Development of an Arc Damage Modeling Tool

Aging Aircraft 2007

April 17, 2007

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Examples of Arcing Damage

Goal of the Program

- Modeling tool that can represent damage incurred from an arcing event.
- Data produced from the tool can be used to support TC and STC applications.

- Supported by the FAA William J. Hughes Technical Center

Program Outline

- 2 year effort that began January 2007
- Effort is divided into 4 Tasks
  1. Generation of Empirical Data
  2. Development of Analytical Methods
  3. Development of the Modeling Tool
  4. Demonstration Kit and Presentation

Types of Damage to be Modeled

- Target (What is arced to)
- Other Wires in the bundle
- Objects at a distance
  - Ejected Metal
  - Hot Ionize Gas Plume

Mitigation Techniques to be Considered

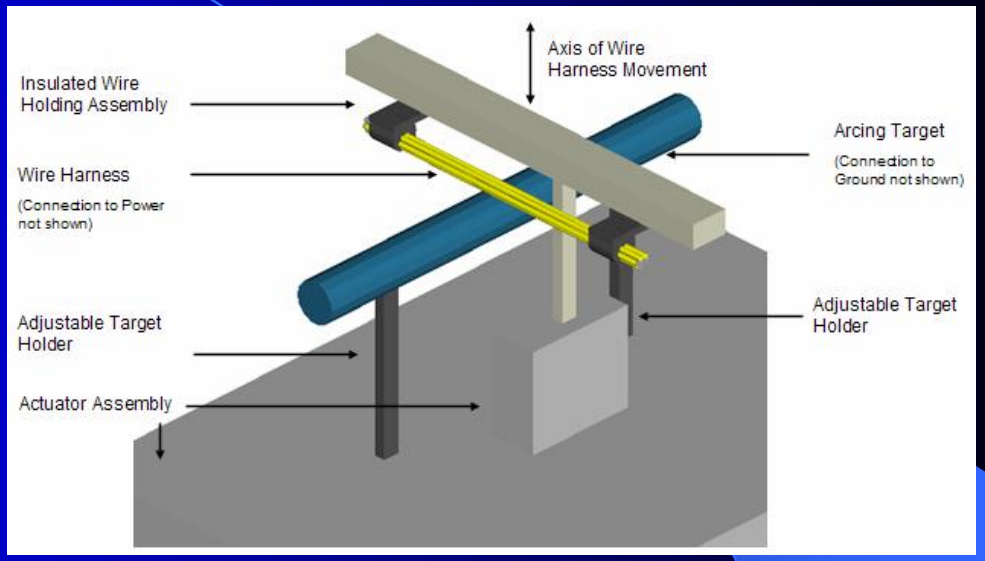
- Arc Fault Circuit Interruption (AFCI)
- Separation and Segregation
- Non Arc-tracking Wire Insulation

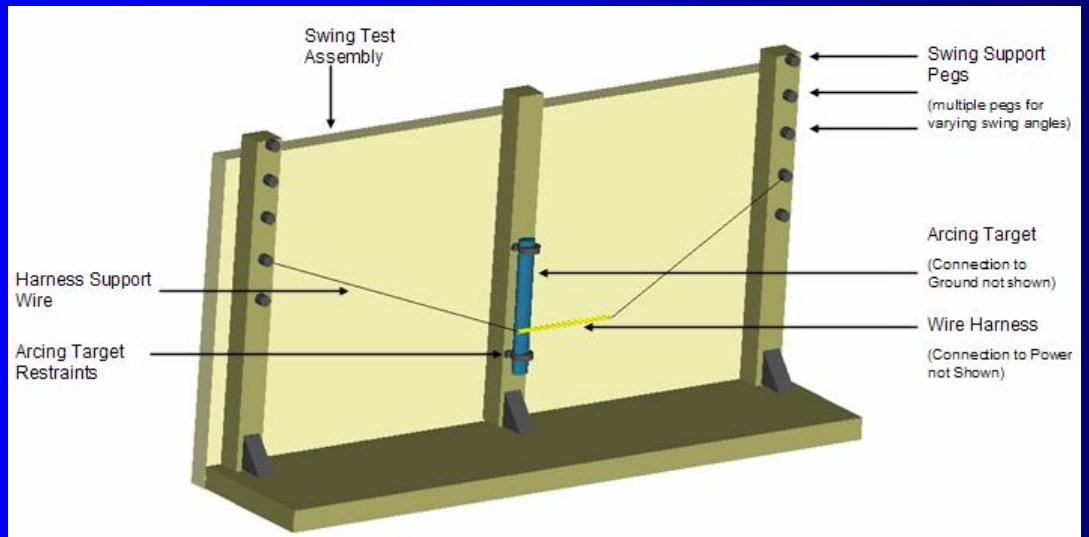
Test Parameters

- Initiation Method
- Source Voltage
- Fault Current
- Arcing Duration (Circuit Protection)
- Wire Gauge & Insulation Type
- Number of Power Wires
- Target Material & Geometry

Initiation Methods

- Swing Test
- Vibration
- Guillotine
- Wet Arcing





Target Material & Geometry

- Hydraulic Line: Aluminum
- Hydraulic Line: Titanium
- Flight Control Cable: Steel
- Aircraft Structure: Aluminum

- Possible: Pressurized Hydraulic Line

Parts of the Model

- Modeling the arc
  - Power
  - Duration of the arc
- Partition of energy
  - Incident on Target
  - Dissipated into the Source (Wires)
  - Ejected from Arcing Area (Hot Gas & Ejected Material)
- Damage
  - Arc Energy Heating Metallic Target
  - Hot Gas Heating Wire Insulation

Example: Damage to Hydraulic Line

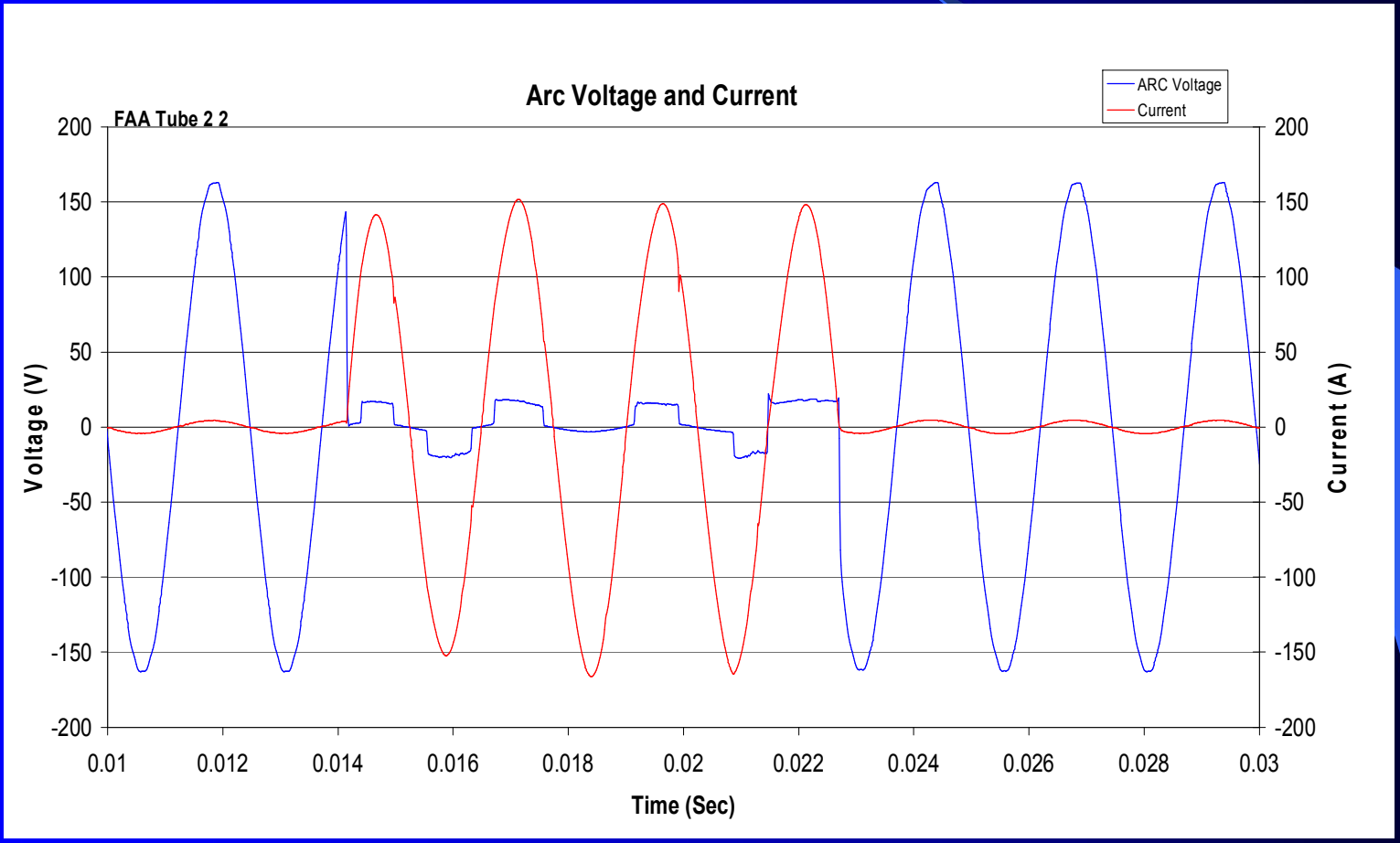
Movie

Example: Damage to Hydraulic Line

Photo

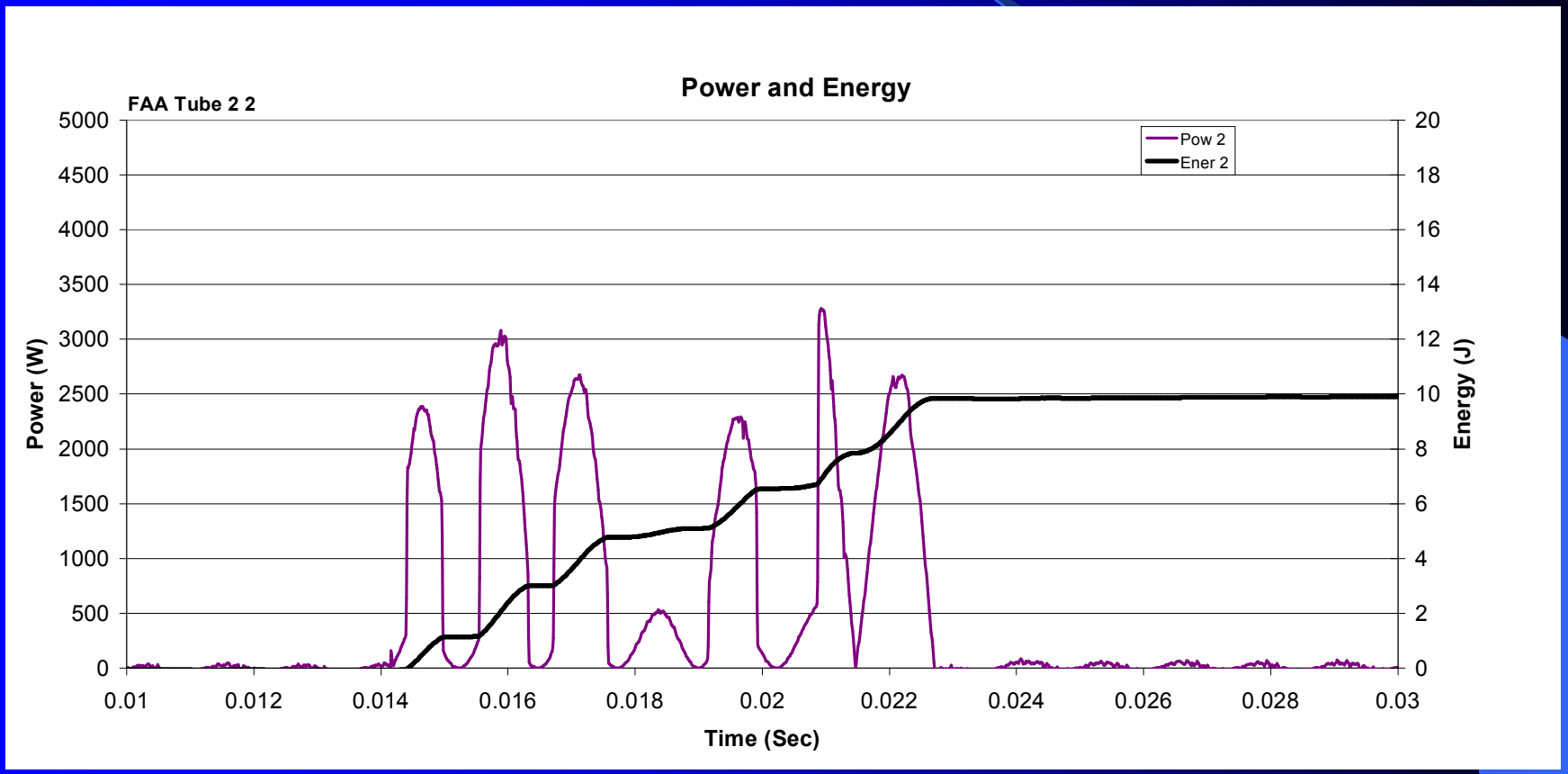
Example: Damage to Hydraulic Line

Voltage and Current Waveform



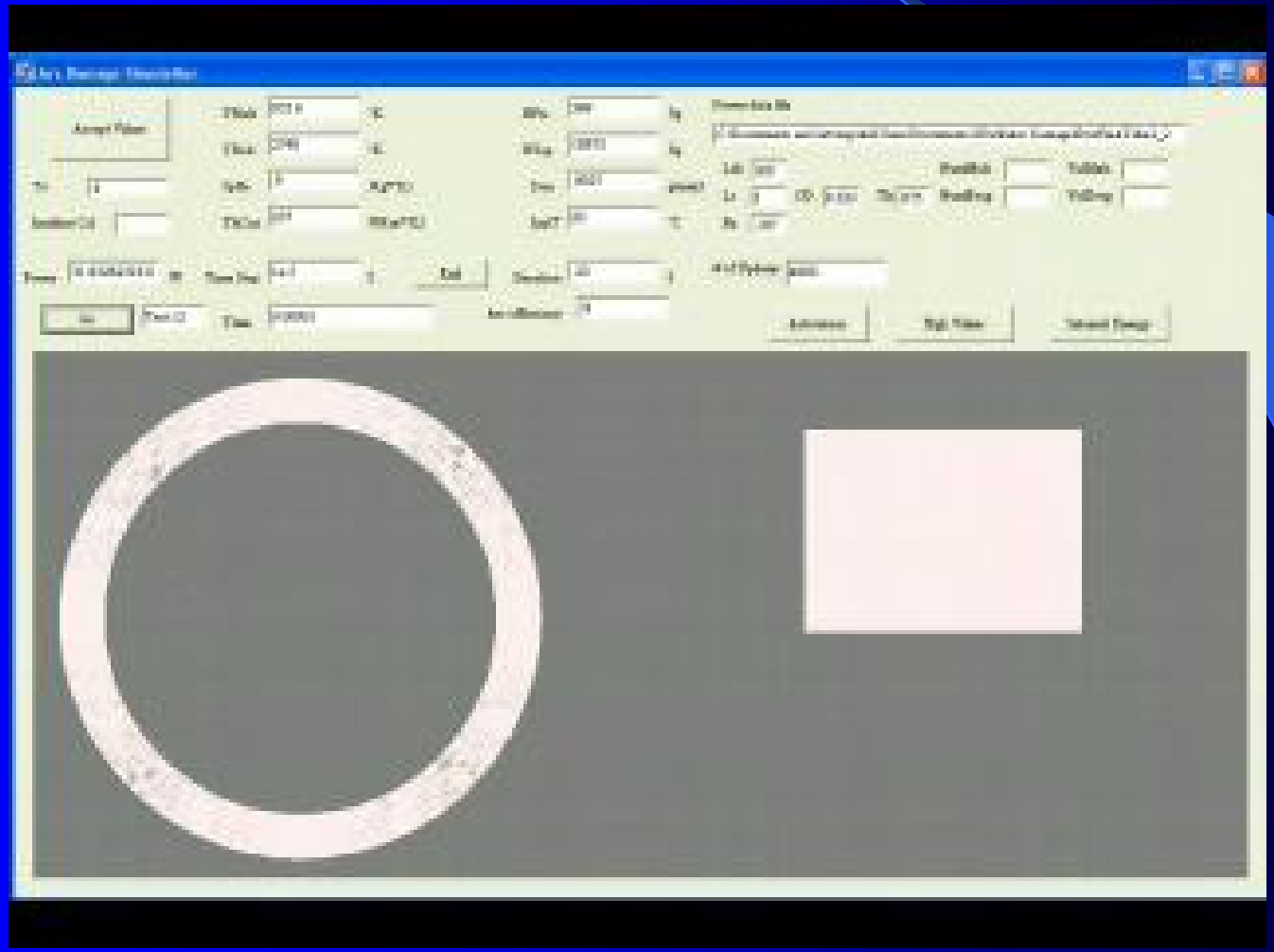
Example: Damage to Hydraulic Line

Power and Energy



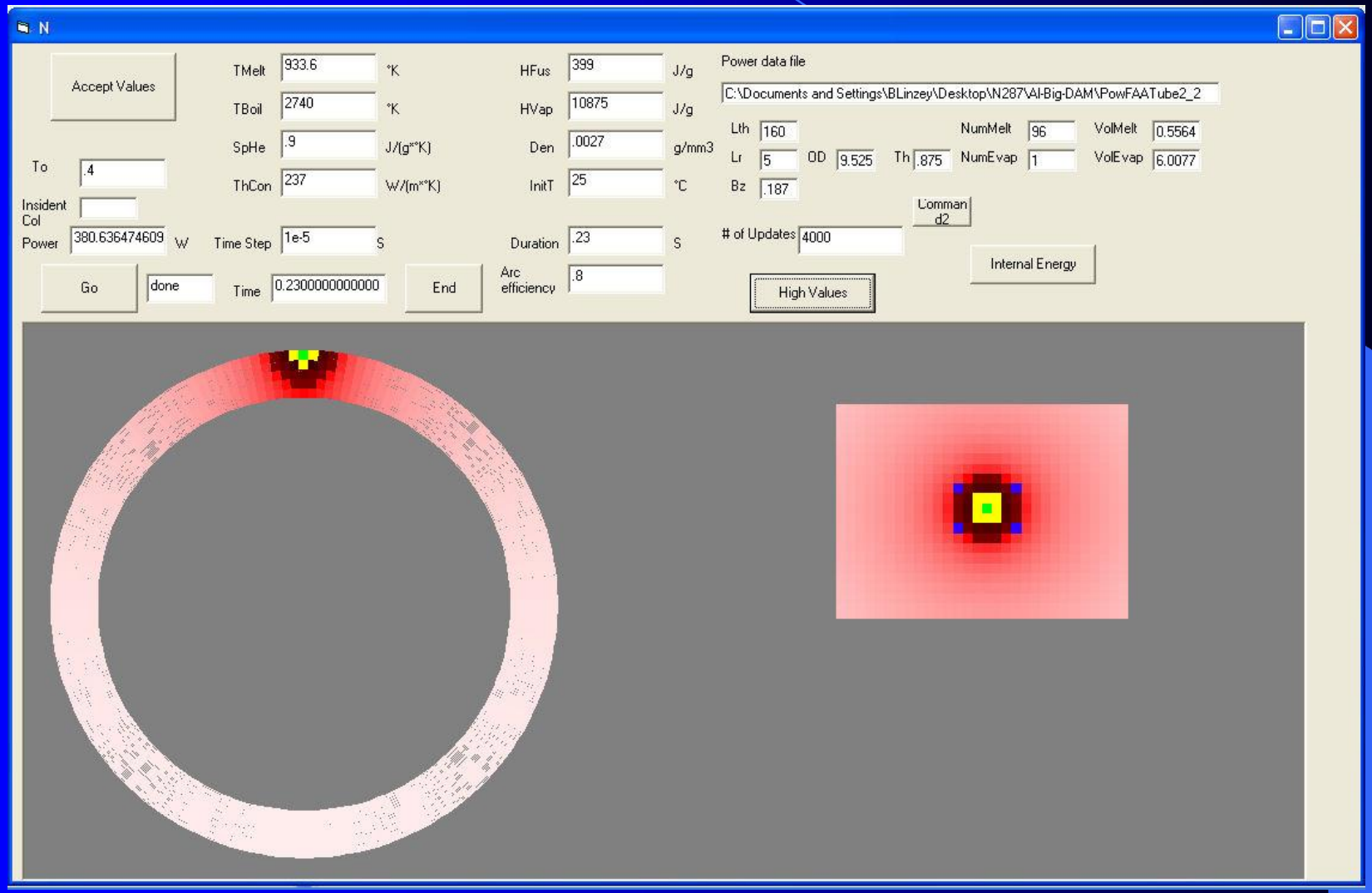
Example: Damage to Hydraulic Line

Finite Volume Simulation



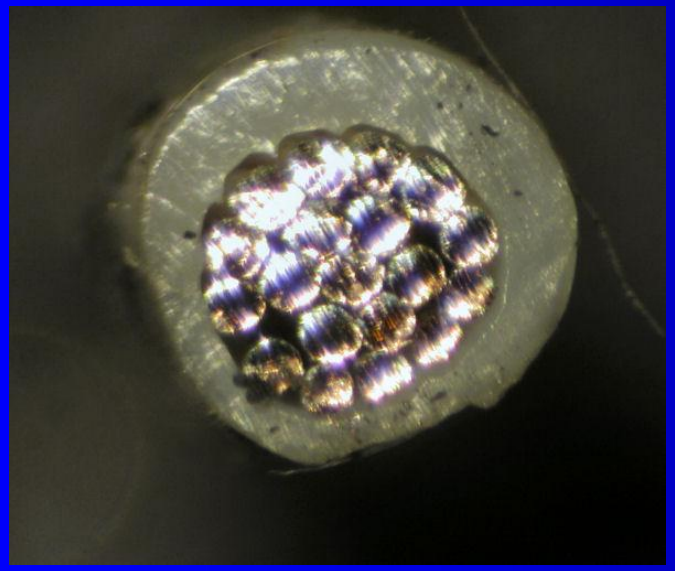
Example: Damage to Hydraulic Line

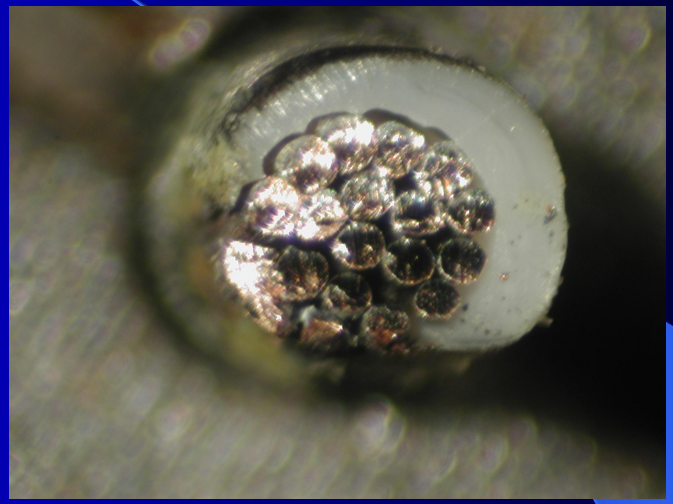
Finite Volume Simulation

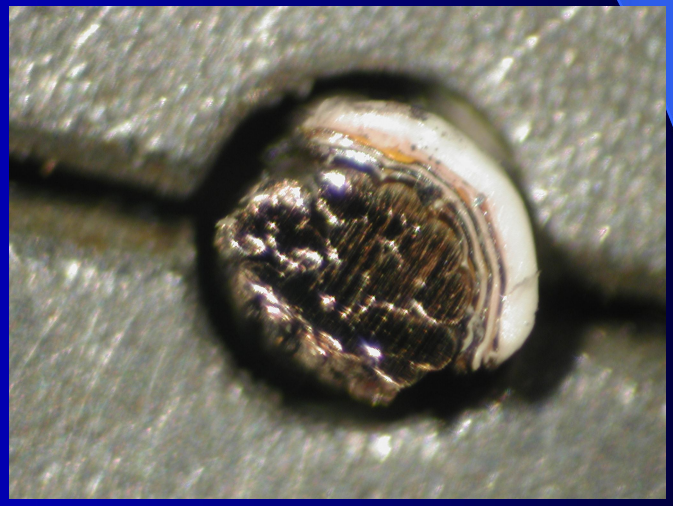


Example: Damage to Other Wires

Photo: Cross-sections

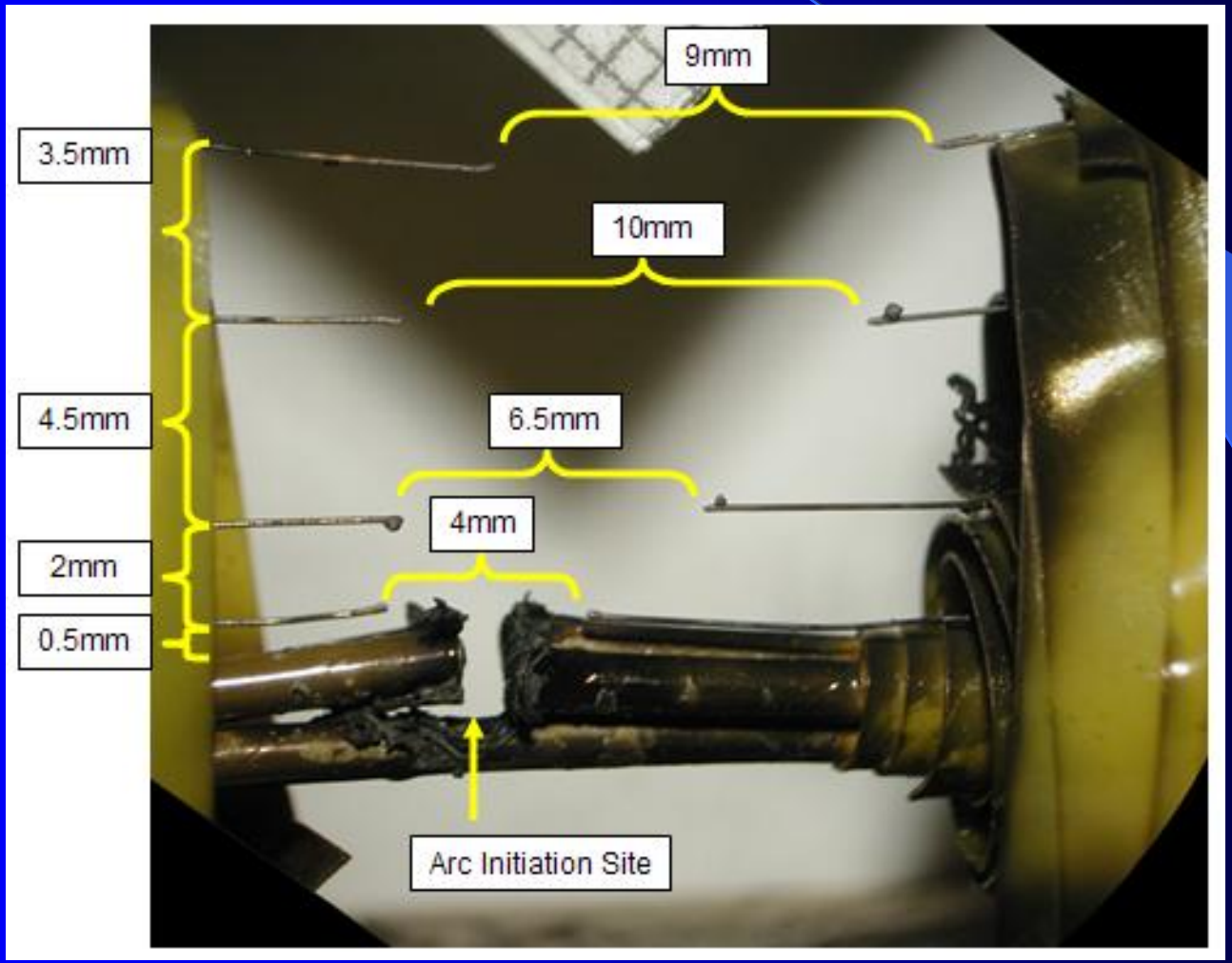






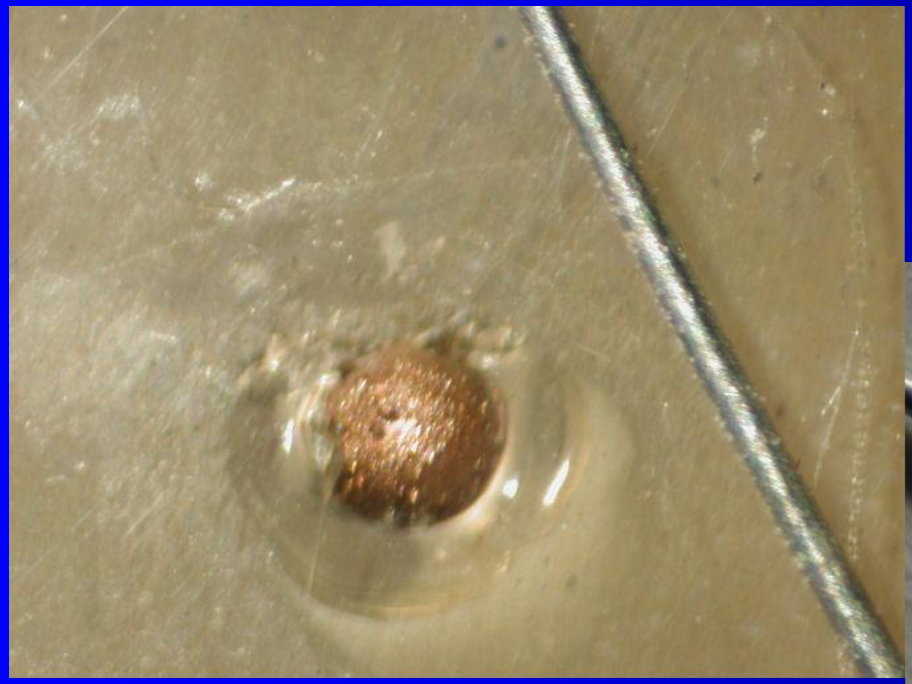
Example: Energy in the Hot Gas Plume

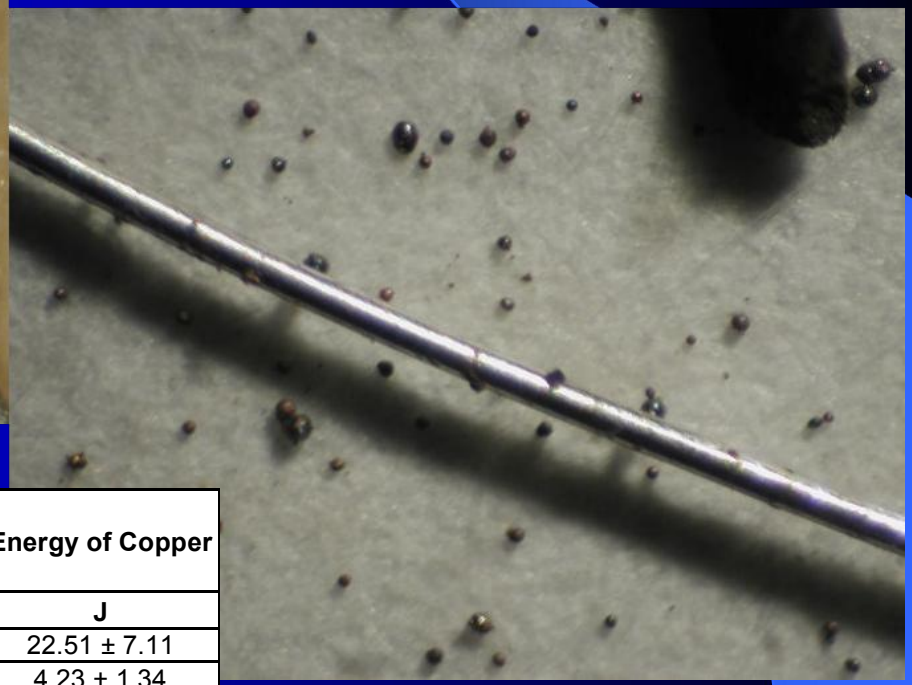
Photo: Thermal Gradient Stratification



Example: Energy in the Ejected Material

Photo: Cross-sections





Diameter of Copper Ball		Volume	Mass	Energy to Melt Copper	Energy to Raise Copper to Evap. Temp	Energy of Copper
Mil	mm	mm^3	g	J	J	J
35	0.875	2.805	0.02513	15.40	29.62	22.51 ± 7.11
20	0.500	0.523	0.00469	2.90	5.57	4.23 ± 1.34
7	0.175	0.022	0.00020	0.123	0.237	0.180 ± 0.057
2	0.050	0.0005	4.69E-06	0.0029	0.0056	0.0042 ± 0.0014