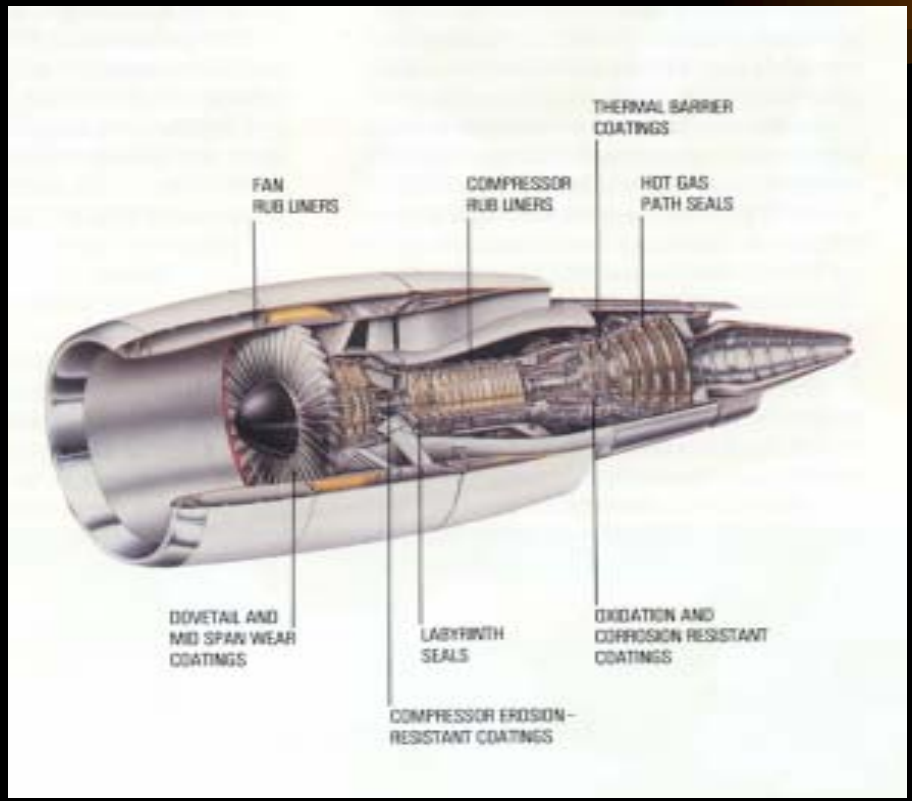
# *TubalCain Company Inc.*

CTMA

Plasma Spray Booth Equivalency System

# *TubalCain Company Inc.*



# *TubalCain Company Inc.*

- Need Defined
  - "Plasma Spray Booth Equivalency", NTSC 1990, Long Beach California
    - >35% Plasma kW/Liter Variance System-to-System
    - Gas Flow Calibration Most Controversial
  - "Plasma Spray Booth Equivalency II: Effect on Coatings Attributes", NTSC 1991, Pittsburgh
    - Tensile Strength Range > 2X
    - R15N Hardness Low 70s – Mid-80s
    - Oxides Negligible – 6%

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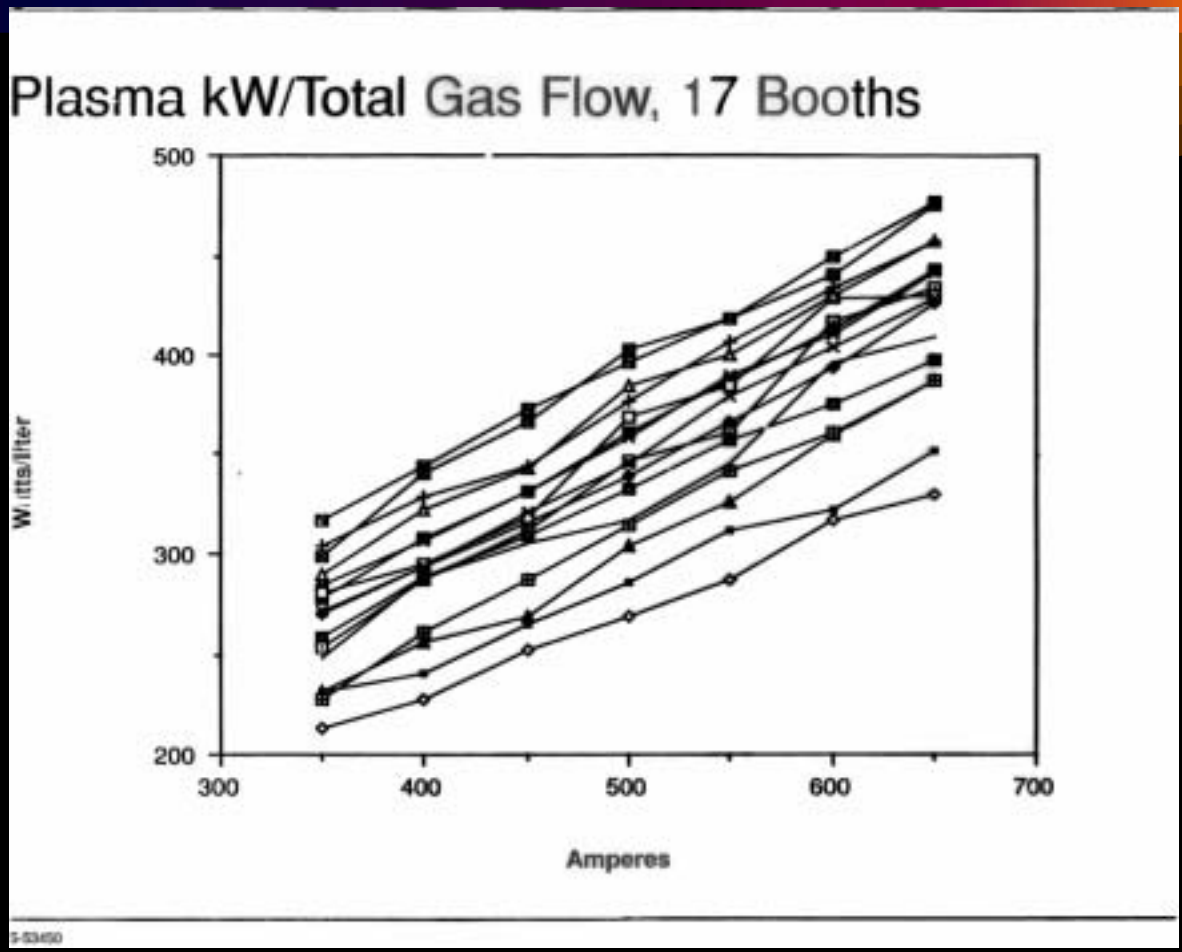

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- Equipment Manufacturer Response
  - Metco 9MC Console Introduced at NTSC 1991
  - Miller Thermal 4500 Console Introduced 1992
- Coating Supplier Base Response
  - >3000 Domestic Plasma Spray Cells
  - Recapitalization During 1990s Not Significant
- TubalCain Recommendation
  - Keep Existing Equipment, Old or New; Perform Regular “Booth Equivalency” Type Diagnostics

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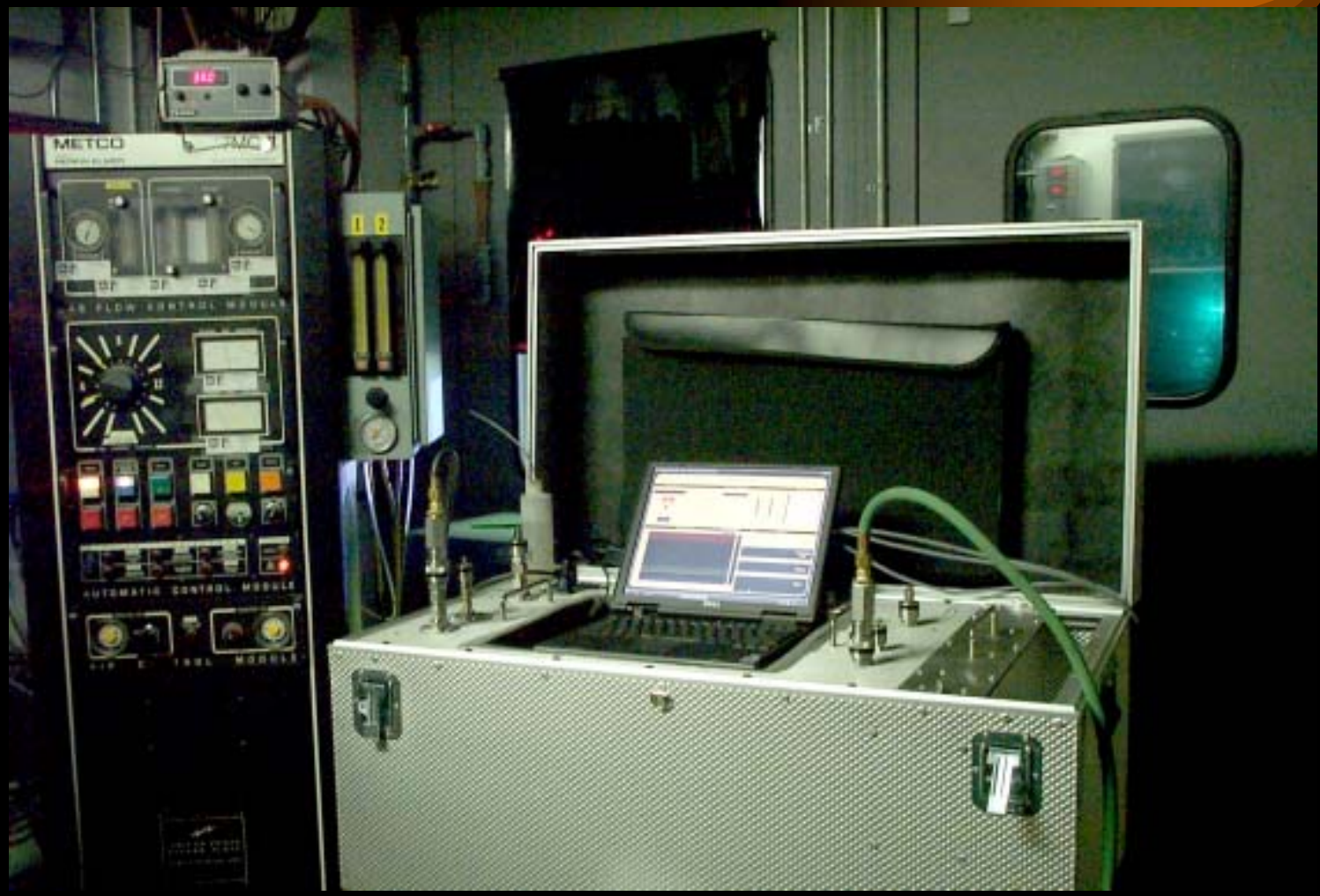

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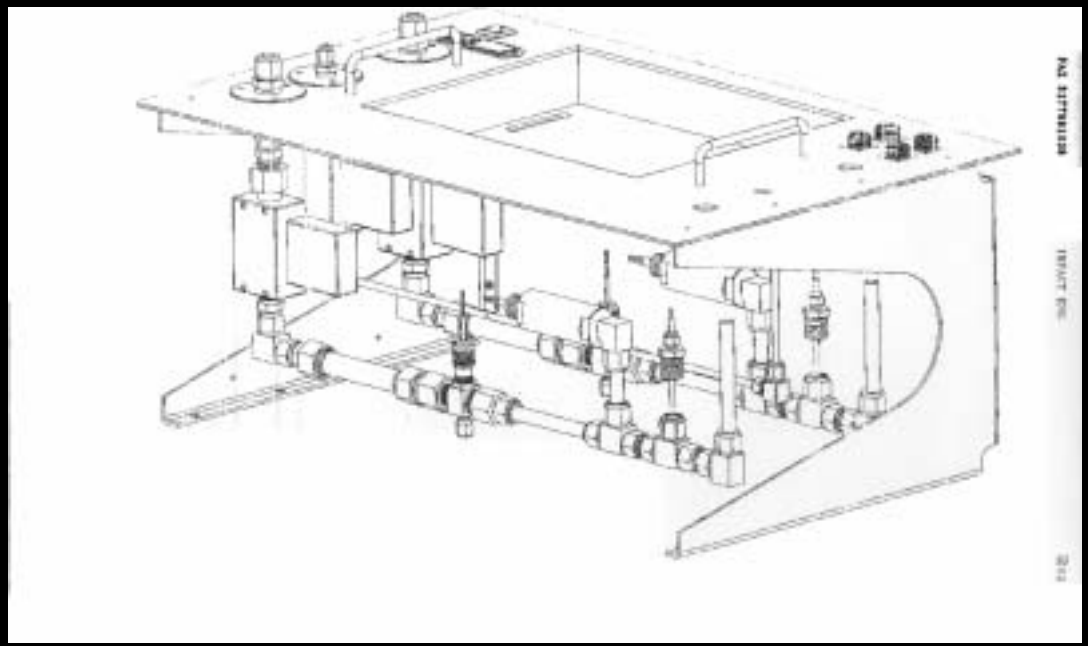
- Hardware Schematic



# *TubalCain Company Inc.*

- New Booth Equivalency System Attributes
  - *Gas Flows Via EG&G Smart Flow Transmitters ± 0.2%*
  - Gas Pressures
  - *Gas Temperatures*
  - Amperage
  - Voltage(s)
  - Water Flow
  - Water Temperature To & From Gun
  - *Data Logging via Lab View Software on Laptop Computer*
  - *Sampling Capability @ 3KHz Frequency*

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- Derivative Engineering Units
  - Control Console kW
  - kW Lost to Cooling Water
  - Plasma kW
  - Voltage Drops Across Cables
  - Energy Density in Gaseous Plume

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- Confirmation of Scientific Phenomena
  - Turbulent-to-Laminar Reynolds Number Transition seen in Gas Flow and Plasma kW/Liter Graphs for Some Nozzles (Critical for High-Quality PWA 53-1 Coatings)
  - @ 100Hz Sampling Rate, Observing Electrical Phenomena Associated with Arc “Restrike” Postulated by E. Pfender, J. Haeberlein, et al, Univ. Minnesota/Univ. Wisconsin ERC
  - @ Low Amperage, Observe More Rapid Cooling Water Heat-up Due to Ultra-Thin Plasma Boundary Layer In Nozzle Postulated by E. Pfender, J. Haeberlein, et al, Univ. Minnesota/Univ. Wisconsin ERC

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- Current Status
  - Hardware System Built, Software Programmed, Received From Impact Engineering, Jackson, MI
  - In “Shake-Out” Process to Optimize System Efficiency, Sampling Rates, User-Friendly Data Management (csv. File exportation to Microsoft Excel)
  - System Immediately Deployable During “Shake-Out” Process; Confirmation via Manual System
  - System to be Tested May 2002: SANDIA, Montana Plasma & Thermal Spray Diagnostics Team

# *TubalCain Company Inc.*

- Potential New Observations
  - Possibly Observing “Cyclical” Dynamic Phenomena @ 15-50 Second Cycle Times Not Heretofore Recorded/Documented
  - Plasma Spray System Responses as f(Gas Temperature)