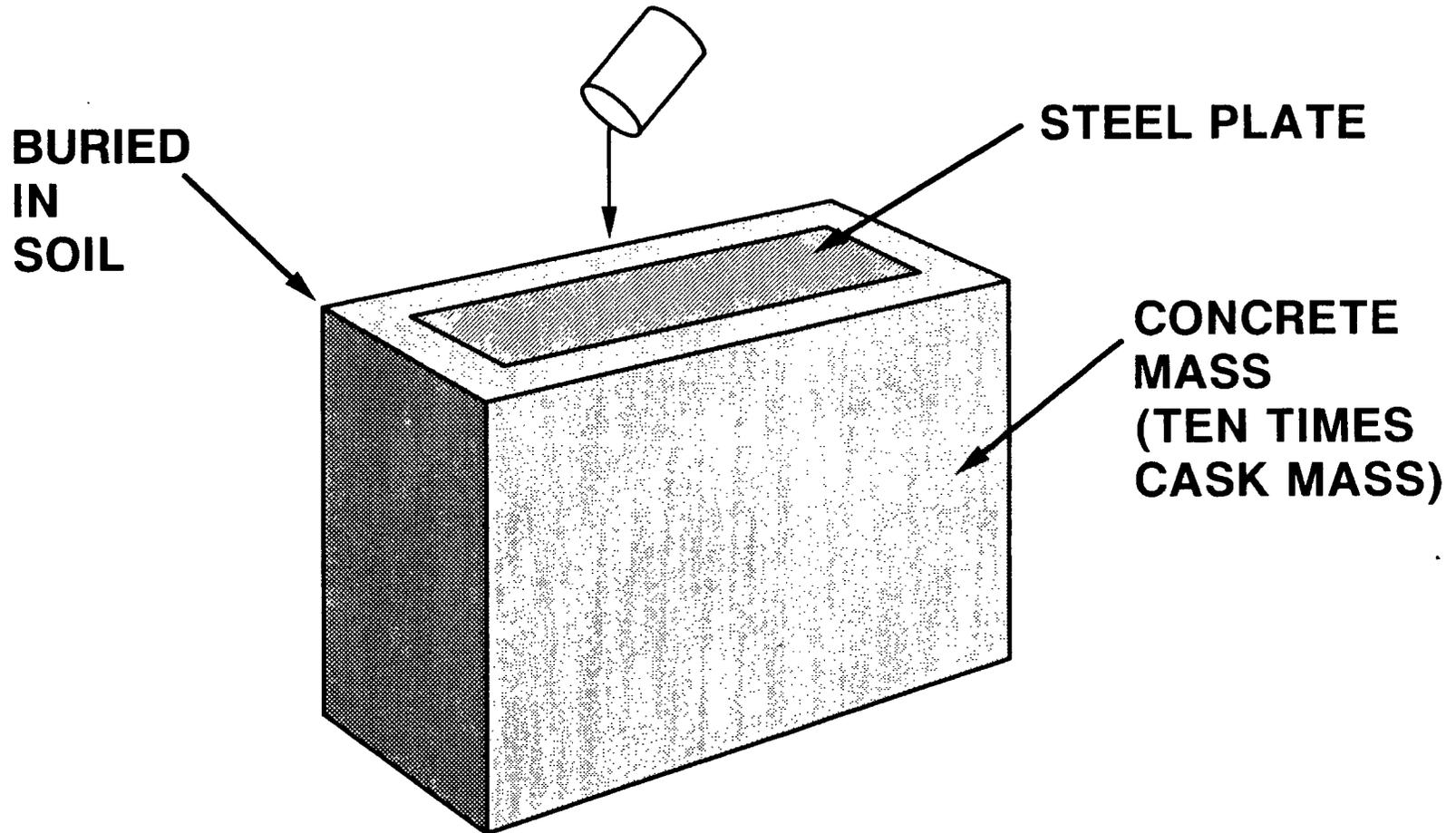
WHERE  $\frac{1}{n}$  = SCALE OF MODEL

## FREE DROP TEST

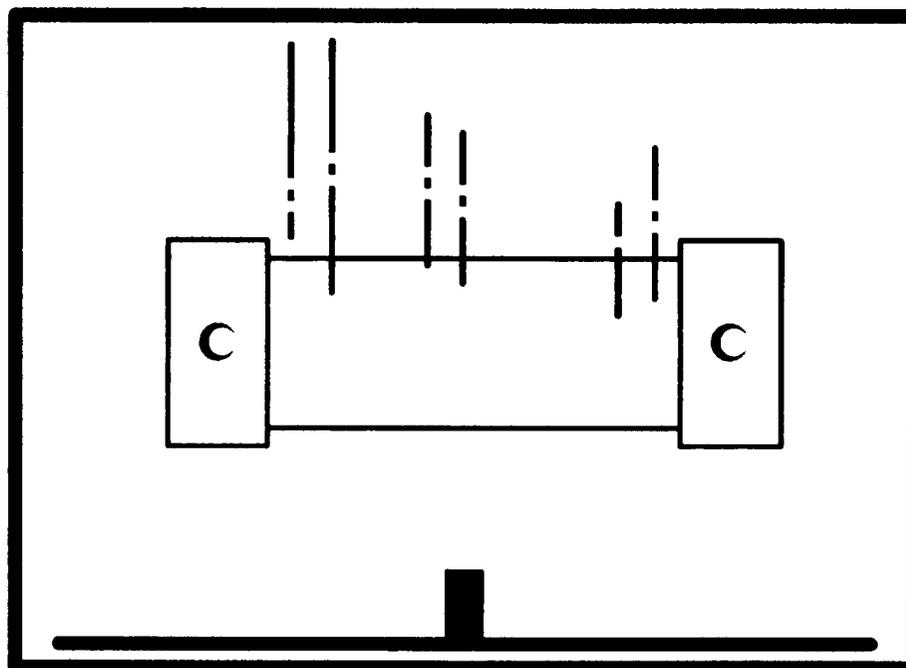


**THIRTY FOOT FREE DROP ONTO A FLAT, ESSENTIALLY  
UNYIELDING HORIZONTAL SURFACE IN A POSITION FOR  
WHICH MAXIMUM DAMAGE IS EXPECTED**

# UNYIELDING TARGET FOR TESTS



# PUNCTURE TEST



**FORTY INCH FREE DROP ONTO A 6 INCH DIAMETER MILD  
STEEL BAR AT LEAST 8 INCHES LONG IN A POSITION  
FOR WHICH MAXIMUM DAMAGE IS EXPECTED.**

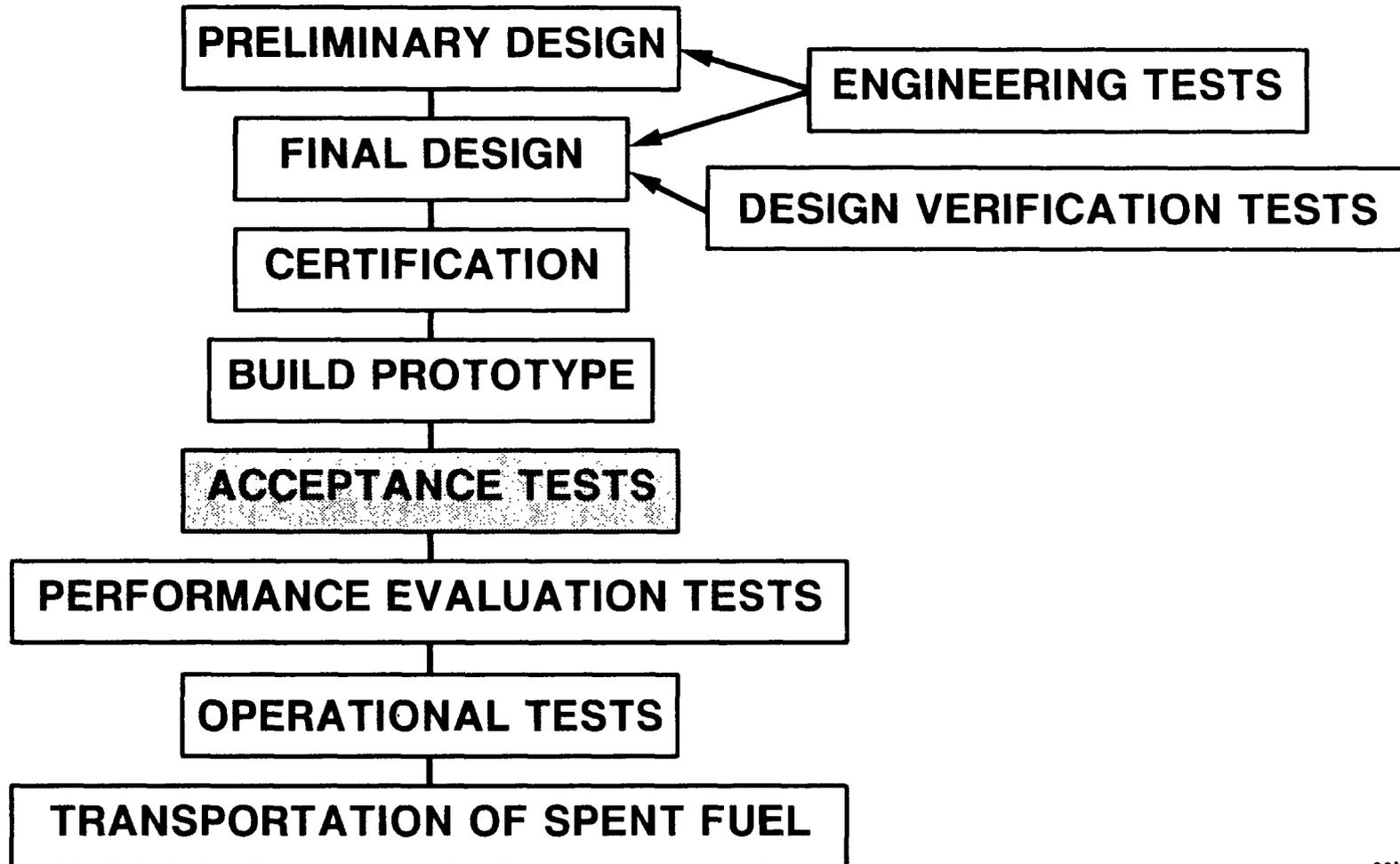
# **TYPES OF DATA COLLECTED FROM TESTING**

- **MECHANICAL MEASUREMENTS**
- **X-RAY EXAMINATIONS**
- **LEAKAGE TESTING**
- **HIGH SPEED PHOTOGRAPHY**
- **INSTRUMENTATION DATA**
  - **ACCELERATIONS**
  - **STRAINS**
  - **TEMPERATURES**

# **IN GENERAL THERMAL TESTS DO NOT SCALE**

- **THERE ARE 11 INDEPENDENT DIMENSIONLESS VARIABLES THAT MUST BE MATCHED FOR PERFECT SCALING OF A TRANSIENT TEST.**
- **THE TEST ARTICLE CAN AFFECT THE LOCAL THERMAL ENVIRONMENT**

# PROCESS FOR DEVELOPING A SPENT FUEL CASK

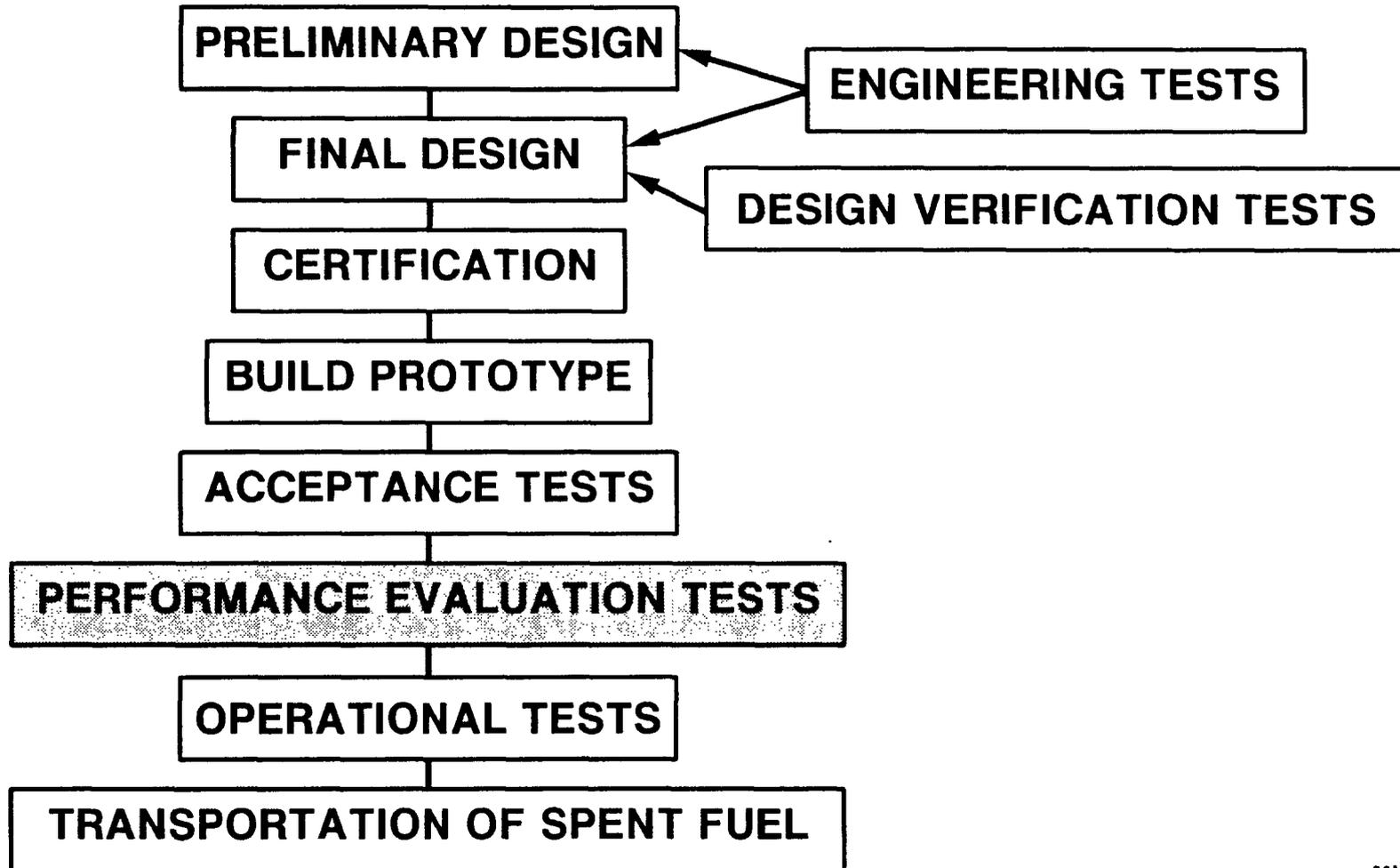


# **ACCEPTANCE TESTING**

**ACCEPTANCE TESTS ARE NONDESTRUCTIVE EVALUATIONS PERFORMED ON EACH FULL SCALE PROTOTYPE TO ENSURE FABRICATION WAS IN ACCORDANCE WITH DESIGN SPECIFICATIONS IN THE SAFETY ANALYSIS FOR PACKAGING.**

- COMPONENT FUNCTION**
- VISUAL**
- PRESSURE**
- LEAKAGE**
- SHIELDING**
- THERMAL**

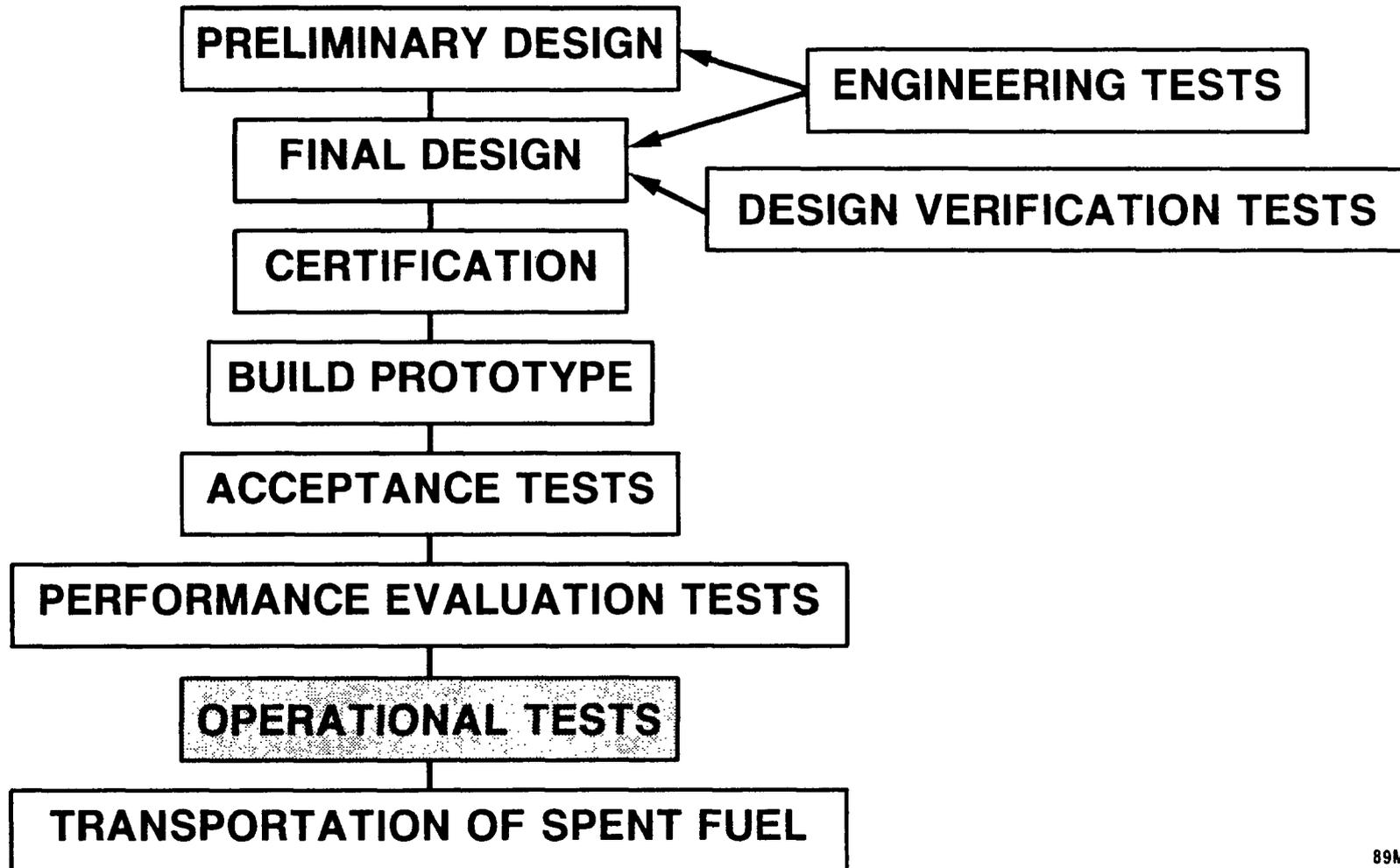
# PROCESS FOR DEVELOPING A SPENT FUEL CASK



# **PERFORMANCE EVALUATION TESTING (AT ONE FACILITY)**

- **DETERMINE IF PROTOTYPE PERFORMS AS INTENDED**
  - **TRANSPORT**
  - **INTERMODAL TRANSFER**
  - **TRANSPORTER LOADING / UNLOADING**
  - **SPENT (OR SIMULATED) FUEL LOADING / UNLOADING**
  - **LEAKAGE TESTING**
  - **DECONTAMINATION**
  - **MANUAL AND AUTOMATED HANDLING**
- **OBTAIN SHIPPING AND HANDLING DATA FOR LIFE CYCLE COST EVALUATIONS**
- **IDENTIFY POTENTIAL IMPROVEMENTS, AND MODIFY DESIGN (IF NECESSARY) BEFORE OPERATIONAL TESTING**

# PROCESS FOR DEVELOPING A SPENT FUEL CASK



# **OPERATIONAL TESTING**

## **(AT NUMEROUS FACILITIES)**

- **INTEGRATE EACH CASK SYSTEM INTO TRANSPORTATION SYSTEM**
- **ESTABLISH OPERATIONAL CHARACTERISTICS**
  - **EVALUATE EQUIPMENT**
  - **TEST DETAILED PROCEDURES**
  - **DEMONSTRATE INTERCHANGEABLE COMPONENTS**
  - **DEFINE SITE-SPECIFIC INTERFACE REQUIREMENTS, PROCEDURES, TRAINING PROGRAMS**
- **IDENTIFY POTENTIAL IMPROVEMENTS, MODIFY DESIGN (IF NECESSARY) BEFORE FLEET PROCUREMENT**

# **SUMMARY OF TESTING OBJECTIVES**

- **VERIFY ENGINEERING DESIGN ANALYSIS**
- **REDUCE UNCERTAINTIES IN CASK DESIGN**
- **EXPEDITE THE CERTIFICATION PROCESS**
- **ASSIST IN PUBLIC UNDERSTANDING**
- **EVALUATE CASK PERFORMANCE**

# **CONSIDERATIONS FOR CONFIRMATORY CASK TESTING**

- **TEST OF A FULL-SIZE “PROTOTYPE” SPENT FUEL CASK**
- **POSSIBLE REASONS FOR CONFIRMATORY CASK TESTING**
  - **CHANGED STATUTORY OR REGULATORY REQUIREMENTS**
  - **IN RESPONSE TO PUBLIC CONCERNS**