World-Class Competitiveness

Pin Load Control Applied to Retractable Pin Tool Technology

Presented By: Peter Oelgoetz

AeroMat 2000

June 28, 2000

Rocketdyne
Propulsion & Power

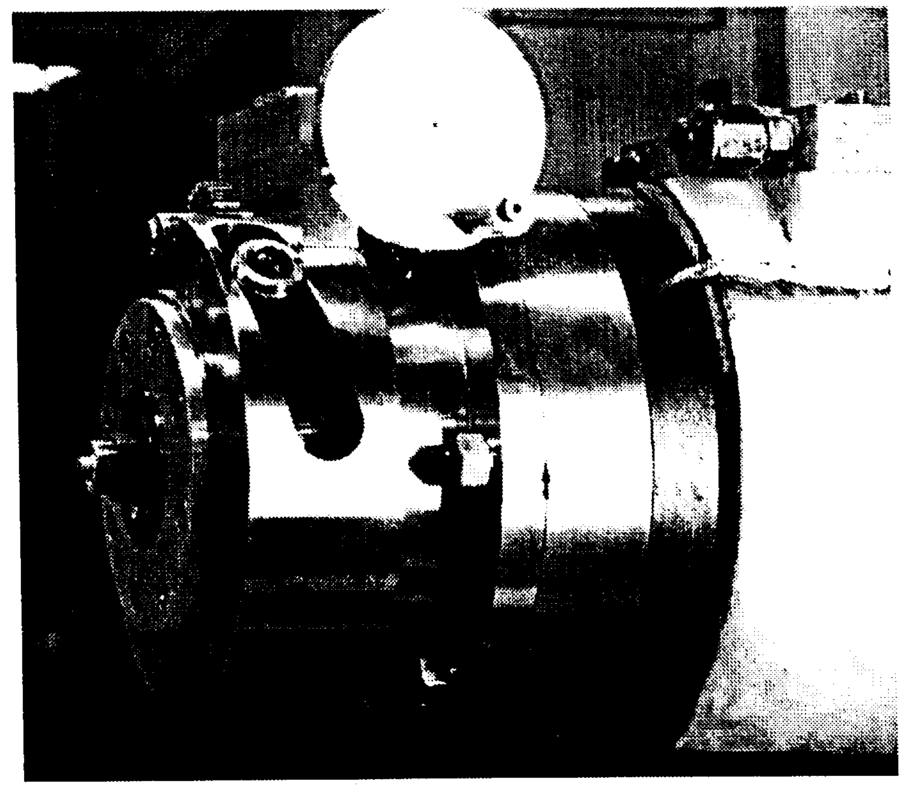
Agenda

- Acknowledgement, NASA/MSFC
- Retractable Pin Tool Development
    - Phase I, Proof-Of-Concept
    - Phase II, Pre-Production Article
    - Phase III, RPT w/ Pin Load Detection
- Retractable Pin Tool Calibration
- Phase III Tests and Evaluation Criteria
- Conclusions

Phase I, RPT Feasibility

Proof-Of-Concept

- Built in the Summer of 1996
- Key-Hole Close-Out First Demo Aug. 1996
- Results of Destructive Tests Very Promising
- Limitations
  - Only Configured for .25” Mat.
  - Manually Operated
  - Probe Placement Inaccurate
  - Fixture Clearance Minimal



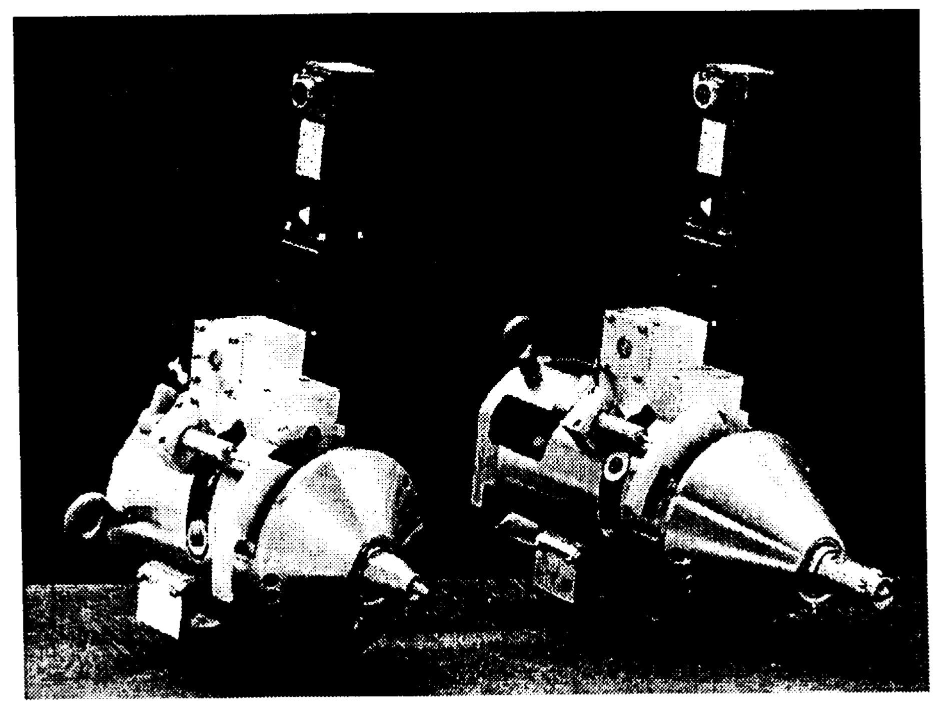
Phase II, Pre-Production

Phase II

NASA Contract Sept 1997

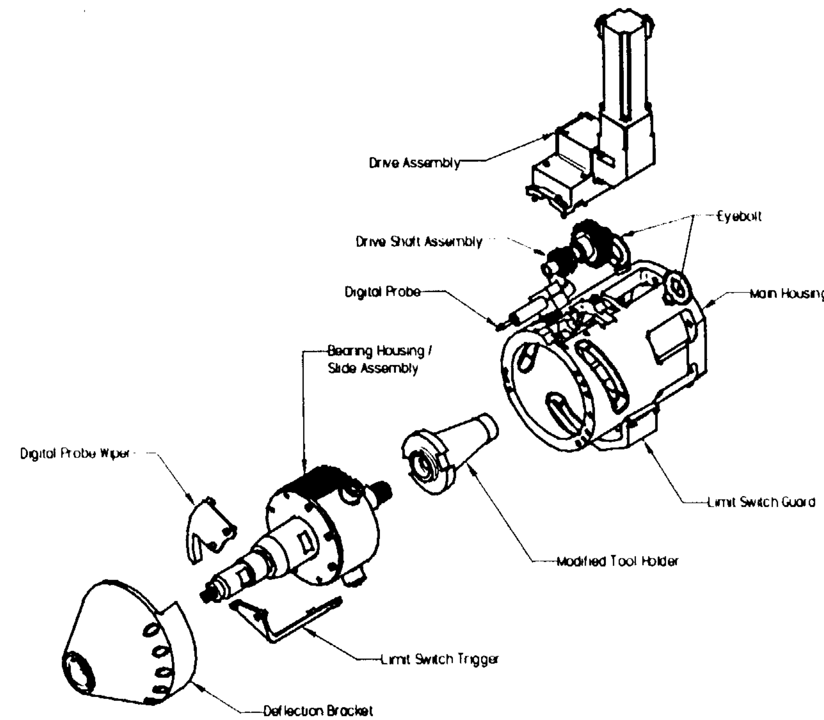
Effort

- Two Programmable RPT
- Configured for Material Thickness range .125"- .750"
- Increased Fixture Clearance
- Incorporates Digital Gauge for Precise Probe Placement
- Key-Hole Elimination Demo Jan. 1998
- Tapered Thickness Joining Demo Feb. 1998

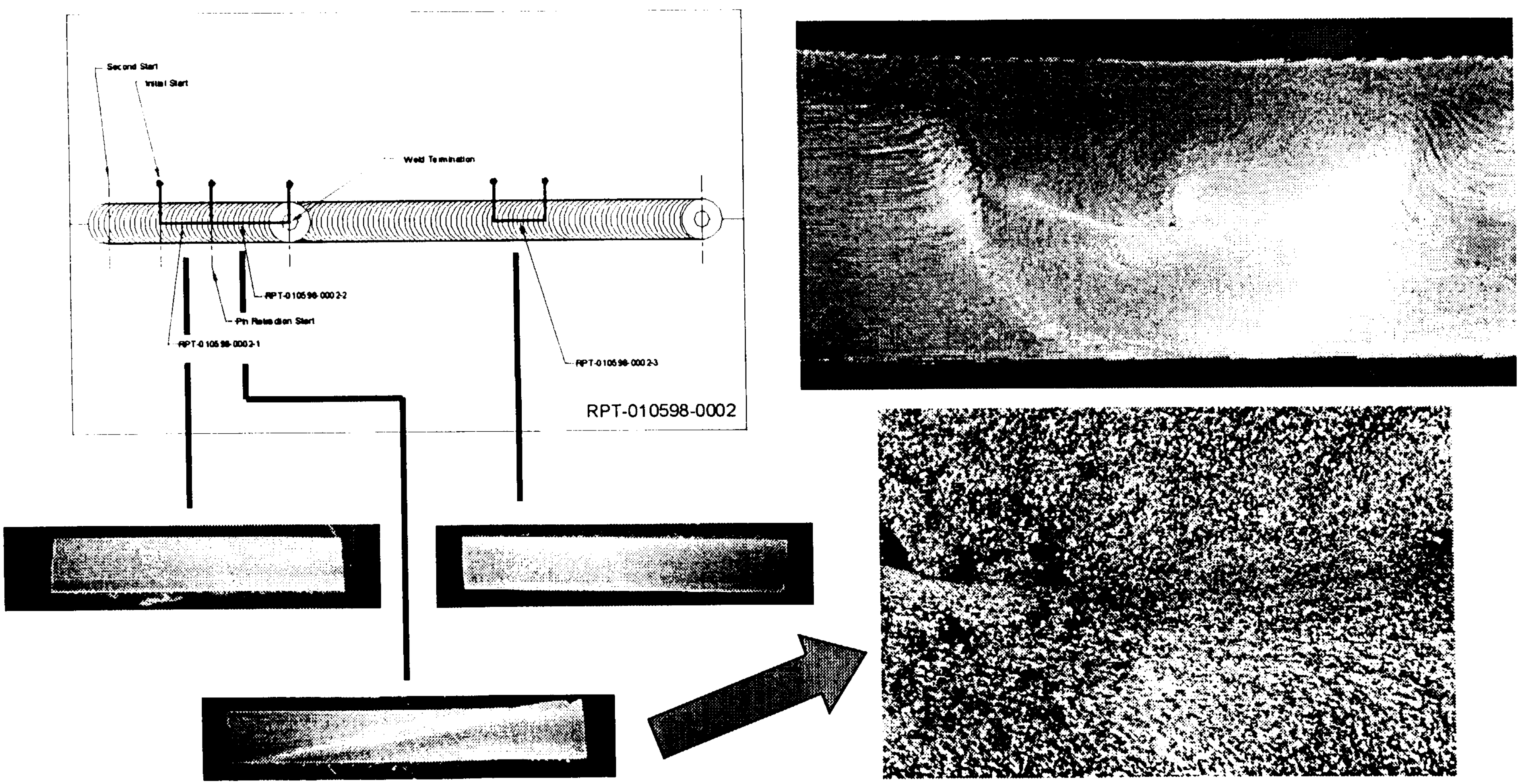


MECHANICAL OPERATION

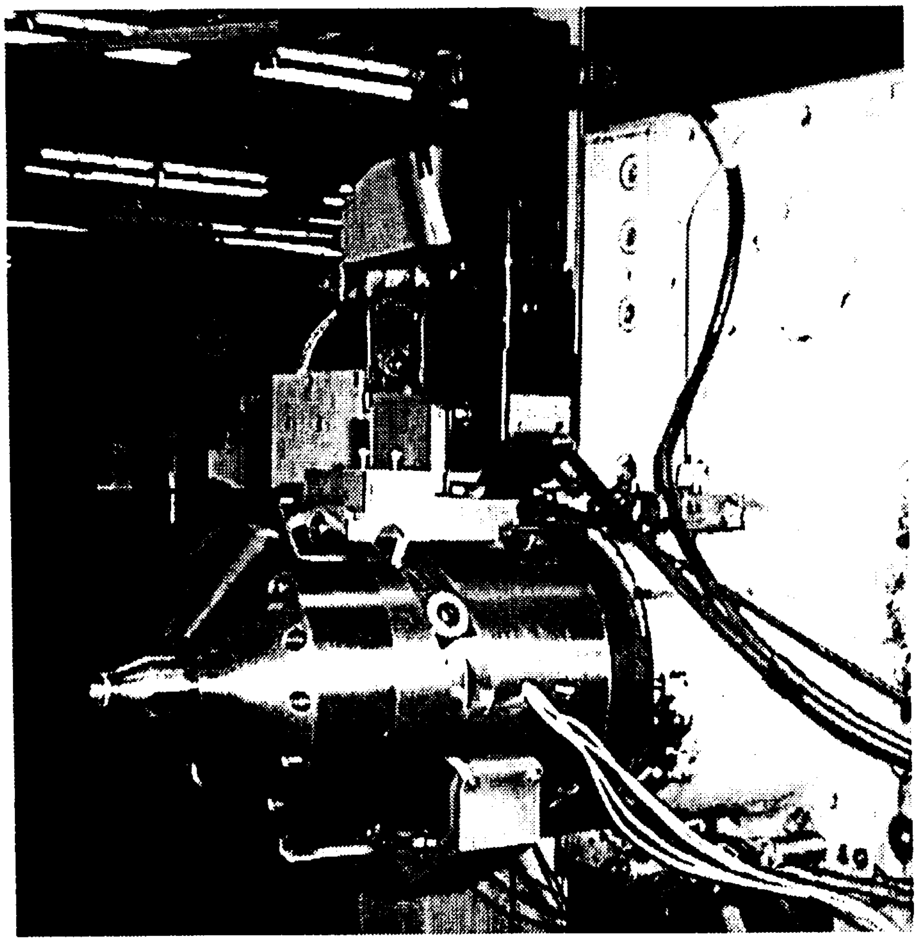
- **Totally Portable, Plug and Play Device**
- **Main Features**
  - Drive Assembly
  - Drive Shaft Assembly
  - Main Housing
  - Specially Designed Rotary/Linear Slide
    - Separated Two Z Axes of Motion
    - Couples Probe and Shoulder Rotary Axis
  - Peripheral Components



Pin Load Control

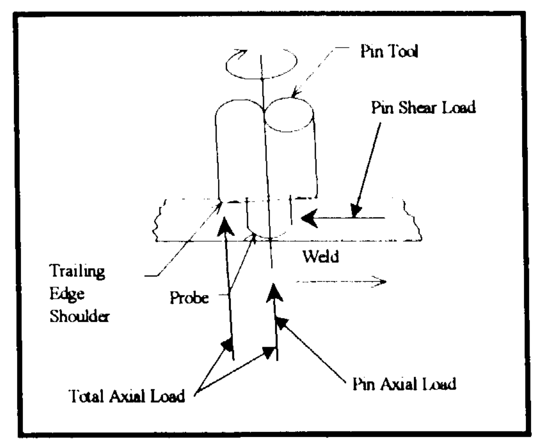


Phase III, Pin Load Detecting Integration



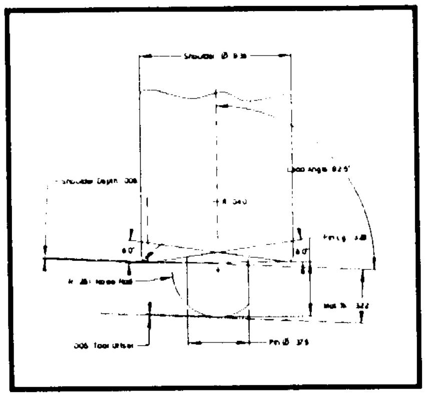
OBJECTIVE:

- Demonstrate Pin Placement Accuracy
- Test a Pin Load Detecting System



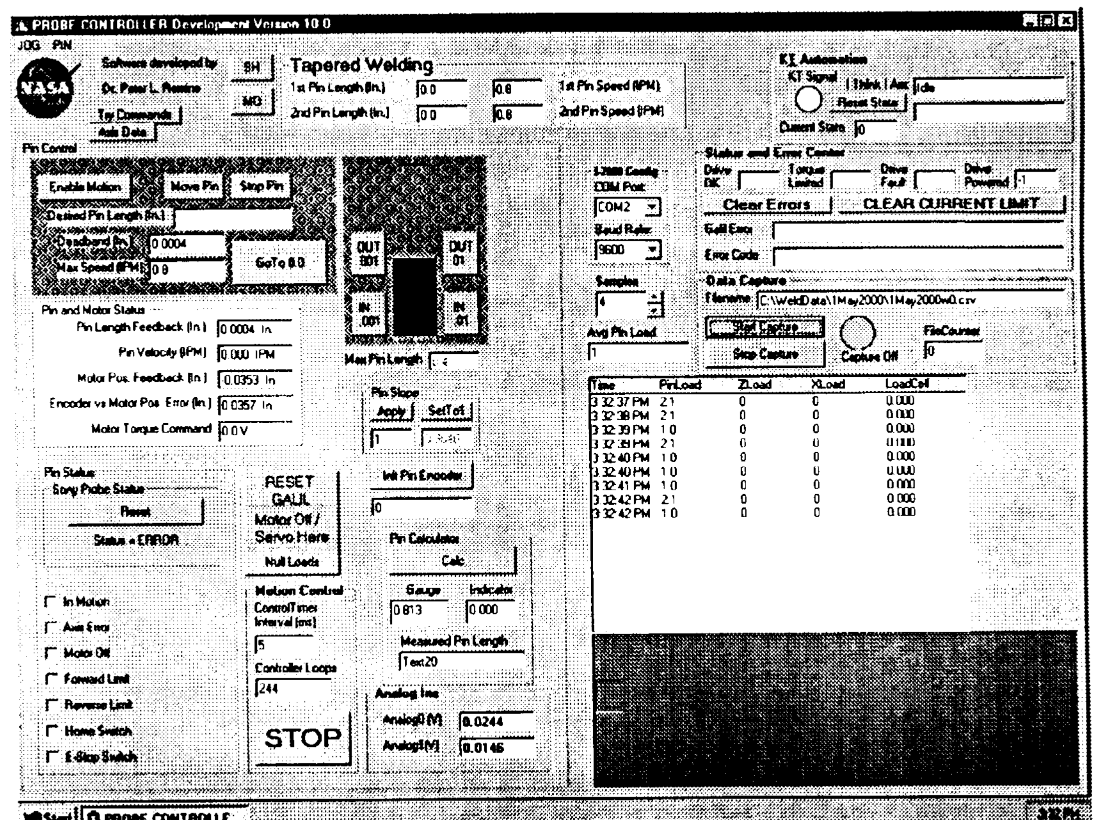
LOAD DIAGRAM

Phase III RPT Calibration



Pin Tool Model

Rpt Pin Length Calibration



RPT Control Panel

Test Parameters and Evaluation Criteria

Tests

- Constant Pin Length/Constant Material Thickness
- Varied Pin Length/Constant Material Thickness
- Varied Pin length/Tapered Material Thickness
- Exit Hole Elimination/Constant Material Thickness

Material: 2219 and 2195

Panel Thickness Mapped Prior to Welding

RPT Pin Length Measured Before and After Welding

Data Collected: Pin Shear Load, Pin Axial Load, Total Axial Load, and Pin length

Data Plotted: Welding Time Verses Load

Weld Parameters

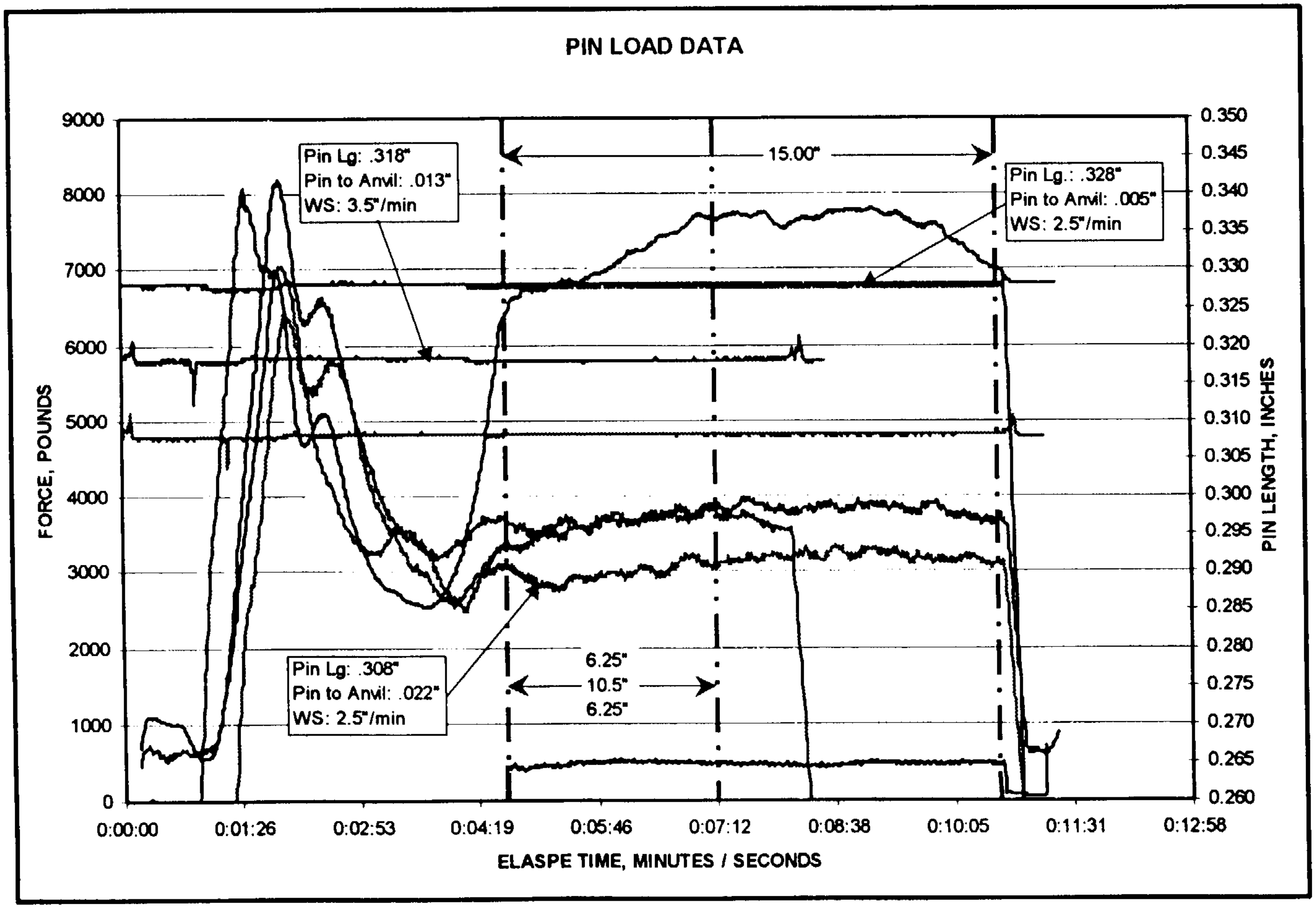
- Pin Diameter:.375” Diameter Pin, 3/4 X 24 LH Thread
- Shoulder Diameter: .938” Diameter
- Plunge Speed: .100”/min
- Lead Angle: 2.5 Degrees
- Welding Speed: 2.5 and 3.5”/min
- Shoulder Material Depth: .008”

Evaluation Criteria

- Visual
- Metallurgical Cross-Sections
- Event verses Load

Pin Load Control

Constant Pin Length/Constant Material Thickness



Transverse Section

Pin Lg: .308, Mat Th: ..319

Transverse Section

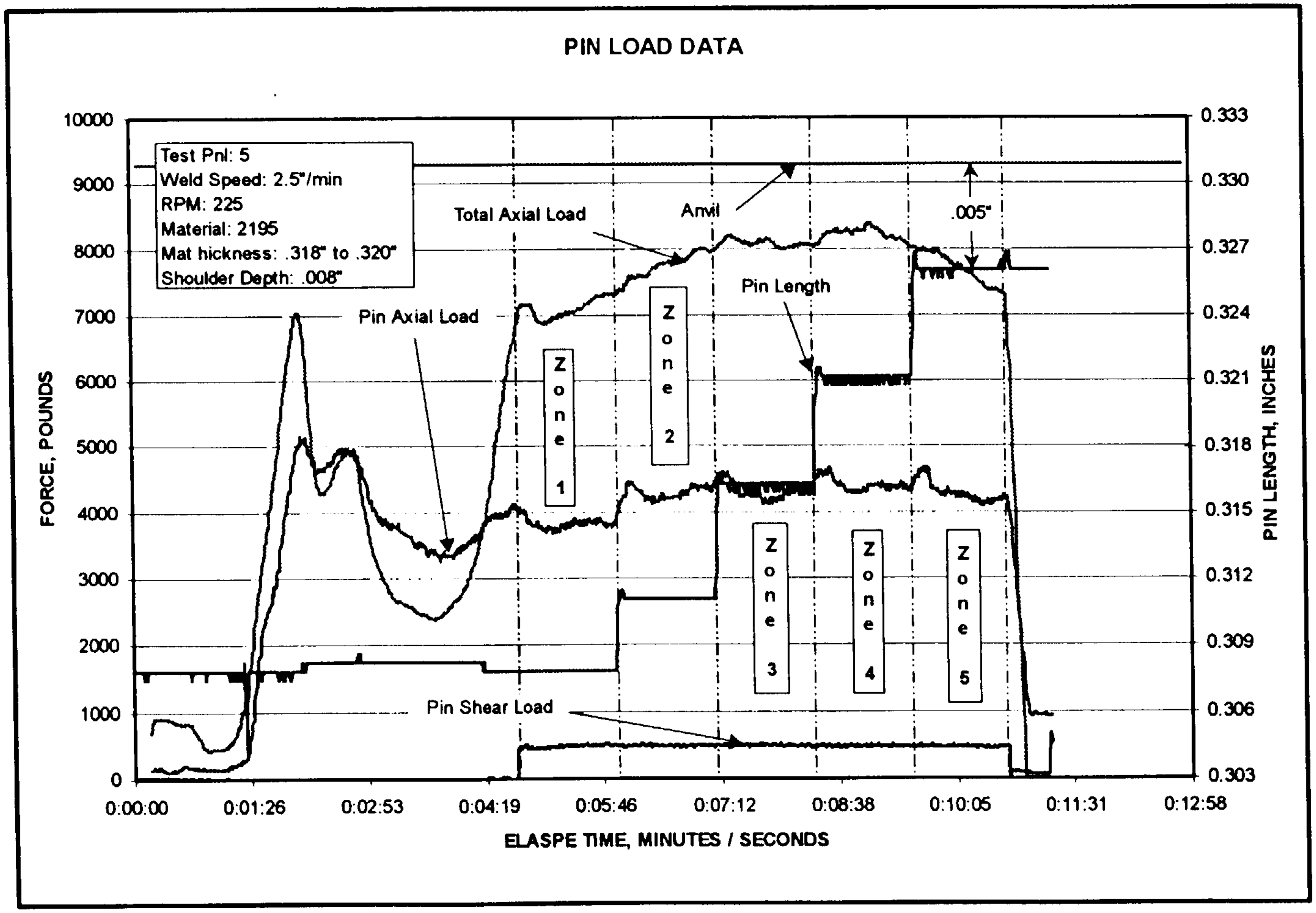
Pin Lg: .318, Mat Th: .320

Transverse Section

Pin Lg: .328, Mat Th: .322

Pin Load Control

Varied Pin Length/Constant Material Thickness



Transverse Section

Zone 1

Transverse Section

Zone 3

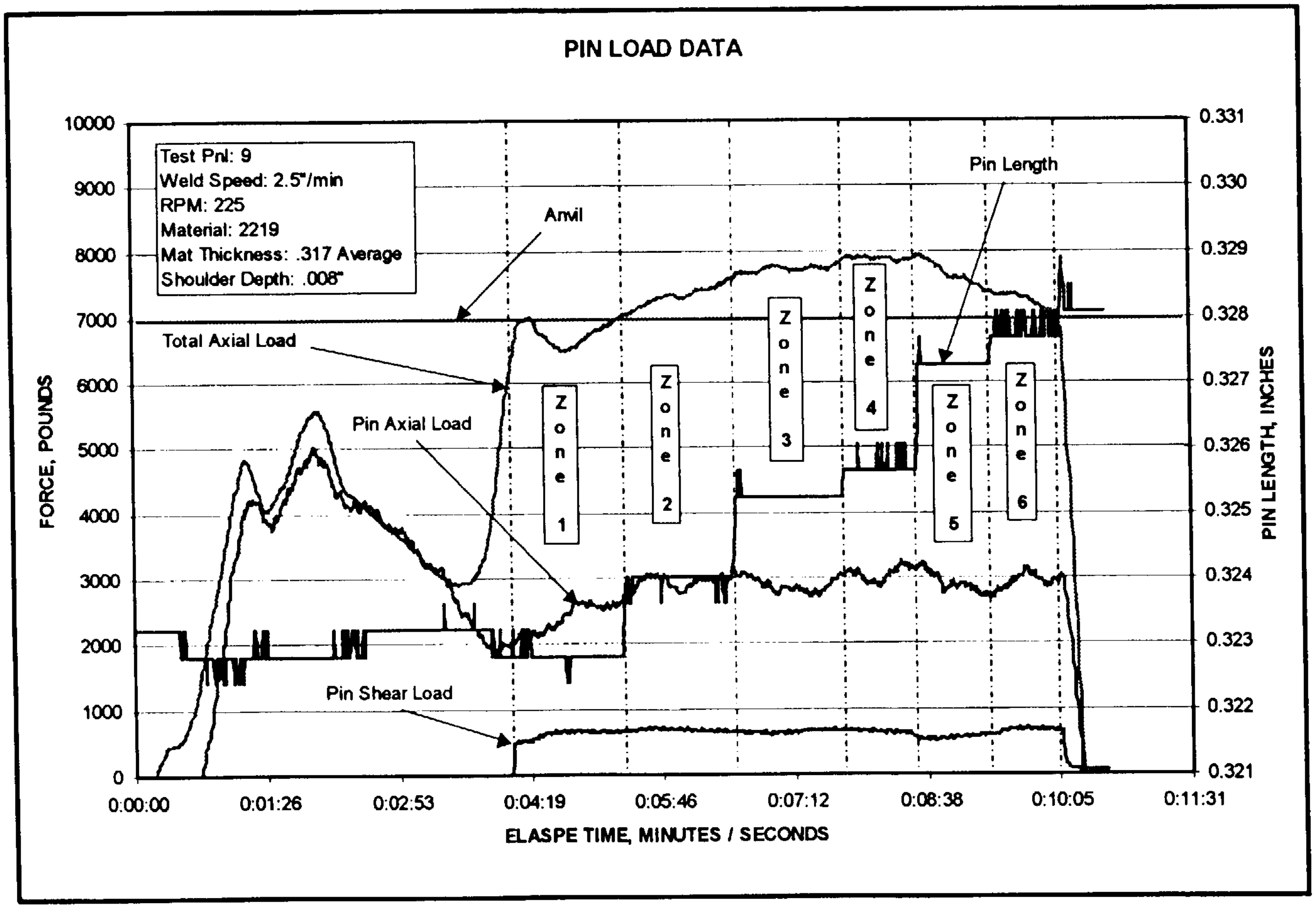
Transverse Section

Zone 5

Rocketdyne Propulsion and Power
Huntsville Materials Application

Pin Load Control

Varied Pin Length/Constant Material Thickness



Transverse Section

Zone 1

Transverse Section

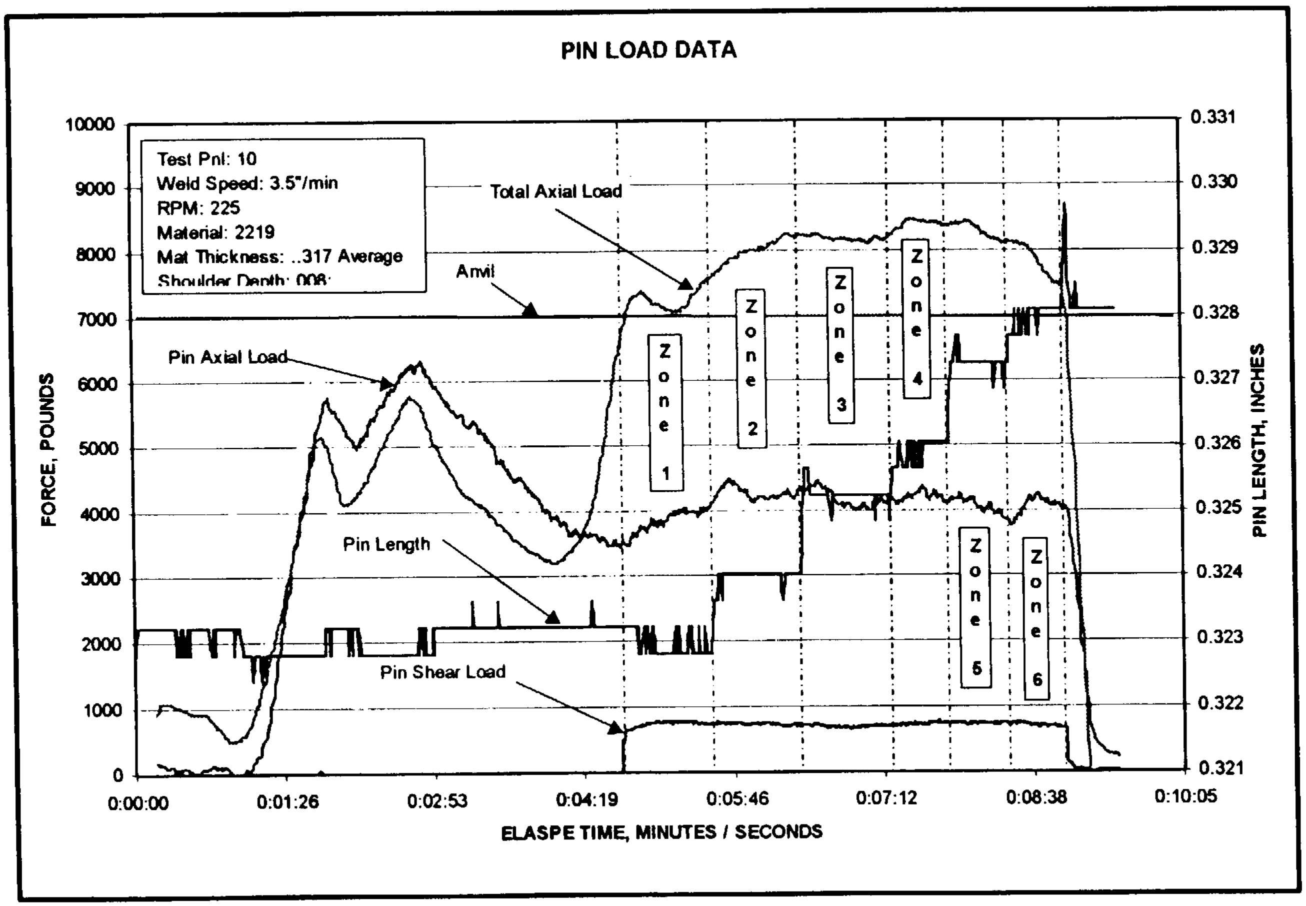
Zone 3

Transverse Section

Zone 6

Pin Load Control

Varied Pin Length/Constant Material Thickness



Transverse Section

Zone 1

Transverse Section

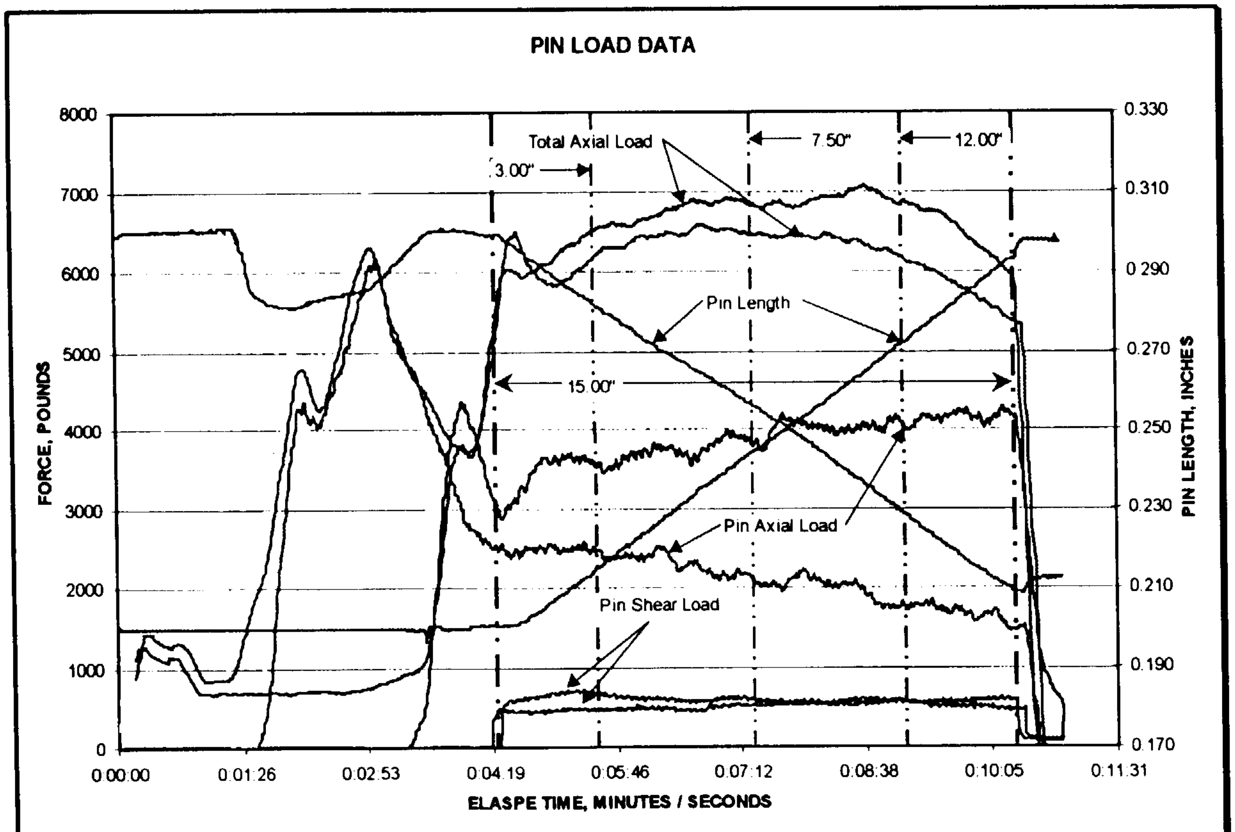
Zone 3

Transverse Section

Zone 6

Pin Load Control

Varied Pin Length/Tapered Material Thickness



Taper Pnl 1 & Taper Pnl 2 Load Comparison

Transverse Section	Transverse Section

3.00" Transverse Sections

Transverse Section	Transverse Section

7.50" Transverse Section

Transverse Section	Transverse Section

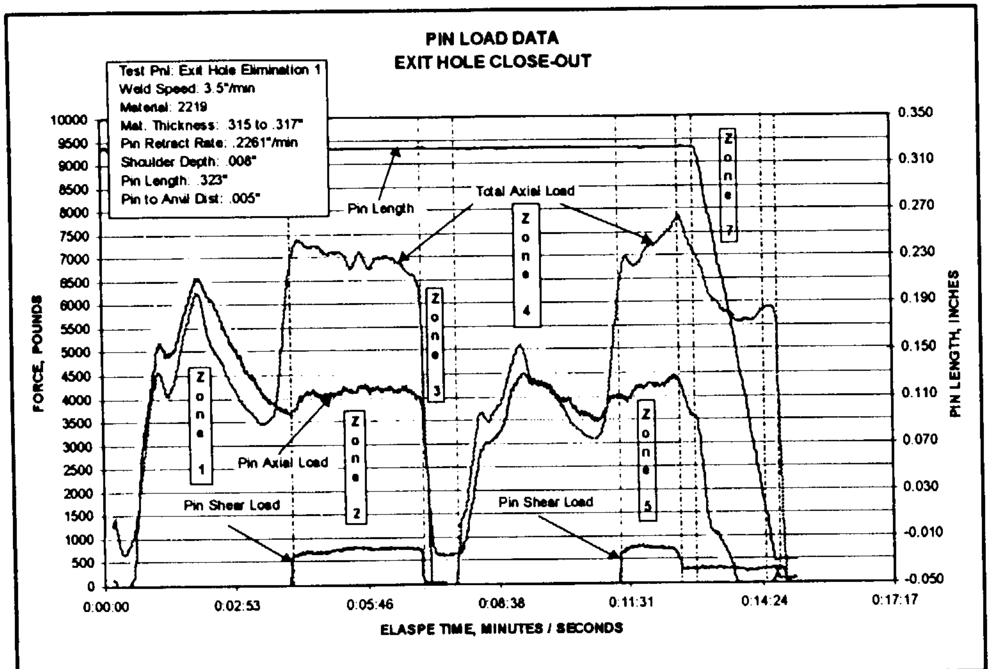
12.00" Transverse Section

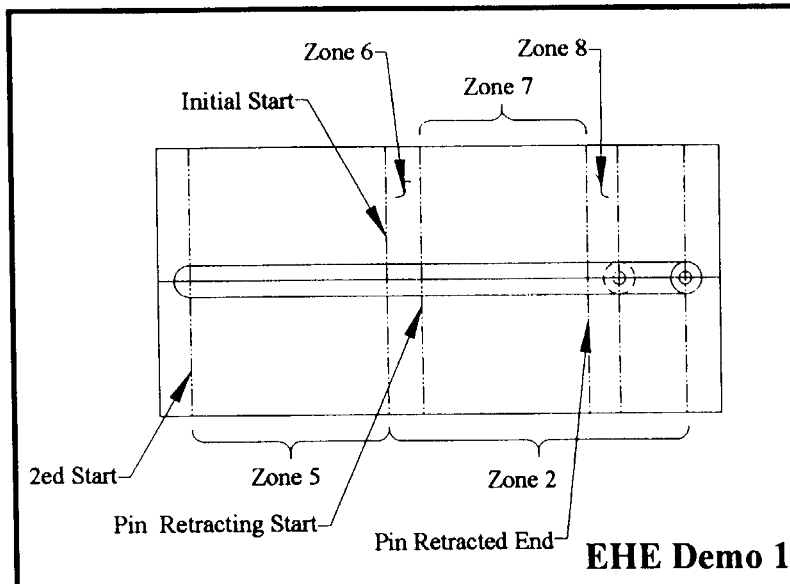
Taper Pnl 1
Thick to Thin

Taper Pnl 2
Thin to Thick

Pin Load Control

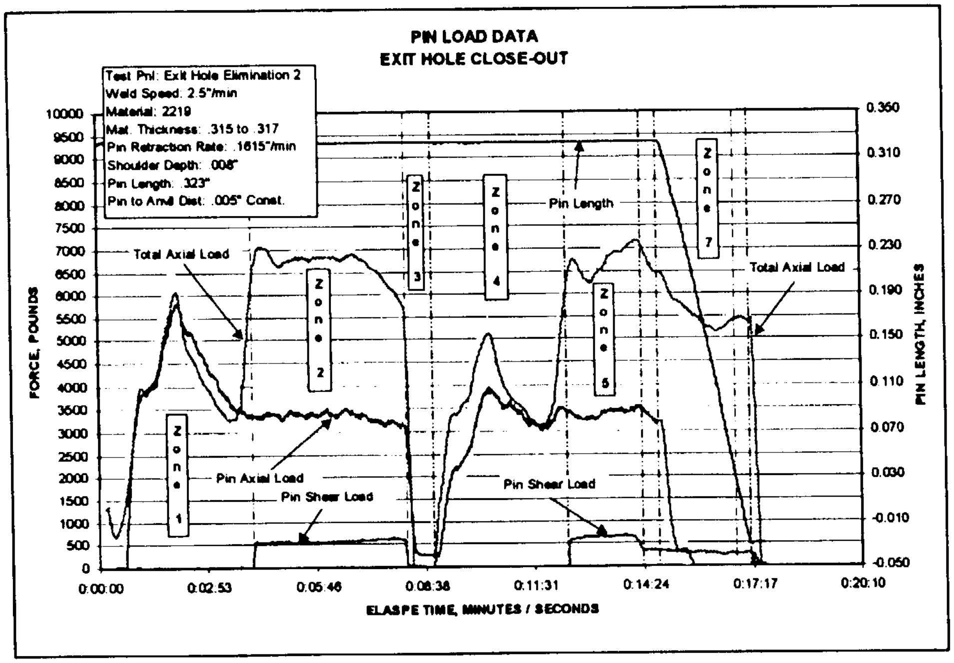
Exit Hole Elimination/Constant Material Thickness

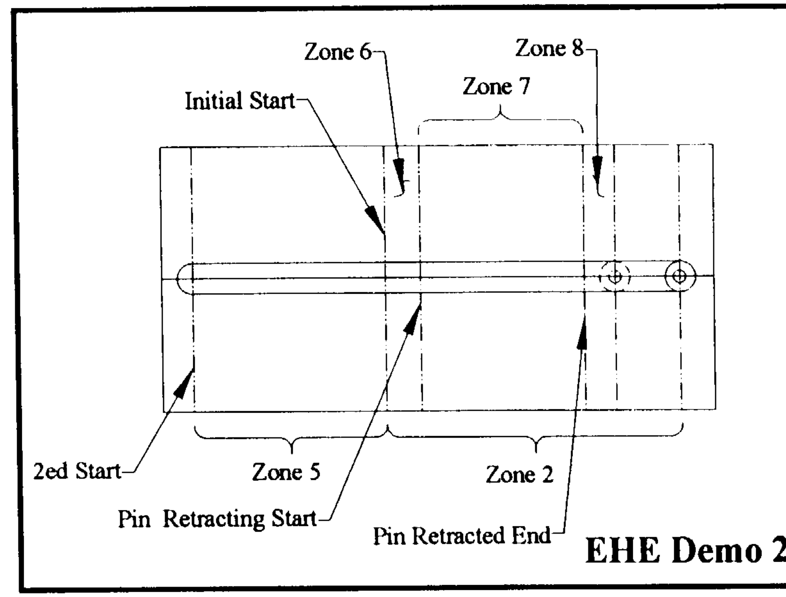




Transverse Section	Transverse Section	Transverse Section	Transverse Section
Zone 5	Zone 6	Zone 7	Zone 8

Exit Hole Elimination/Constant Material Thickness





Transverse Section	Transverse Section	Transverse Section	Transverse Section
Zone 5	Zone 6	Zone 7	Zone 8

Pin Load Control

Conclusions

- Demonstrated Pin Placement Accuracy
- Load Value Delta Between Total Axial Load and Pin Axial Load During Plunging verses Similar Load Profiles
  - Calibration Error
  - Electronic Noise
  - Bent RPT Components
- Recorder Pin Axial Loads are Believed to be High
- Greater Pin Depth - Higher Pin Axial Load
  - Pin Diameter
  - Number of threads in substrate
  - Alloy
- Higher Travel Speeds - Higher Pin Axial Load
- Incremental Pin Extension Produces Pin Axial Load Response Then Decays
- Welding Thick to Thin Taper Panels Produces Decreasing Pin Axial and Pin Shear Loads
- Welding Thin to Thick Taper Panels Produces Increasing Pin Axial and Pin Shear Loads