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

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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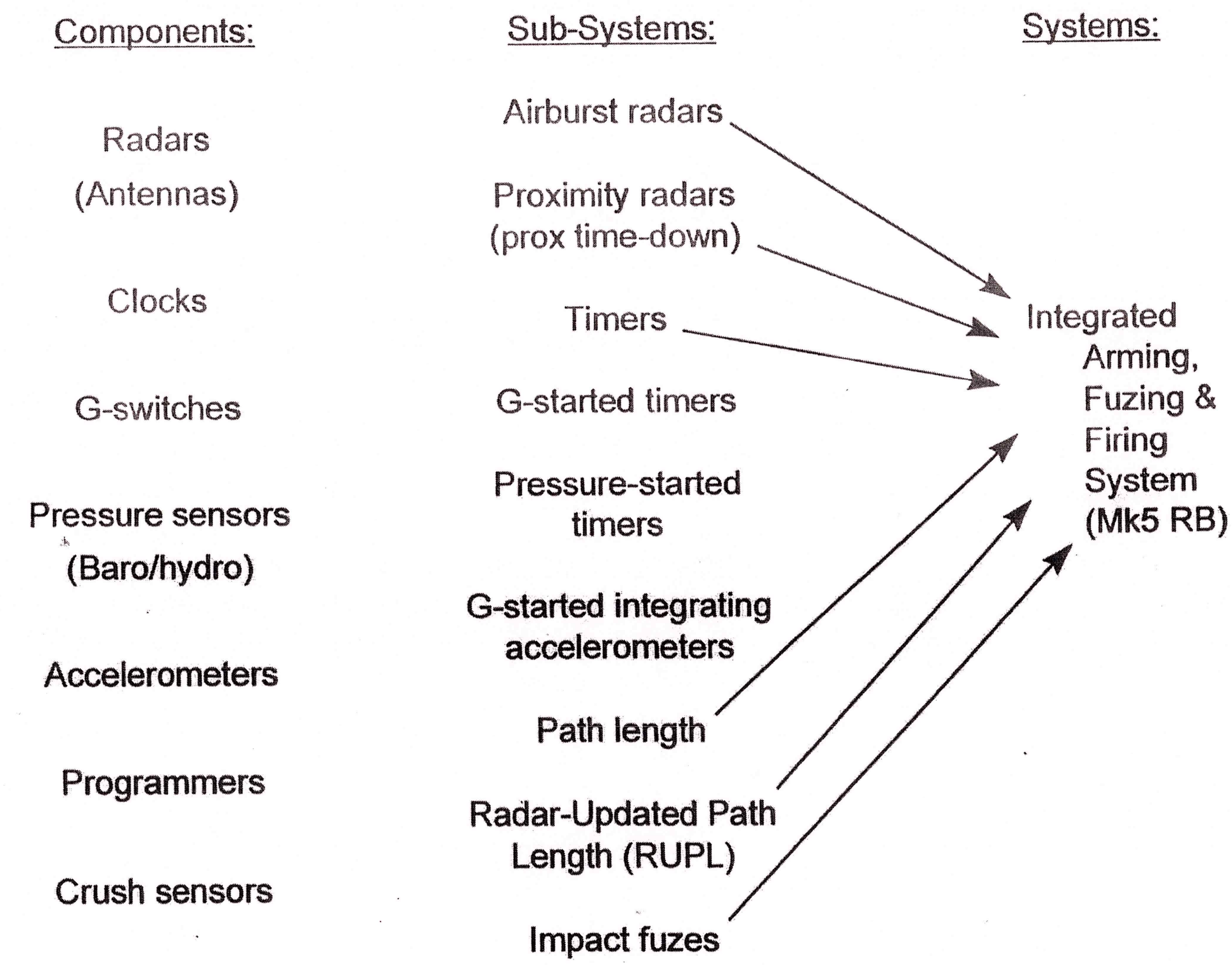
Fuzing System Hierarchy



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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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Radar design considerations, cont'd

- Antenna gain patterns
  - affects both transmit *and* receive
  - must accommodate all flight path angles and roll orientations

- Target reflectivities
  - peak reflectivity & angular attenuation

- Frequency
  - Higher frequencies required for proximity fuze narrow pulse width
  - Higher frequencies require less "real estate" for antenna windows
    - Smaller antennas thought to have less impact on reentry body flight
  - Lower frequencies have lower "path loss" requiring less receiver loop sensitivity

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Contact Fuze Characteristics

- Advantages
  - Very little penalty in weight, cost or volume
  - Desirable as backup to air burst fuzing
  - Radiation hardened and immune to jamming
  - Very reliable as a component
  - Maximizes crater volume and ground motion in comparison to other air burst options
- Disadvantages
  - Reduced "effects radius" for air burst targets
  - Range offset associated with backup role
  - Qualification / testing has been costly
  - Dependability concerns (system reliability)

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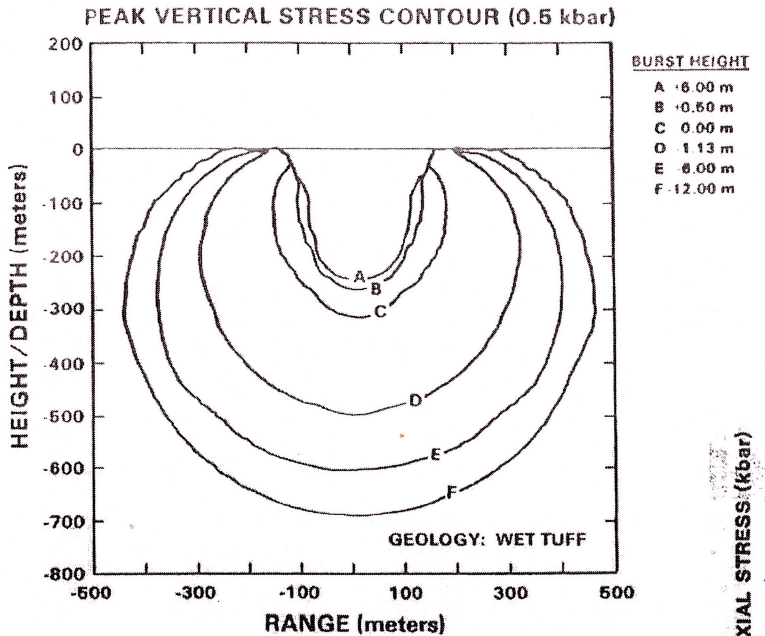
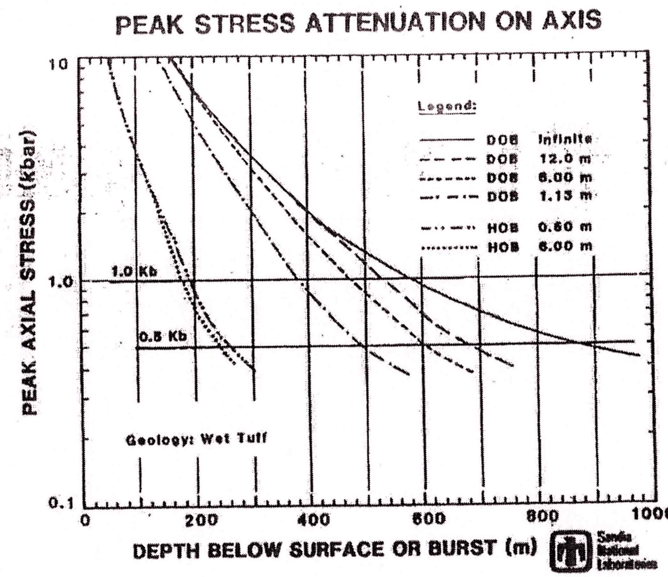
Contact vs. Proximity - Ground shock environments





Proximity fuzing consistently results in minimal degradation in ground shock environments when compared to contact

— Similar diagram in Earth [illegible]

Sand 88-0569

Improved surface fuzing concepts have been explored for every new reentry system

- Faster-responding impact sensors
  - concepts include:
    - faster-sensing mechanisms
    - forward deployment of traditional sensors
  - little, if any, additional protection against impact irregularities
- **Radar proximity fuzing**
  - adequate survivability for all impact scenarios
  - little, if any, degradation in burst height effectiveness

Inertial Devices

- ***Mechanical*** g-switches & integrating accelerometers
  - Stand-alone inertial fuze or initiation of reentry timer fuze
  - Closure of electrical contacts cause by completion of sensing mass travel
  - Features to attain minimum g's and g-seconds
    - Fluid-metering
    - Escapement mechanism
  - Mechanical feature variations limit accuracy to 1%
  - Extensive use as nuclear safety switches

- ***Electronic*** integrating accelerometers
  - Stand-alone inertial fuze or part of "path length" mechanization
  - Control circuitry generates "restoring current" proportional to acceleration
  - Provides continuous measurement of integrated deceleration
  - Electrical circuit tolerancing controls accuracy to 0.1%

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Fuzing options for replacement Mk4 AF&F

Mk4	Mk5
• airburst radar, 3 ranges	• radar-update path length (RUPL)
• inertial airburst, g-started timer	• airburst radar, 5 ranges
• contact backup	• **inertial airburst, path length**
	• **high airburst, timer**
	• **proximity radar**
	• **contact backup**

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MC4708 batteries

W76 MC2912 - 68 in³ — (15 in³ allowed bridge)

W88 MC3810 - 132 in³

Fuzing options for replacement Mk4 AF&F

Mk4 | Mk5

- ← eliminate long-life thermal battery
- ← dormant electronics during coast
- ← minimum perturbation to existing antennas & RF system
- ← reduced clock accuracy requirements
- ← reduced inertial sensor accuracy requirements
- ← simplified processing
- ← reduced non-volatile memory requirements
- ← **nuclear safety upgrades enabled** →
- ← **improved instrumentation** →
- **dependable surface fuzing** →
- **new fuzing option for Mk4** →
- ← ***reduced development & production costs***

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