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Propellants/Propulsion/Power and Explosives Engineering

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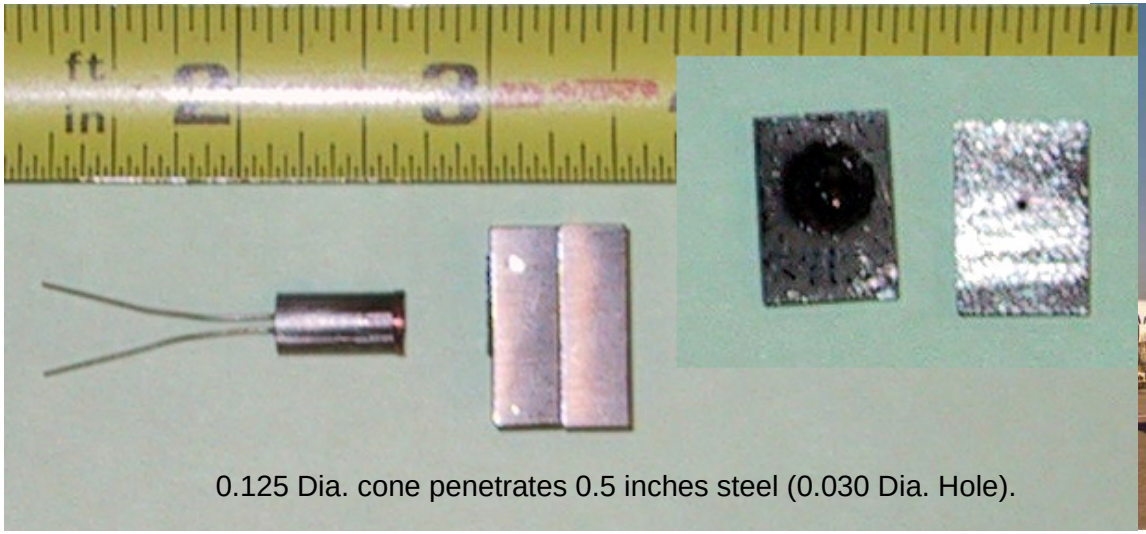
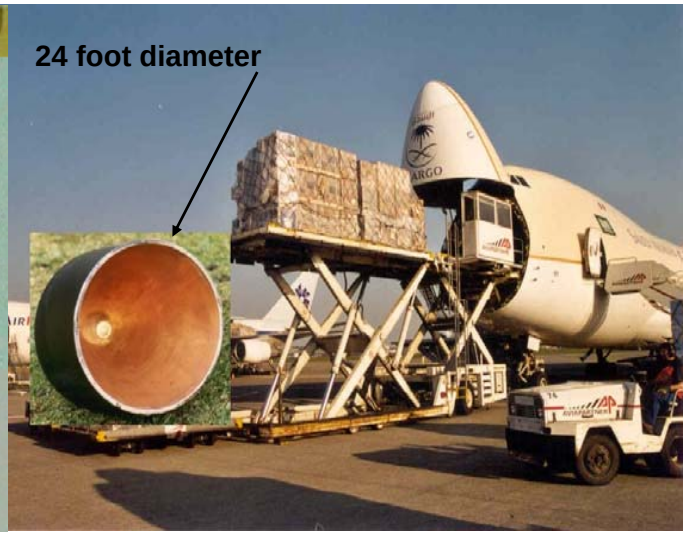
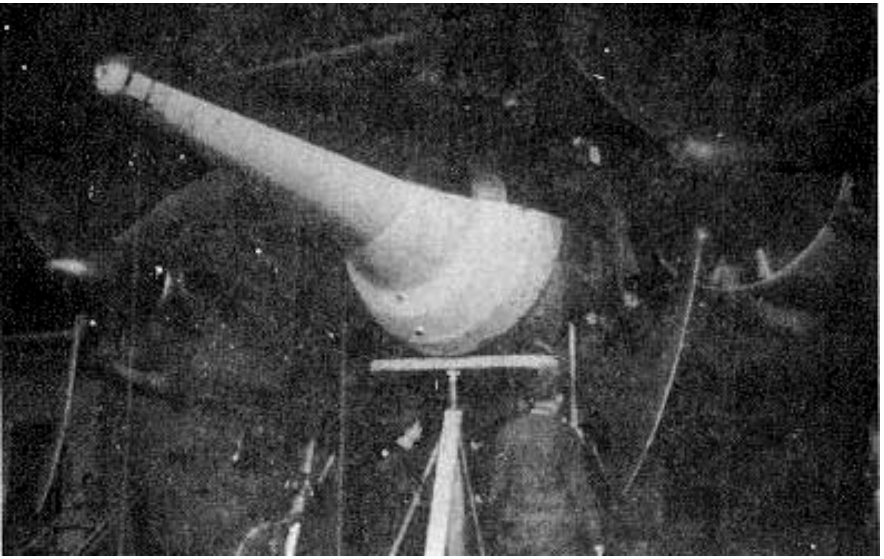
Conical Shaped Charges (scale-able technology)



0.125 Dia. cone penetrates 0.5 inches steel (0.030 Dia. Hole).





Warhead:
7700 lb
3800 lb HE
6.0 ft diameter
Penetration: 24 feet steel, 60 feet concrete

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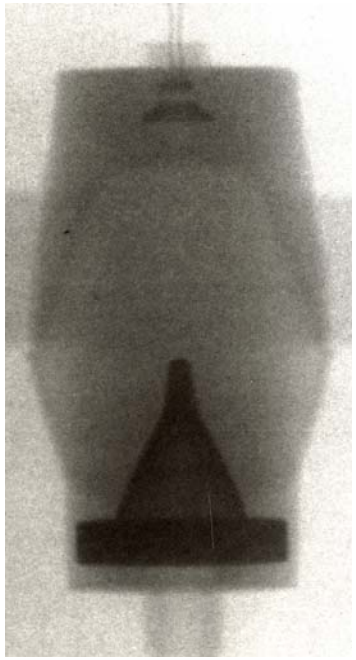
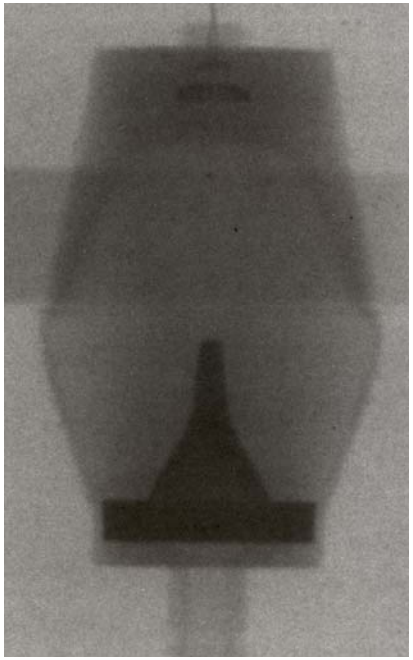
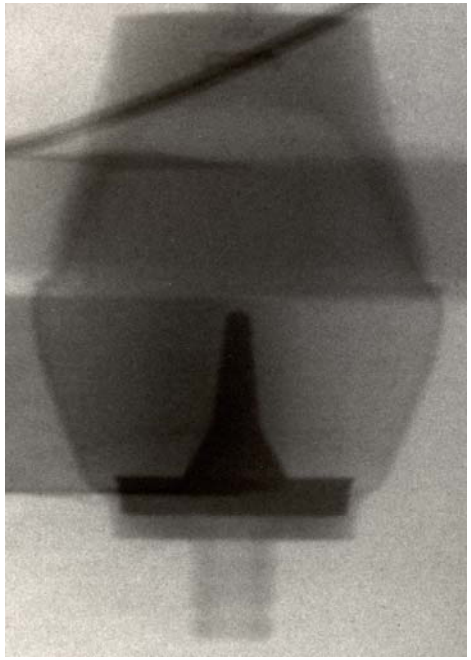
X-Ray of Conical Shaped Charge
Explosive Driven Liner Collapse and Jet Formation



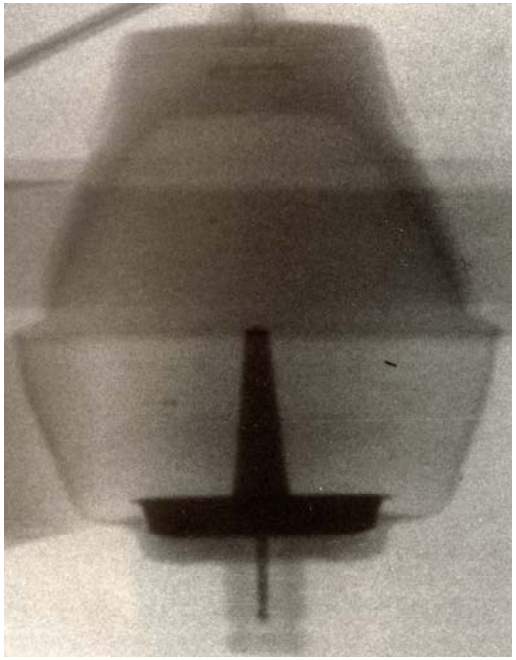
10.97μs



12.34μs



13.89μs



16.30μs

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New areas…?

- Liner materials
  - Reactive liners (intermetallics*, thermites, polymer-binders)
  - amorphous metals
- Engineering
  - Improved energy transfer (corrugated liner?)
- New explosives
  - PYX… ???

* Brazing foil development at SNL

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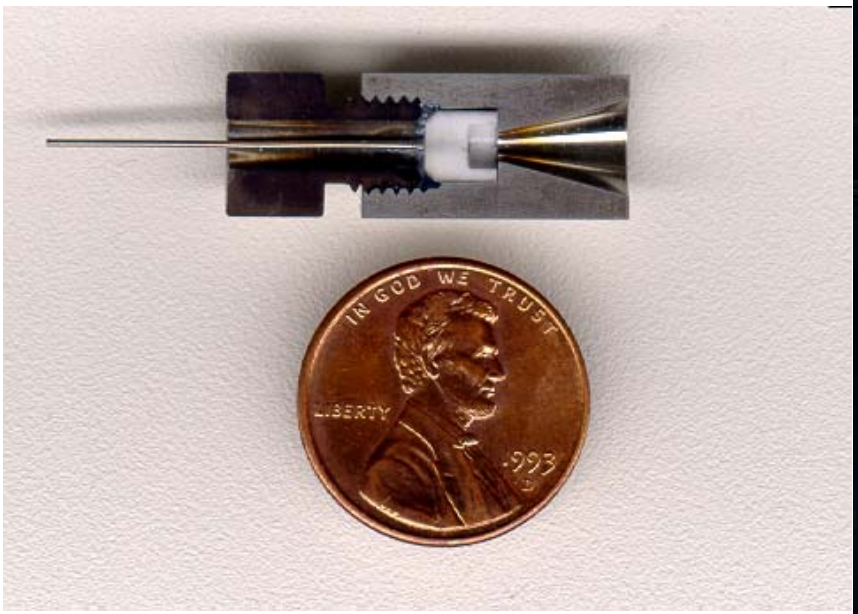
Propulsion/Power & Gas Generation (scale-able technology)



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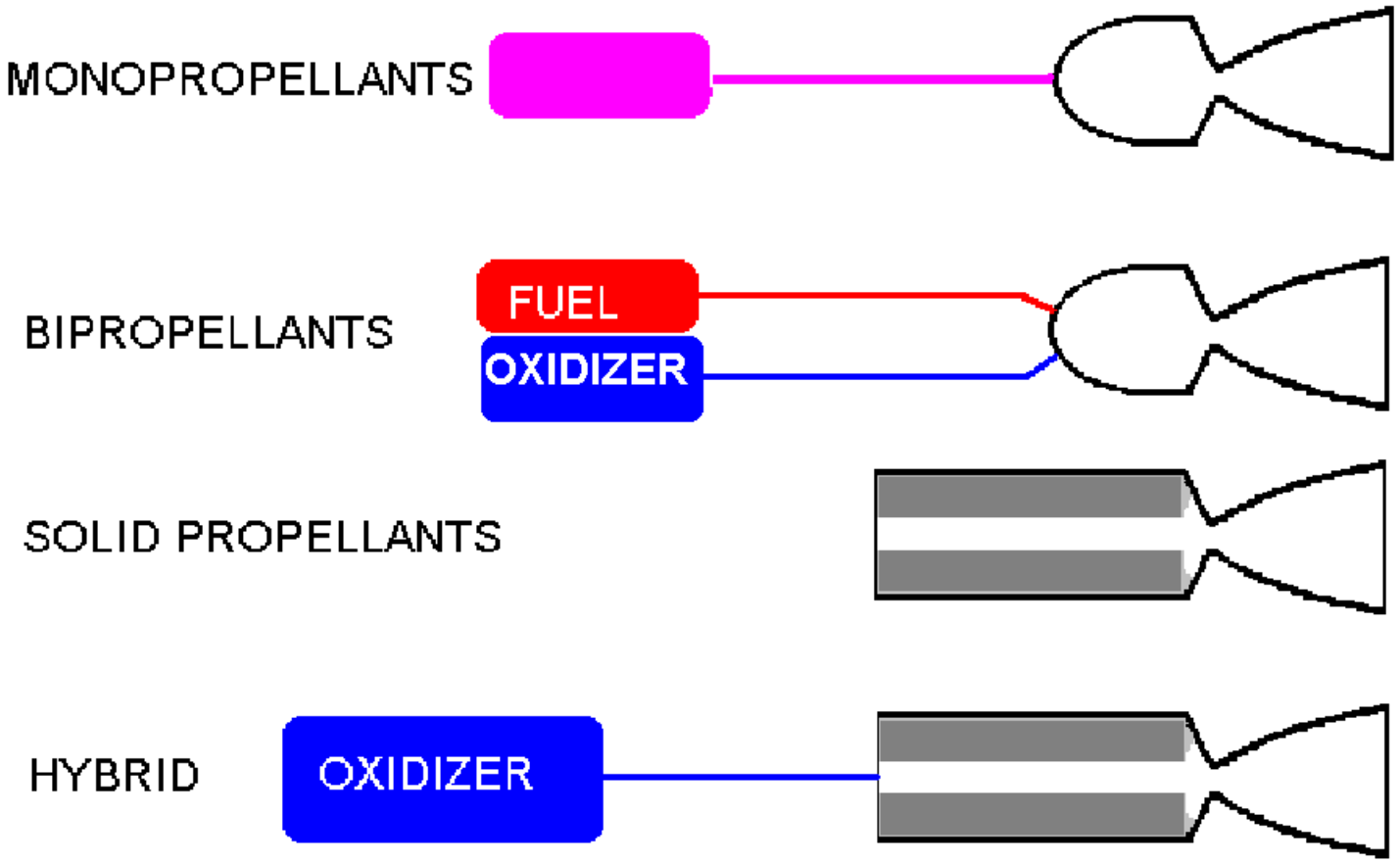
Chemical Propulsion/Gas Generator Systems



Propellant Categories

- **Type by Physical Properties:**
  - **Earth Storable**
    - » **Stable Liquid at Room Temperatures (298K, ~77°F)**
  - **Space Storable**
    - » **Generally, Liquid Phase in the Range –200 to 0°F (150-250K)**
  - **Cryogenic**
    - » **Generally, Liquid Phase < -238°F (-150°C, 123K)**

- **Type, by Reactivity:**
  - **Hypergolic (React upon Contact)**
  - **Igniter/Torch (Non-Hypergolic), Hypergolic Slug**
    - » **Requires External Ignition Source**

Yesterday & Today

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Hydrogen Peroxide

What is it?

- $H_2O_2 \rightarrow H_2O + \frac{1}{2}O_2 + Energy$

  - 3% pharmaceutical
  - 31% semiconductor
  - 50% waste-water
  - 60% oxidizer/IC engine
  - 70% oxidizer/monopropellant rocket engine
  - 90~99.6% propulsion grade (RGHP or HTP)

Monopropellant Rocket Engine or Gas Generator

Pressurant tank

Regulator

Propellant tank

Cavitating Venturi

Valve

Injector

Catalyst bed

Nozzle

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Engine Firing

Availability

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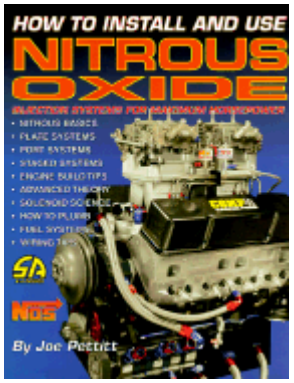
NITROUS OXIDE, N_2O (DINITROGEN MONOXIDE)

- **Not commonly recognized as a rocket propellant until mid ’80**
  - **Monopropellant or oxidizer**
- **Typical uses:**
  - **Aircraft engine performance enhancer WW2**
  - **Automotive racing**
  - **Pressurant for “instant” whipped cream**
  - **Dental anesthetic (laughing gas)**
  - **Amateur rocketry (hybrids)**
  - **Recreational drug**



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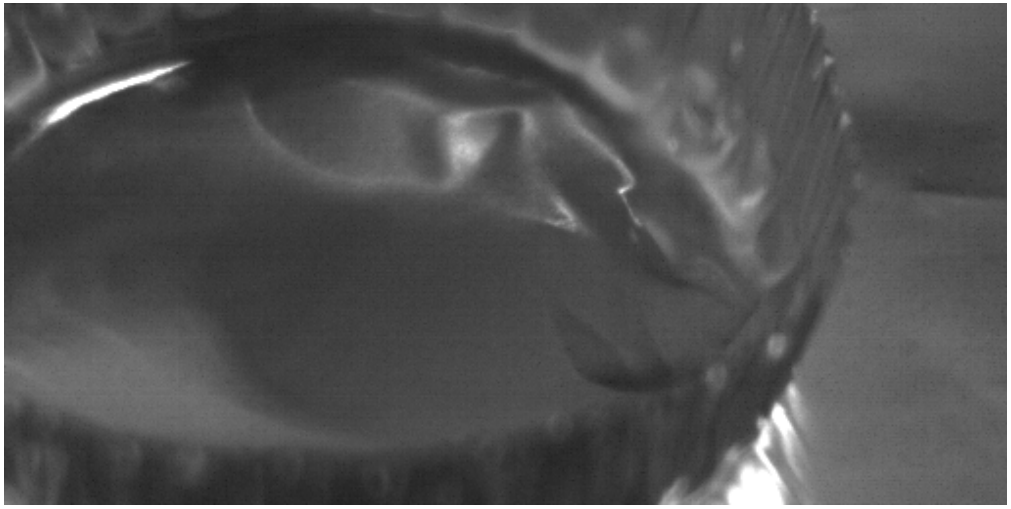
Hypergolic Testing

- **High speed video**



192 millisec delay; DMAZ onto WFNA

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~Hypergolic Oxidizers & Liquid Explosives

- Hydrogen peroxide
- CTF….other inter-halogens
- NTO
- ~N_2O
- WFNA/RFNA
- …..
- NM, Ionic liquids,…HAN, HNF, ADN etc