UNIQUE DESIGN PROBLEMS IN TRITIUM RESERVOIRS (U)

- *System*
  - Must Deliver In Specified Time
  - Must Be Consistent
  - Satisfy Weight And Space Requirements
  - Fire And Accident Considerations

- *Long Term Degradation*
  - Subject To Hydrogen Embrittlement
  - Subject To Helium Embrittlement
  - Withstand Pressure Increase With Time
  - Subject to Radiation Induced Effects
    (Loss of Permeability, Stoichiometry)

- *Safety*
  - Must Be Super Safe Against

    Burst

    Permeation (Walls, Welds, Stringers)

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Consequences of a stockpile tritium release:

a. Weapon reliability

b. Personnel safety

c. Political/environmental ramifications

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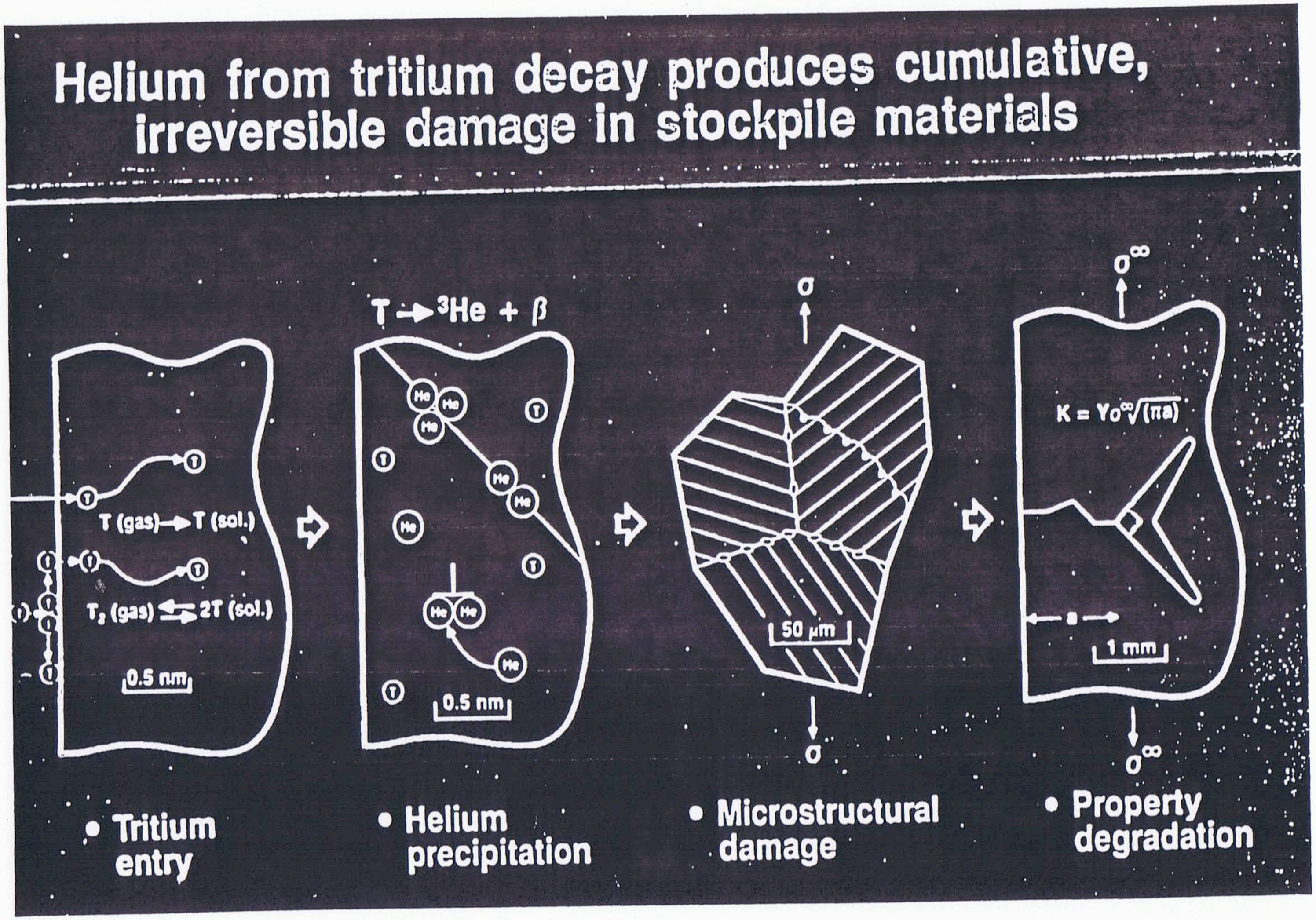

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Specifications

- Narrow chemistry——promotes weldability
- Grain size——less than ASTM 5
- Vacuum—arc—remelt (VAR) material
    - Inclusions——ultraclean
    - Ferrete distribution—— < 3% minimize stringers

Acceptance

- Chemistry
- Metallography
    - Grain size
    - Ferrite distribution
    - Inclusion
- Ultrasonics——porosity

For tritium reservoirs, it is necessary to improve the material properties

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It is most important to clean all surfaces of undesirables

CLEANING

Why

- To remove residues and oxides which could interface with welding, plating, or heat treating processes
- To remove any metallic materials imbedded into the surfaces permitting the formation of a continuous protective oxide film
- To prevent sources of rusting and corrosion on the surfaces
- To remove contaminants which could react with tritium

How

- Detergent solutions agitated ultrasonically
- Nitric acid solutions for dissolving imbedded copper and iron particles
- Nitric—hydrofluoric acid solutions for dissolving oxide films and imbedded particulate matter, and to etch certain stainless steel alloys
- Freon and alcohol rinsing for removing organic contaminants
- High purity water for rinsing
- High temperature vacuum bake

We take extreme care to verify cleanliness

CLEANLINESS VERIFICATION

- Monitor the resistivity of the rinse water to verify the absence of ionizable material
- Use analytical rinses to check for organic and inorganic contaminants with infrared spectrophotometer and ion chromotagraphy
- Perform particulate analysis on each reservoir
- Check for imbedded iron particles with a copper sulfate test
- Borescopic examination where applicable
- Visual examination for discoloration, staining, or superficial corrosive attack

Both piece parts and assemblies are cleaned prior to inspection

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Inspection and gaging costs approximate one-third of the piece part costs

INSPECTION AND GAGING

To assure:

- Interchangeability of piece parts
- Fit with next assembly
- Conformation with engineering drawings

We inspect and gage using:

- In process monitoring—feedback
- Open——set up inspection
- Dedicated gages
- Contour gages
- Air gages——non-contact
- Statistical sampling
- Control of numerical machine tapes
- Coordinate measuring machines

To minimize scrap and rework costs, we inspect early in the process

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Mechanical joints are not used for storage of tritium

ASSEMBLY AND JOINING

Joining:

- Weldments
  - Gas-tungsten are——autogenous and wire feed
  - Electron beam——autogenous and wire feed
  - Laser
  - Friction
  - Inertia
  - Resistance forge weld
- Brazes
  - Copper
  - Copper-silver-tin

Inspection and Control:

- Process monitor
- Radiographic
- Ultrasonic
- Dye Penetrant

All pressure rated components are pressure tested

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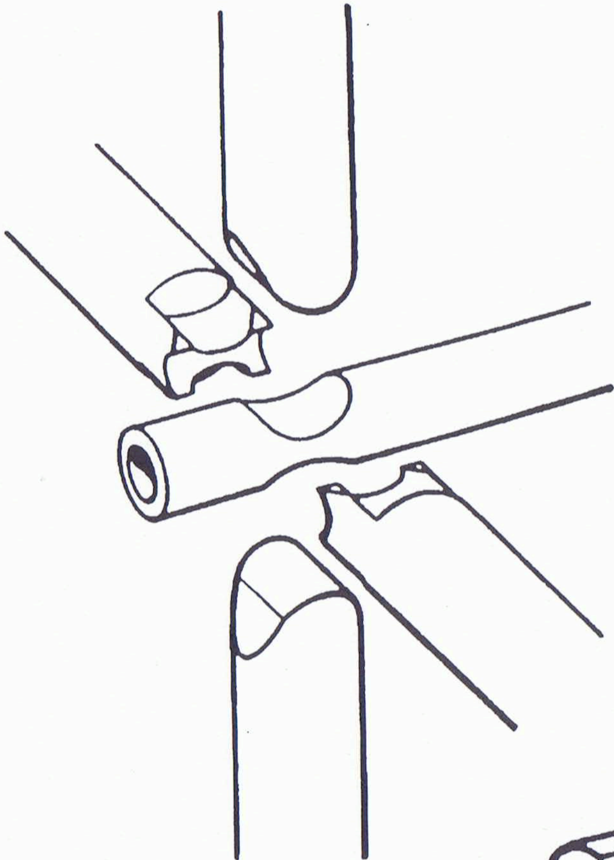
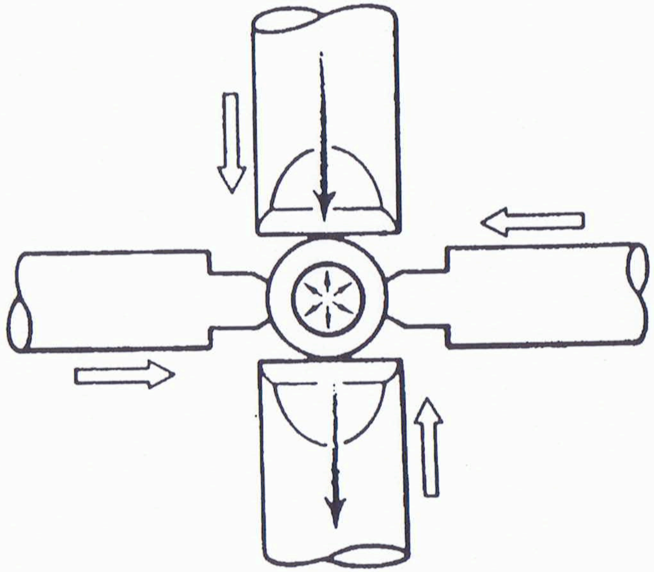
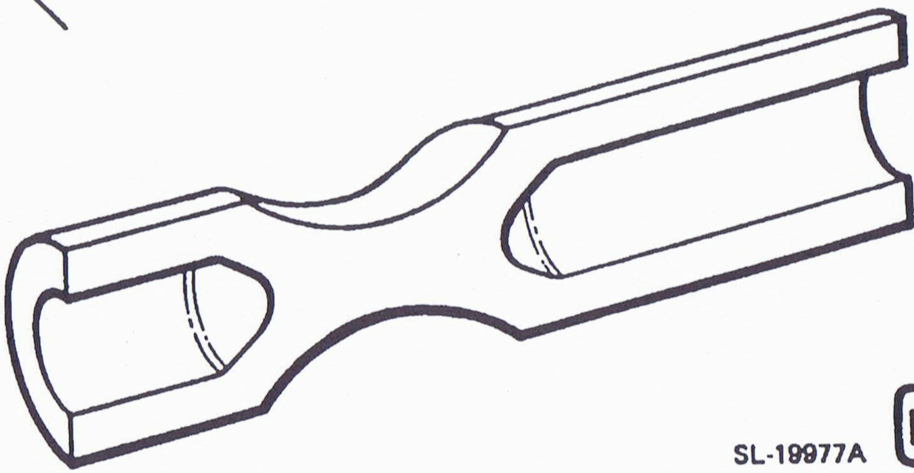
PINCH WELDING







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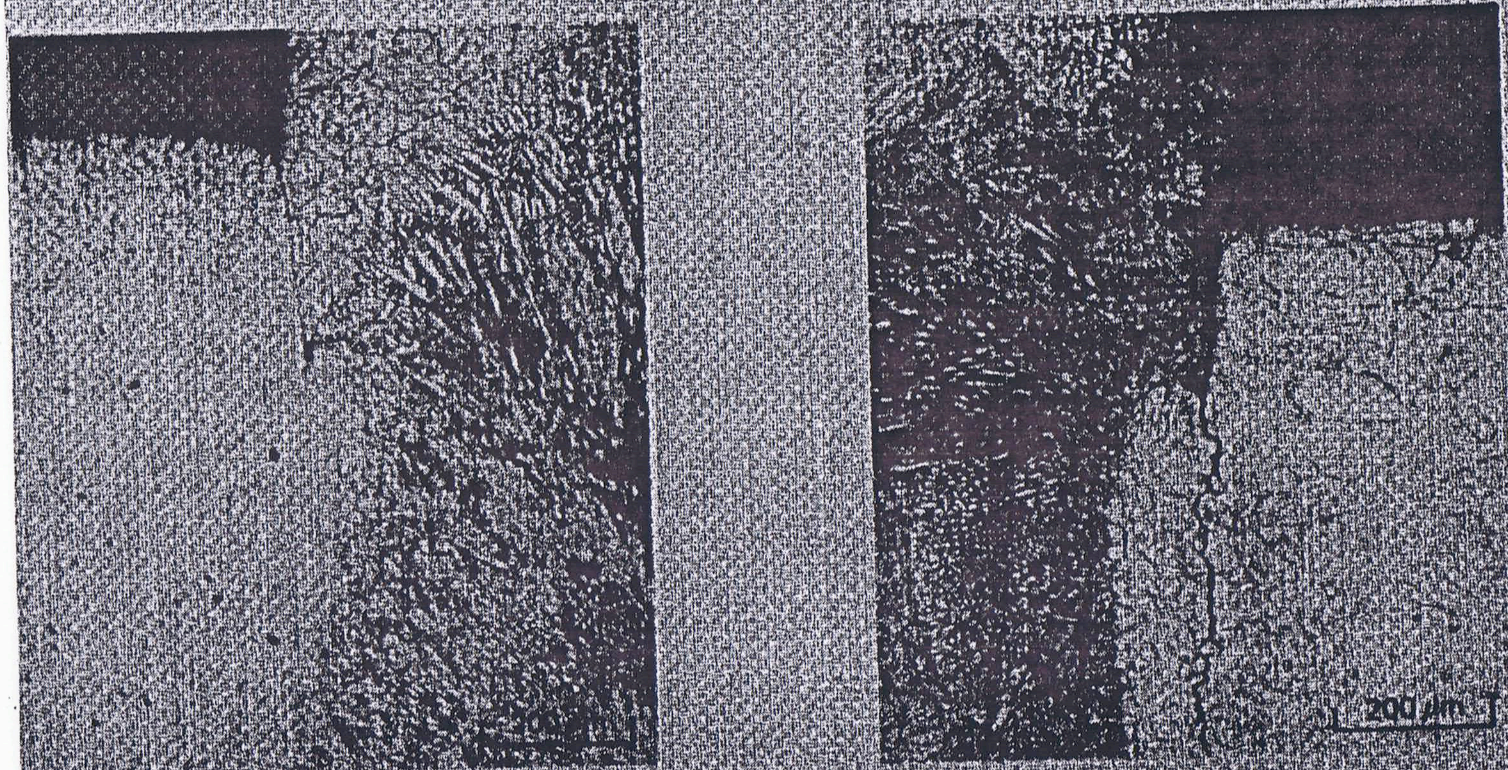
Crack growth experiments show tritium (and helium) to be much more deleterious than hydrogen or deuterium.



No crack growth is seen in HYDROGEN

Crack growth is seen in TRITIUM

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PRODUCT DEVELOPMENT (U)

AT SANDIA - R&D

- MATERIALS SELECTION AND TESTING
  SPECIMEN AND STRUCTURAL ANALYSIS
- COMPONENT DESIGN
  DRAWING AND SPECIFICATIONS
- PROTOTYPE DEVELOPMENT
  FABRICATION AND JOINING
- COMPONENT EVALUATION
  STORAGE AND STRUCTURAL TESTING
- SYSTEMS TESTING
  LABORATORY AND FLIGHT TESTS
- PRODUCT DEFINITION

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PRODUCT DEVELOPMENT (U)

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WE HAVE NO REASON TO ASSUME WE FOUND ALL THE TRITIUM SURPRISES

It is not possible to extrapolate with adequate confidence, tritium effects on components

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SURVEY OF WEAPONS DEVELOPMENT AND TECHNOLOGY

WR708

SESSION XIV

- RADAR FUZING TECHNOLOGY
- OTHER FUZING MODES
- ADVANCED FUZING CONCEPTS

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Nuclear Weapon Fuzing Technology

- Introduction to Fuzing Components & Systems
- Radar Fuzing
- Contact Fuzing
- Inertial, Barometric, and Timer Fuzes
- Fuzing Systems
- ***Future*** Fuzing Systems
    - SLBM Warhead Protection Program

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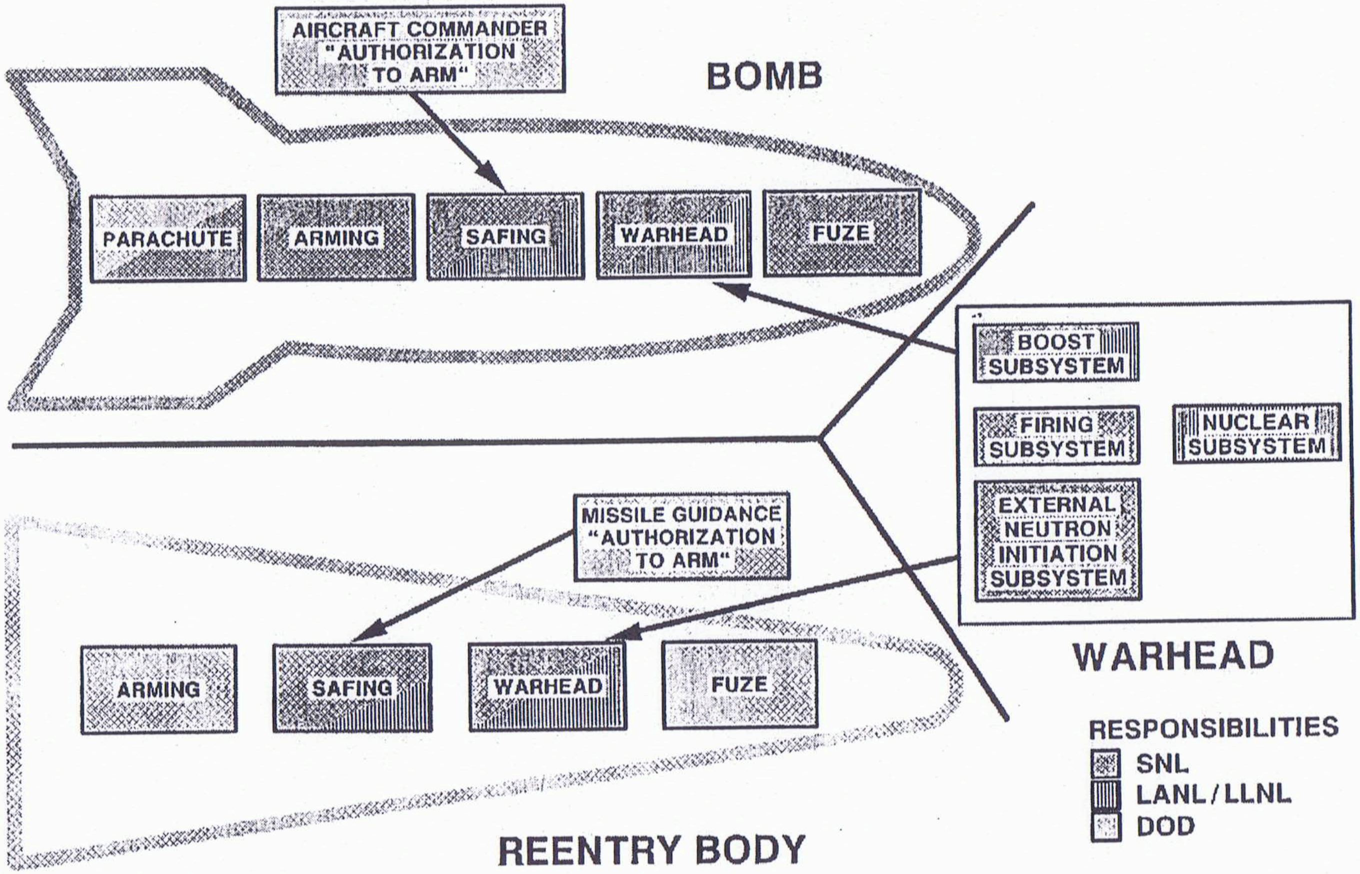
What is a Fuze ?

- Mechanism(s) within a weapon responsible for optimizing the location of weapon detonation
- Initiates the final, irreversible phase of weapon detonation
  - Follows "arming" functions, which are
    - reversible
    - time-uncritical
  - Precedes "firing"


AIRCRAFT COMMANDER
"AUTHORIZATION
TO ARM"
BOMB
PARACHUTE
ARMING
SAFING
WARHEAD
FUZE
BOOST
SUBSYSTEM
FIRING
SUBSYSTEM
NUCLEAR
SUBSYSTEM
EXTERNAL
NEUTRON
INITIATION
SUBSYSTEM
MISSILE GUIDANCE
"AUTHORIZATION
TO ARM"
ARMING
SAFING
WARHEAD
FUZE
WARHEAD
RESPONSIBILITIES
SNL
LANL/LLNL
DOD
REENTRY BODY

TA400.56

Fuzing System Hierarchy

<u>Components:</u>

Radars
(Antennas)

Clocks

G-switches

Pressure sensors
(Baro/hydro)

Accelerometers

Programmers

Crush sensors

Fuzing System Hierarchy

Components:

- Radars (Antennas)
- Clocks
- G-switches
- Pressure sensors (Baro/hydro)
- Accelerometers
- Programmers
- Crush sensors

Sub-Systems:

- Airburst radars
- Proximity radars (prox time-down)
- Timers
- G-started timers
- Pressure-started timers
- G-started integrating accelerometers (FBIAs)
- Path length
- Radar-Updated Path Length (RUPL)
- Impact fuzes

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Fuzing System Hierarchy

Components:

- Radars (Antennas)
- Clocks
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- Crush sensors

Sub-Systems:

- Airburst radars
- Proximity radars (prox time-down)
- Timers
- G-started timers
- Pressure-started timers
- G-started integrating accelerometers (FBIAs)
- Path length
- Radar-Updated Path Length (RUPL)
- Impact fuzes

Systems:

- Integrated Arming, Fuzing & Firing System (Mk4 RB)

Airburst radars → Prime → Integrated Arming, Fuzing & Firing System (Mk4 RB)

G-started timers → Prime/Backup → Integrated Arming, Fuzing & Firing System (Mk4 RB)

Impact fuzes → Backup → Integrated Arming, Fuzing & Firing System (Mk4 RB)

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Fuzing System Hierarchy

Components:	Sub-Systems:	Systems:
Radars (Antennas)	Airburst radars	Integrated Arming, Fuzing & Firing System (Mk5 RB)
Clocks	Proximity radars (prox time-down)	
G-switches	Timers	
Pressure sensors (Baro/hydro)	G-started timers	
Accelerometers	Pressure-started timers	
Programmers	G-started integrating accelerometers	
Crush sensors	Path length	
	Radar-Updated Path Length (RUPL)	
	Impact fuzes	

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How is a Fuze selected?

Traditional fuzing system priorities:

- Reliable
- Light weight (reentry body)
- Accurate
- Small (reentry body)
- Flexible
- Testable
- Producible
- Inexpensive

How is a Fuze selected?

Future fuzing systems must be:

- Inexpensive
- Producible
- Reliable
- Accurate
- Certifiable (test & analysis)
- Flexible
- Small (reentry body)
- Light weight (reentry body)

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Radar Fuzing

- Role of radar fuzing
- Basic radar fuze operation
- Radar design issues
- Current technology

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Why use a radar ?

- Height of burst precision to maximize extent of low overpressure levels
  - setability
  - accuracy
- Height of burst control to minimize fallout
- Dependable surface fuzing
  - Ensure detonation prior to collision
- Accurate altitude reference for improving inertial fuze accuracy (radar-updated path length fuze)

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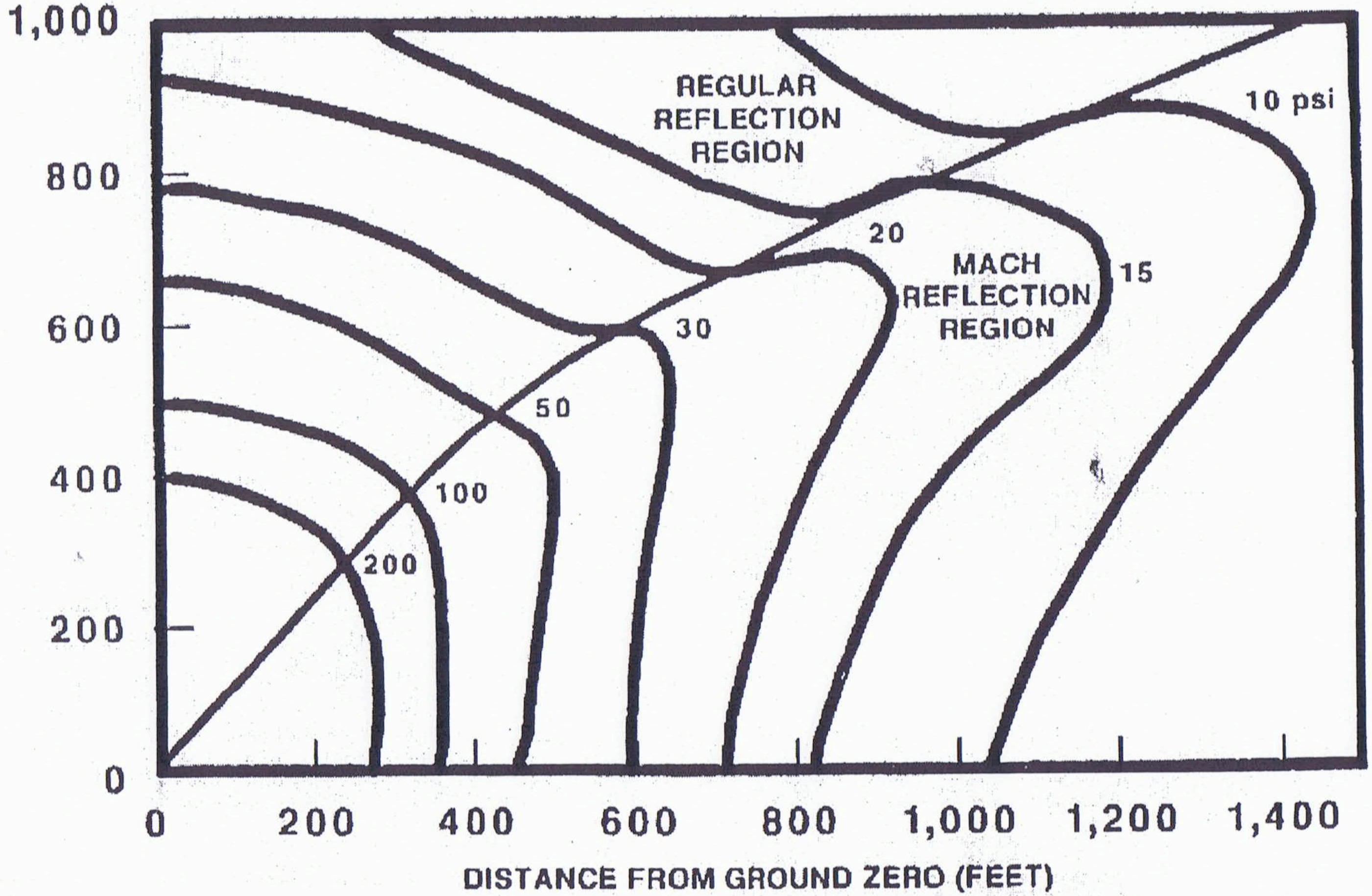
PEAK OVERPRESSURES ON THE GROUND FOR A 1-KILOTON BURST



REFERENCE: GLASSTONE AND DOLAN, THE EFFECTS OF NUCLEAR WEAPONS, 3RD EDITION US DOD AND DOE, 1977