

**API Inspector Summit  
Galveston Island Convention  
Center  
Galveston, Texas**

January 27-30, 2009

THE 2009 API  
**INSPECTOR  
SUMMIT**



# Electromagnetic Inspection of Wire Ropes and Strand

Flare Stack Guy Wires

Pipeline Bridge Spans



# Flare Stacks and Pipeline Bridges and Spans

- Approximately 2500 Flares Stacks
  - Average Age is 20 years
  - Many as old as 40 years
  - 3 to 16 guy wires
    - Half and half wire rope –vs- strand
- Approximately 1200 Pipeline Bridges
  - Average age is 18 years
  - Many built in the early 40's



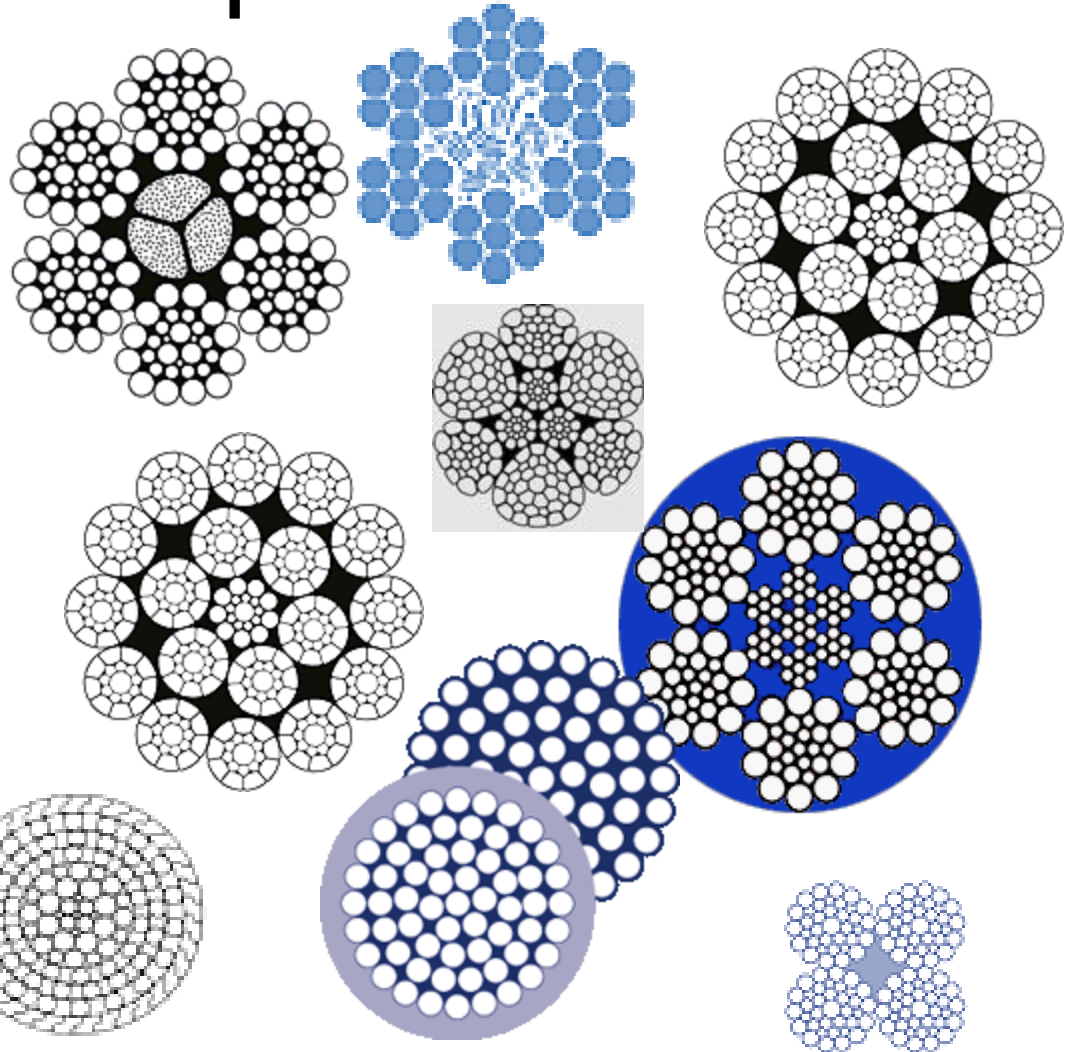
# Why Inspect



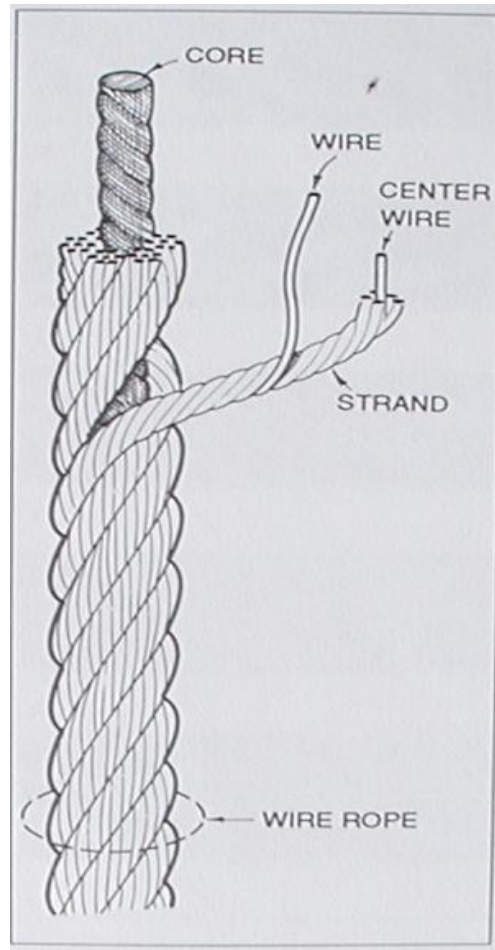
For those of you who aren't familiar.....

# Wire Rope Jarqon

- Wires
- Strands
- Core
  - Fiber
  - IWRC
- Shaped Wire
- King Wire
- Bridge Socket
- Turnbuckles
- Attachments
- Clips
- Sockets



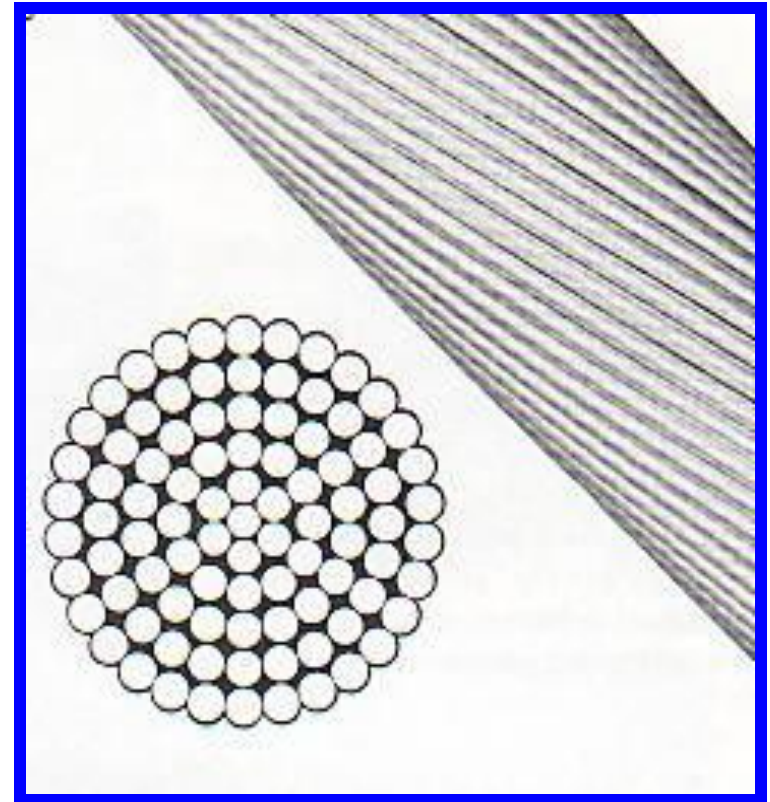
# Construction of Wire Rope Typical for Guys and Supports



- Number of Strands
  - Typically 6
- Wires/Strand
  - Typically 19 – 30
- Core
  - Fiber or IWRC
- Lay
  - Right or Left
  - Regular or Lang
- Coating
  - Galvanized or Bright

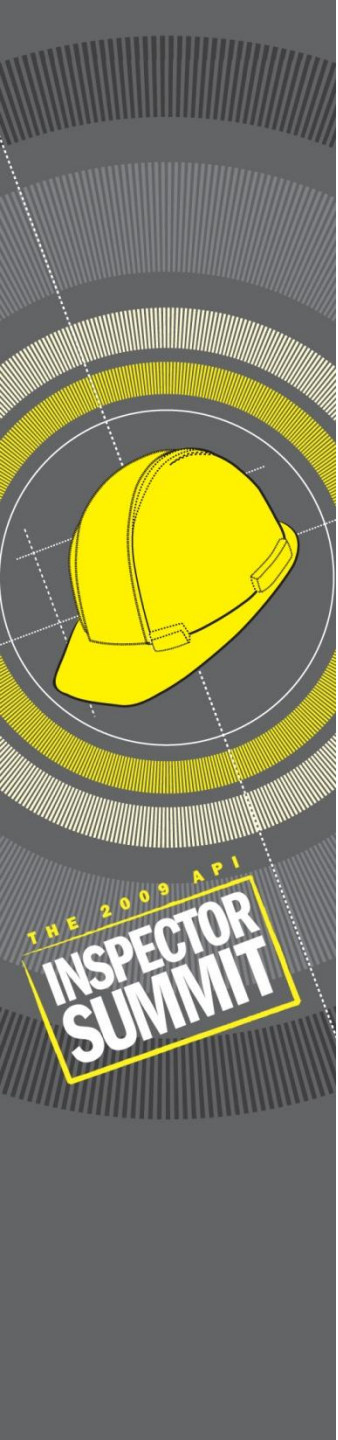
# Structural Strand

- Stronger – 1"  $\varnothing$ 
  - Wire Rope - 52 Tons
  - Strand – 62 Tons
- Stiffer – Static Only
- Zinc Coated
- Balanced Torque
  - Alternate Lay
- Less Stretch



# Causes for Failure

- Corrosion
  - Internal and External
- External Abrasion - Damage
  - At Ground Terminations
  - Stack Attachments
- Wear
  - Inadequate/Infrequent Lubrication
- Fatigue
  - Broken Wires at terminations
  - Internal and External
- Stretch
- Guy Wires Have a Finite Life Span



# Corrosion

- Internal and External
- Lack of Lubrication
- Inadequate Maintenance
  - Rope Partially Sealed
- Hydrogen Embrittlement
- Intergranular Corrosion
- Fretting Corrosion
  - At attachments



# External Corrosion Top of Guy Wire



# Severe Corrosion Deteriorated External Wires

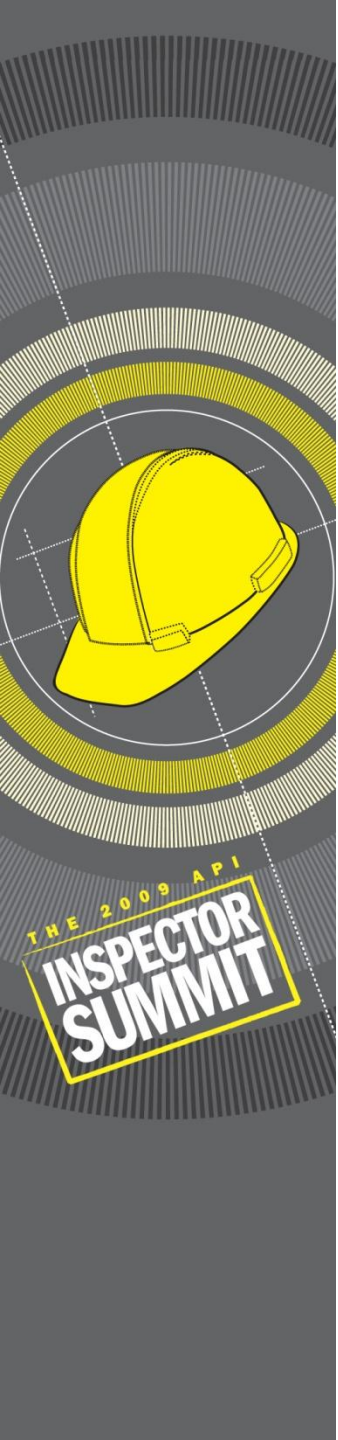


# Broken Wires Severe Corrosion



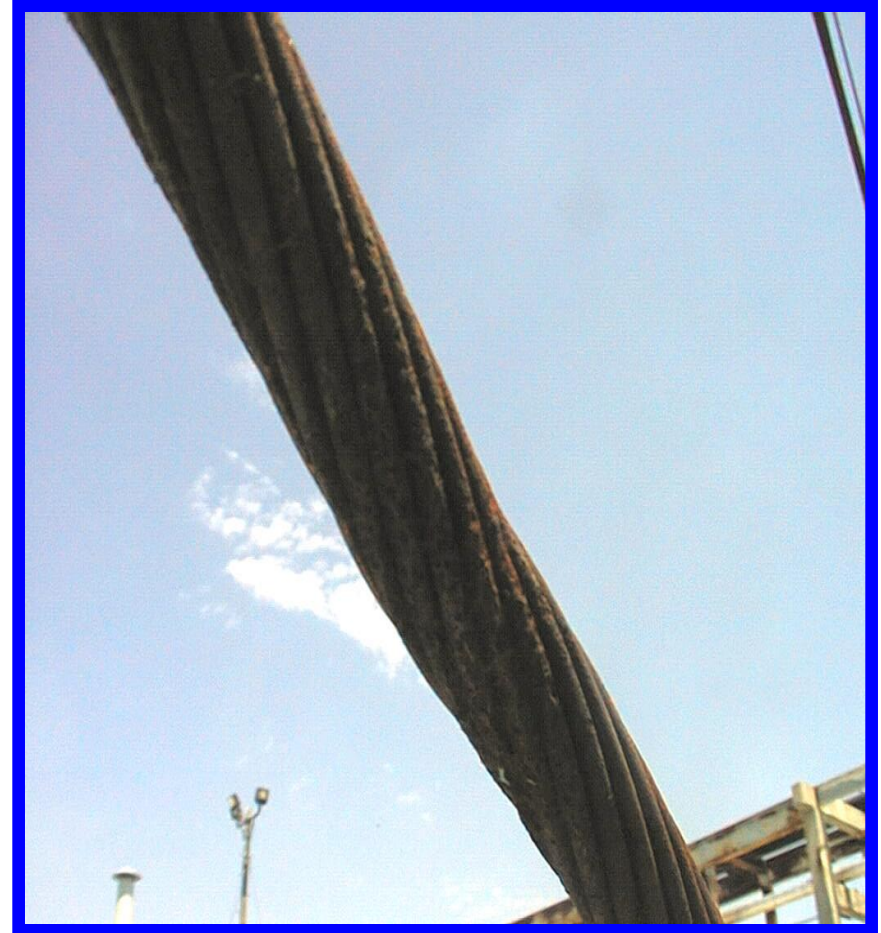
# External Damage

- Vibration
  - Erosion
  - Fatigue
  - Broken Wires
  - Loss of Strength
  - Fretting Corrosion
- Improper Lubrication



# Wear

- Internal - External
  - Outside Influence
  - Vibration
  - Crown wire wear
- Lack of Lubrication
  - Fretting Corrosion
- Loss of Metallic Area



# Fatigue

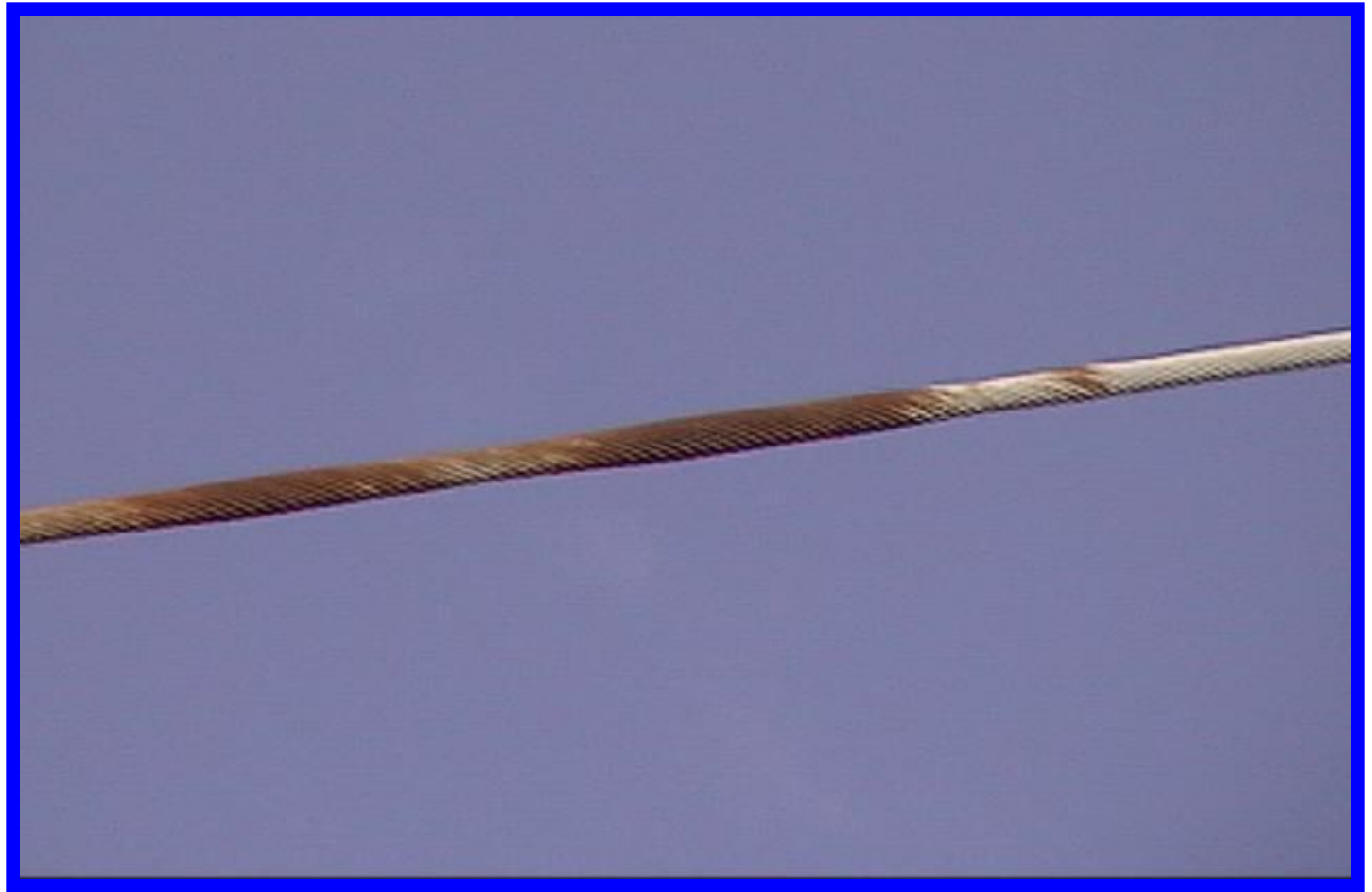
- External –  
Internal
- Anchor Attachments
  - Corrosion
  - Vibration
- Mid-Span
  - Vibration
  - Unknown Causes
- Stack Attachments
- Broken Wires-  
Result



# Vibration Causes Fatigue and Ultimate Failure-



# Unknown Causes of Deterioration



# Improper Grounding Procedures

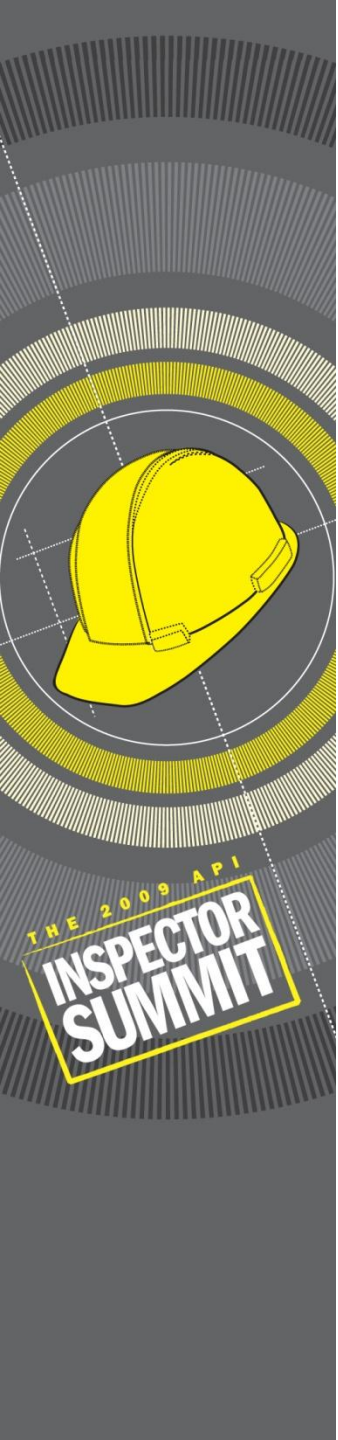
- Deterioration of anchor fittings



# Methods of Examination...

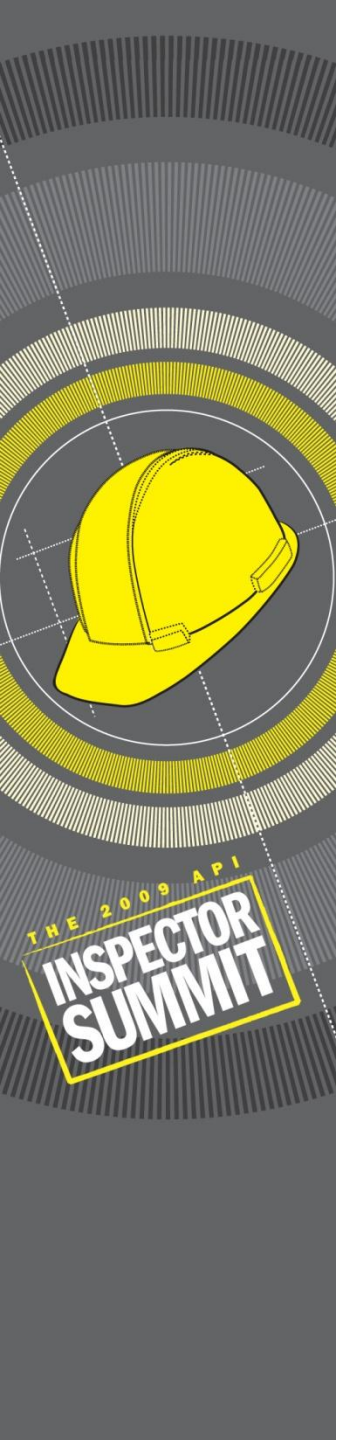
## Visual

- External Only
- Necessary to clean prior to exam
- Very Expensive due to pre-cleaning
- Diameter Measurements
- Lay Length Measurements
- No Comparison – exam to exam
- Remote Visual or Visual



# Visual Examination

- Visual
  - Clean thoroughly so that individual, external wires are visible,
  - Crown wires and wires in the valleys are visible,
  - Ground terminations or attachments only.
- Take Diameter Measurements
  - Where ever wear is evident,
  - Approximately 10 diameters from socket
  - At any suspect point
- Internal inspection is not possible
  - If rope is not under load, marlin spikes may be used to look at the outside structure of the core in the rope or possibly the second layer of wires in a strand.



# Methods of Examination...

## Electromagnetic

External and Internal

- Broken wires and loss of metallic area

Not necessary to clean prior to exam

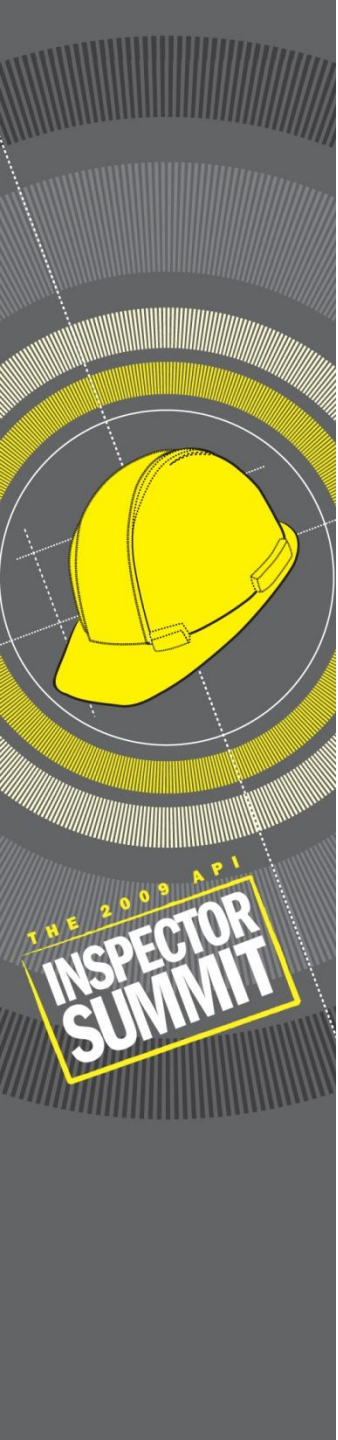
Diameter Measurements

Lay Length Measurements

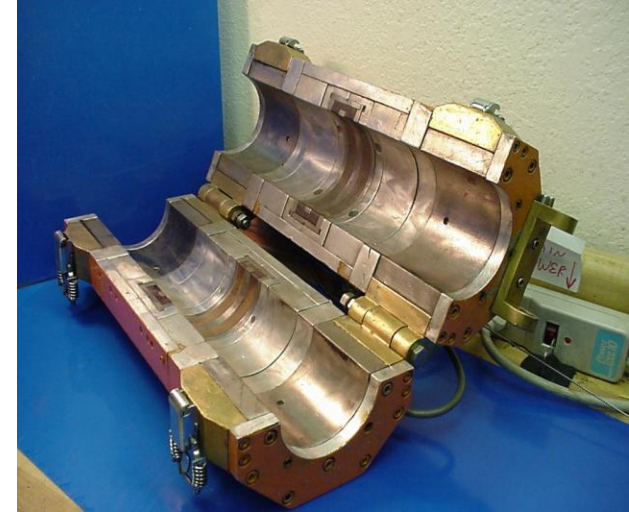
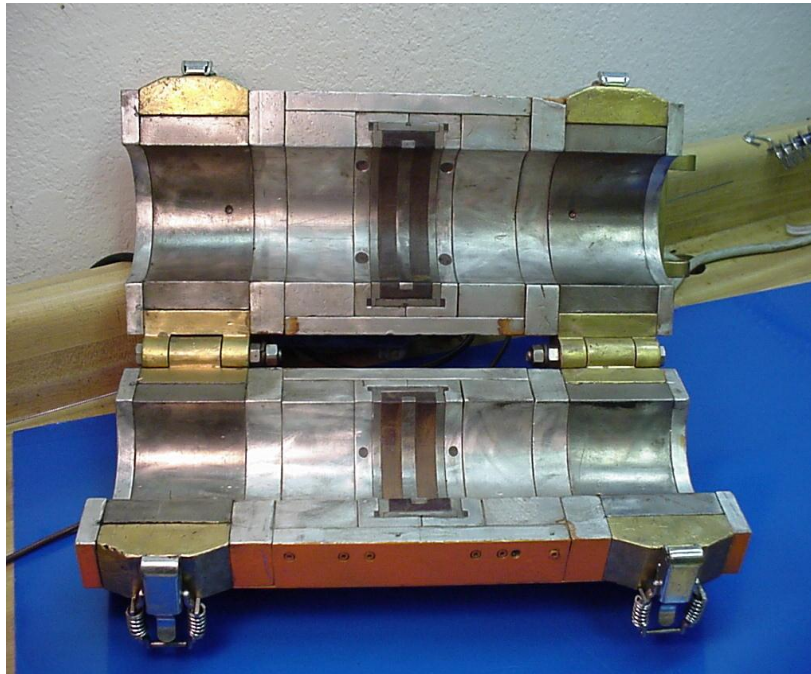
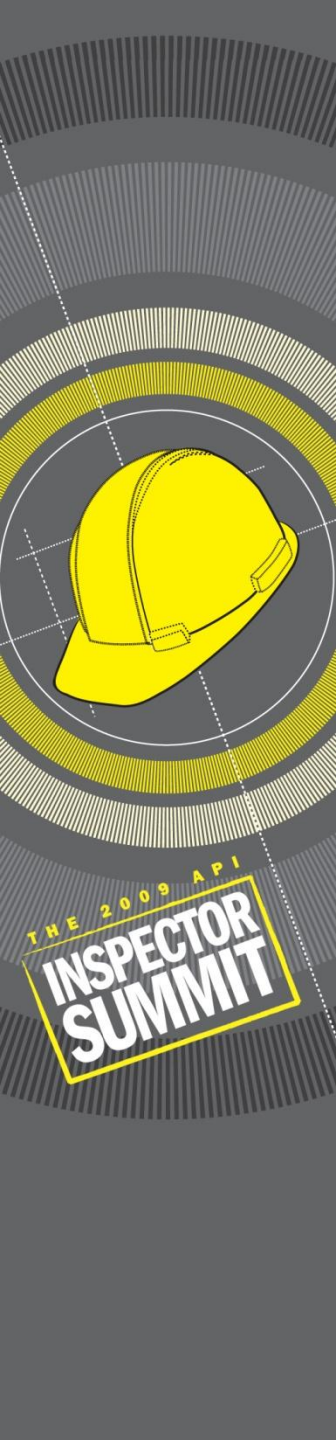
Comparison – Exam to Exam

- Extrapolation of data

Bottom to top inspection

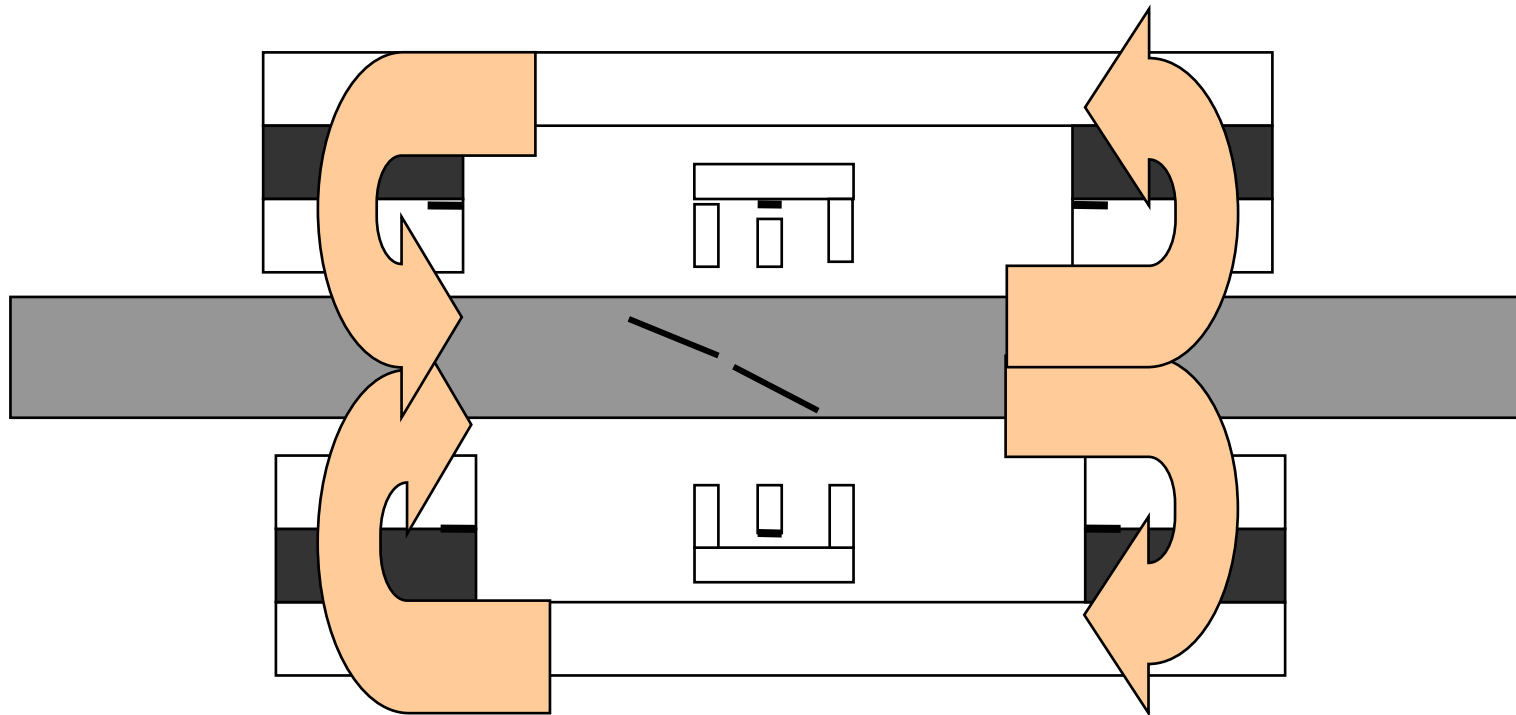


# Sensor Head - $\frac{3}{4}$ " through 3"

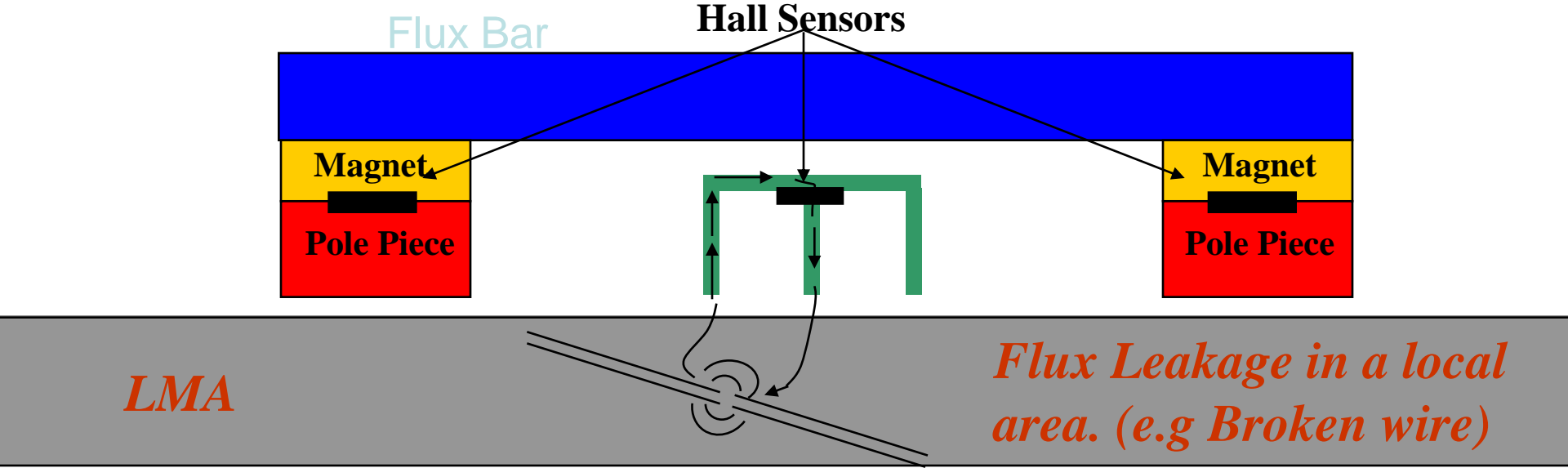


# Principles of Operation

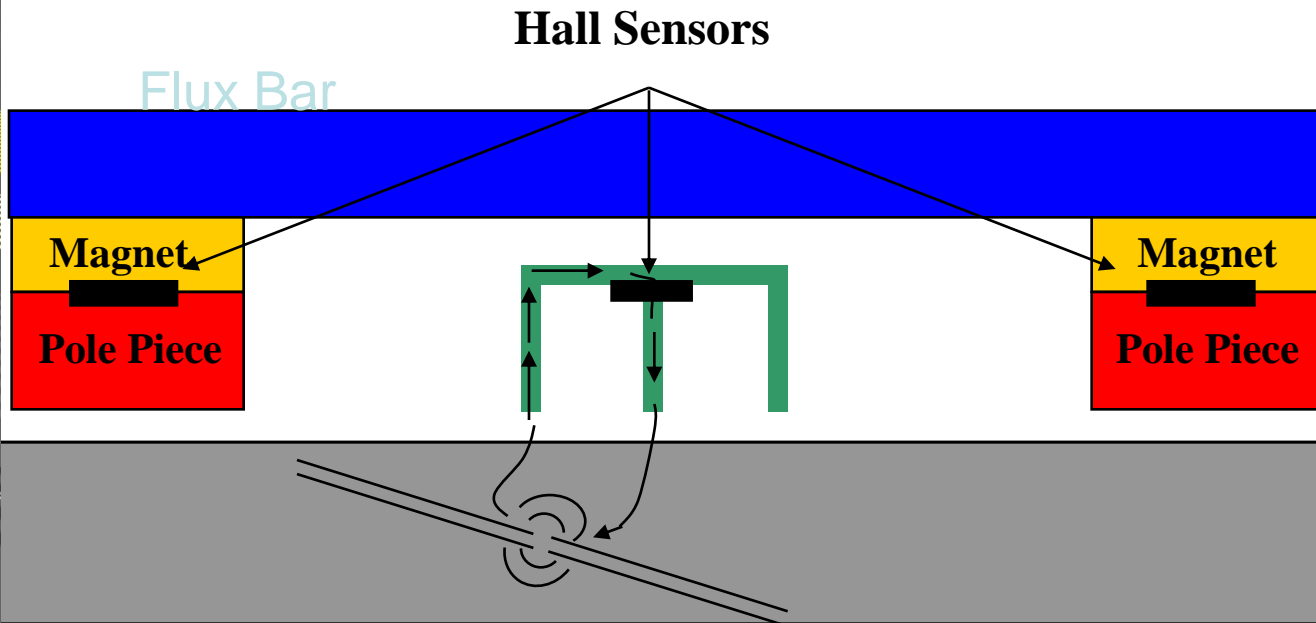
## Sensor Head



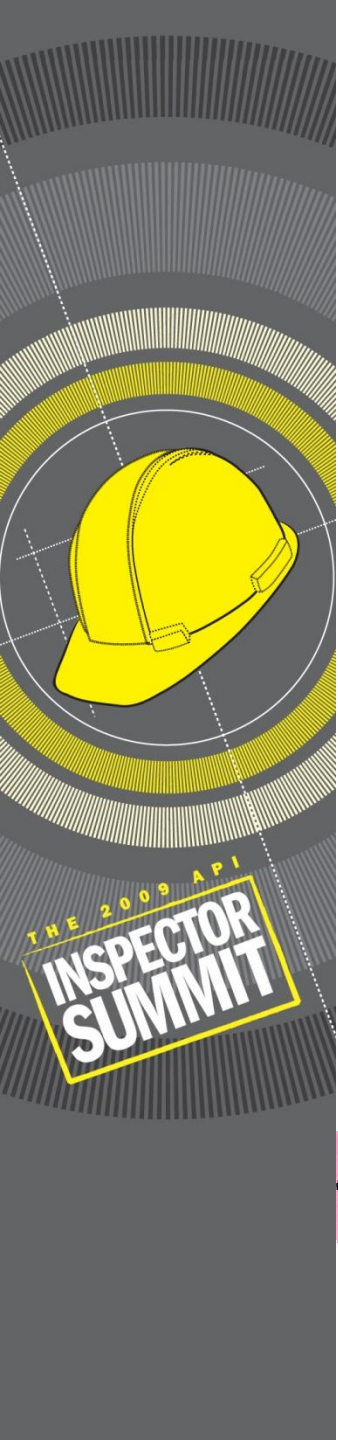
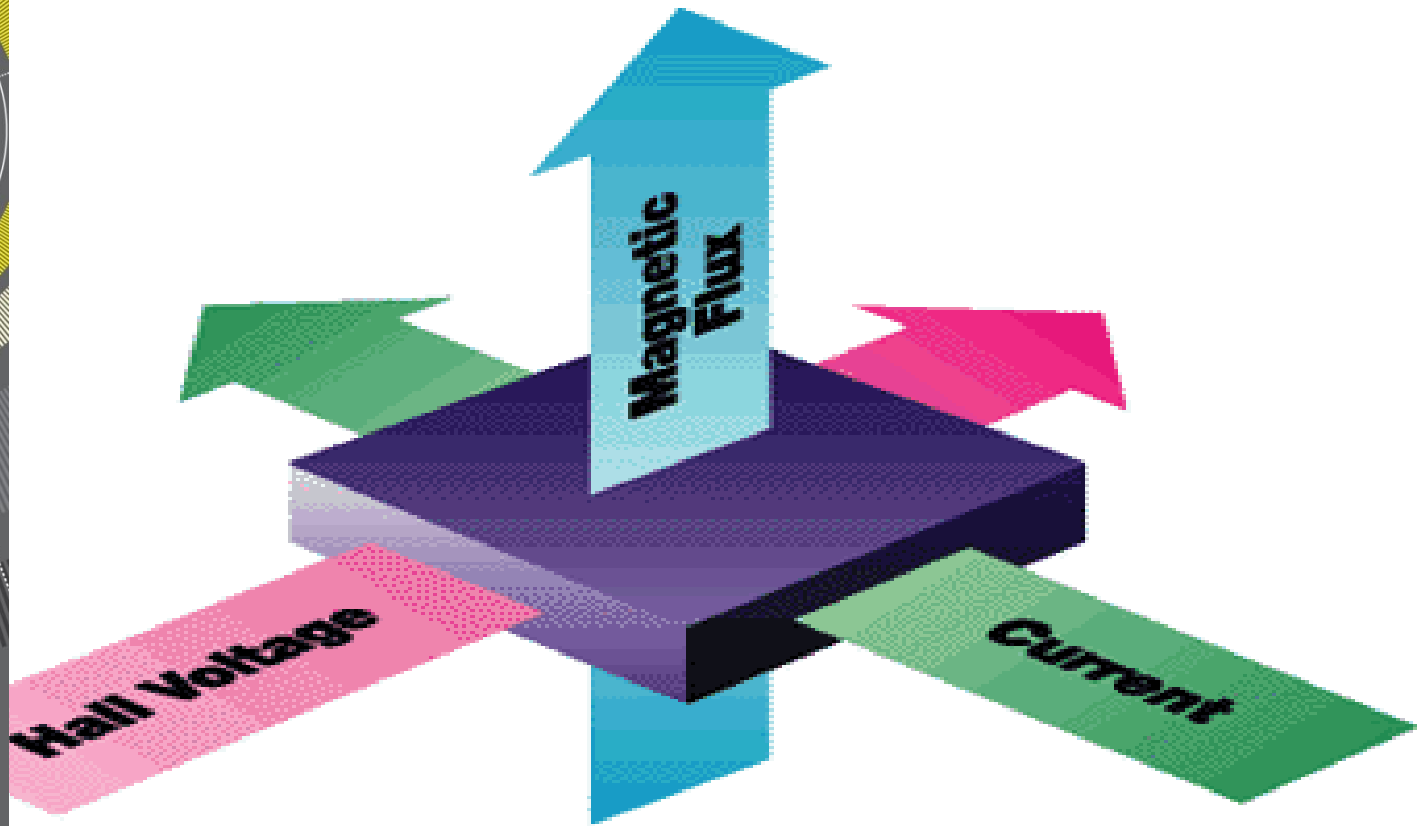
# Sensor Head Arrangement



# Sensor Head Arrangement

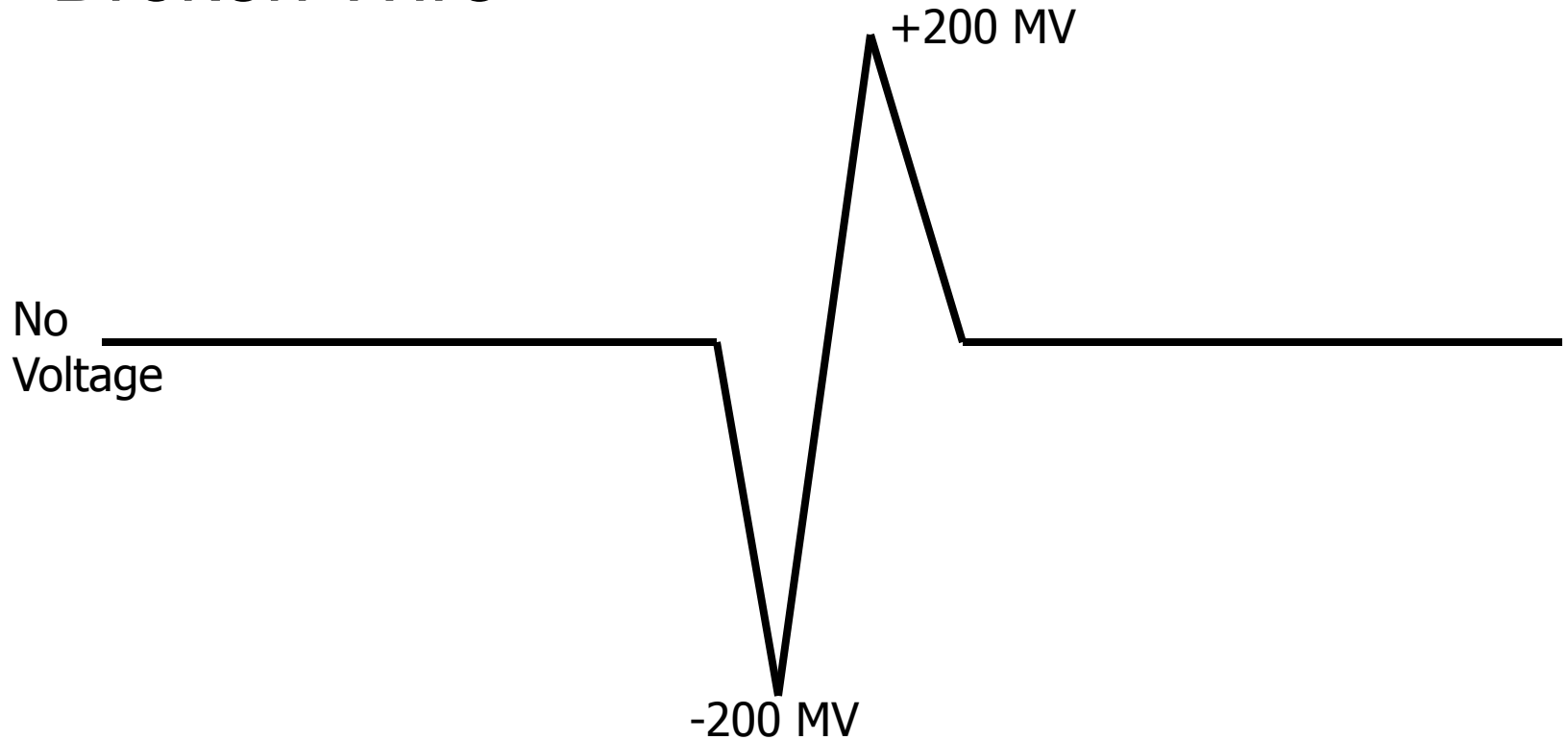


# Hall Effect Sensor

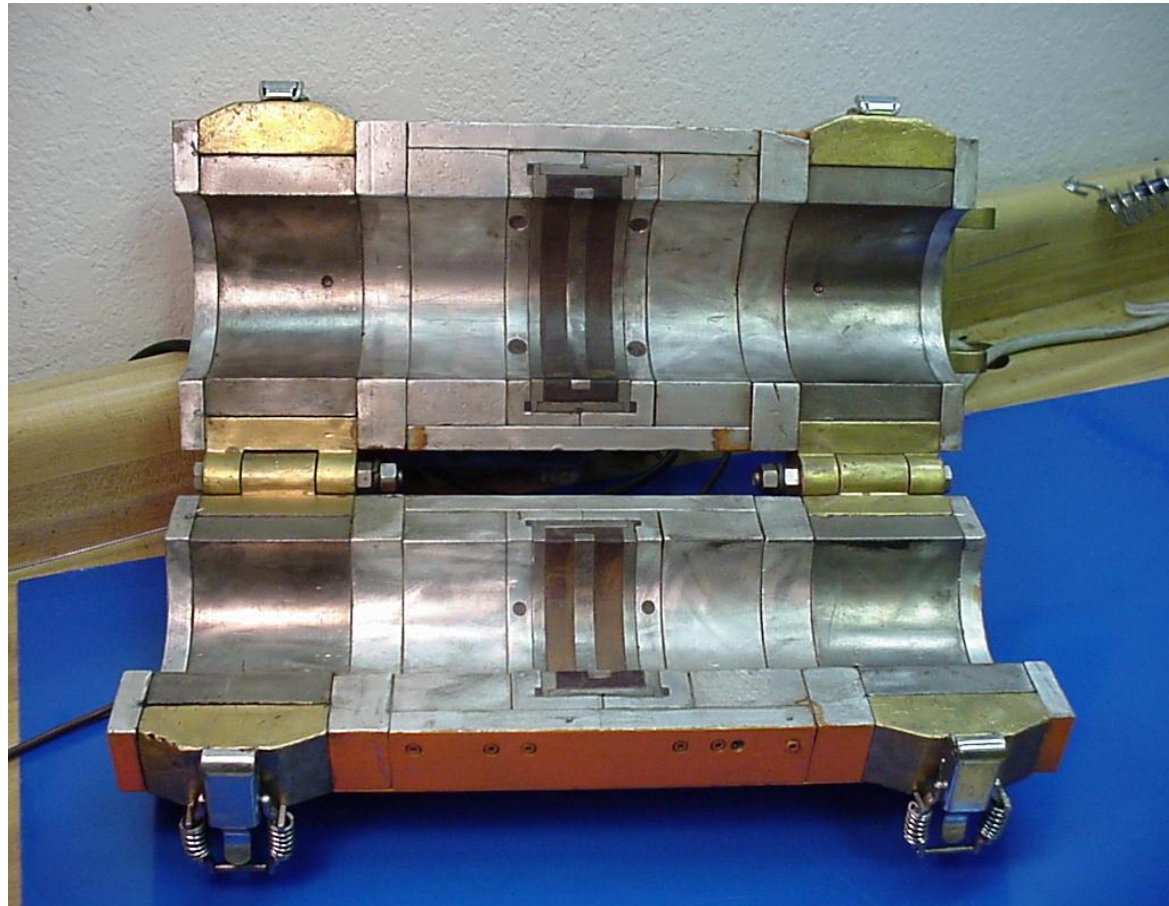


# LF Voltage from Hall Sensors

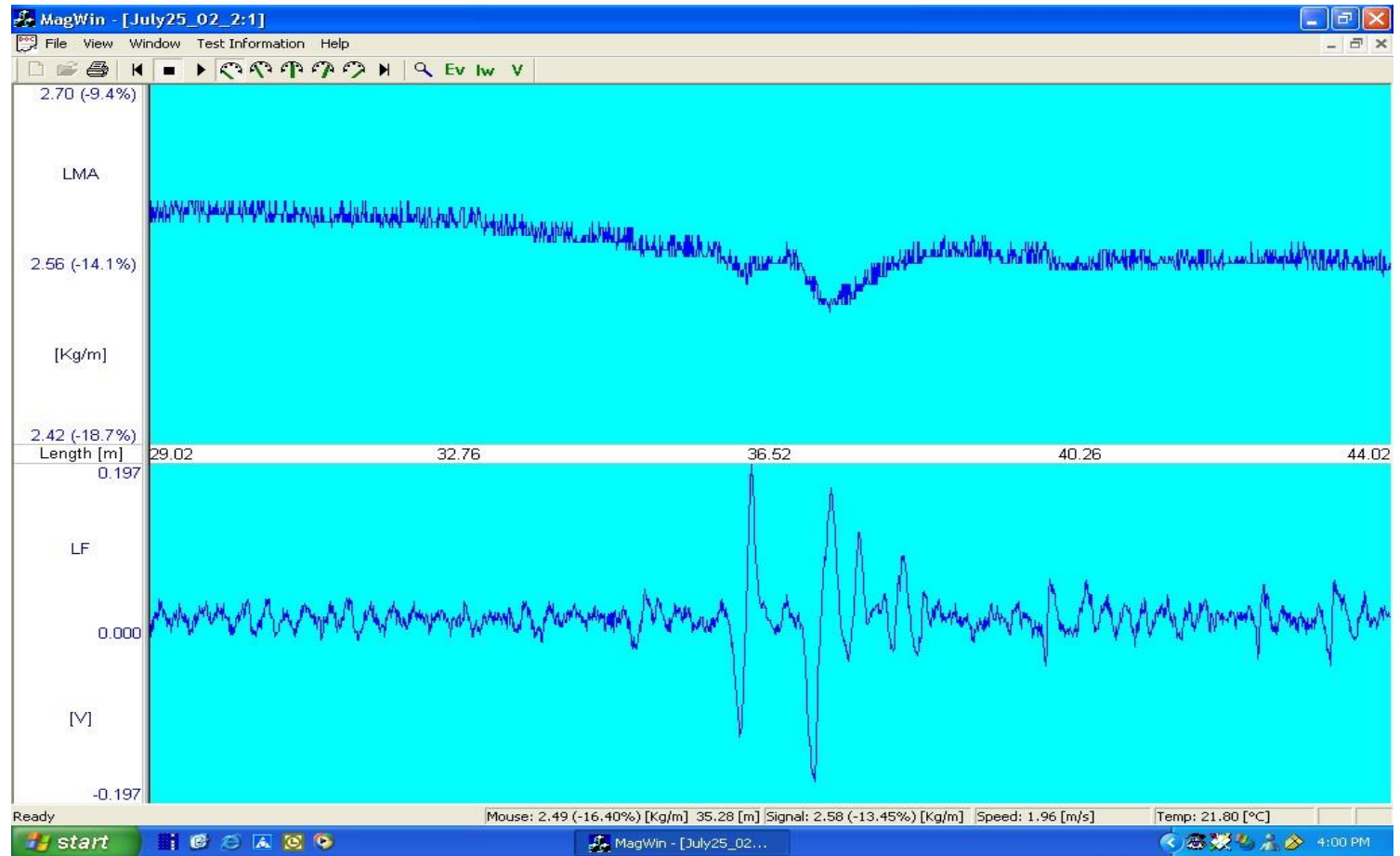
- Broken Wire



# Configuration of Head



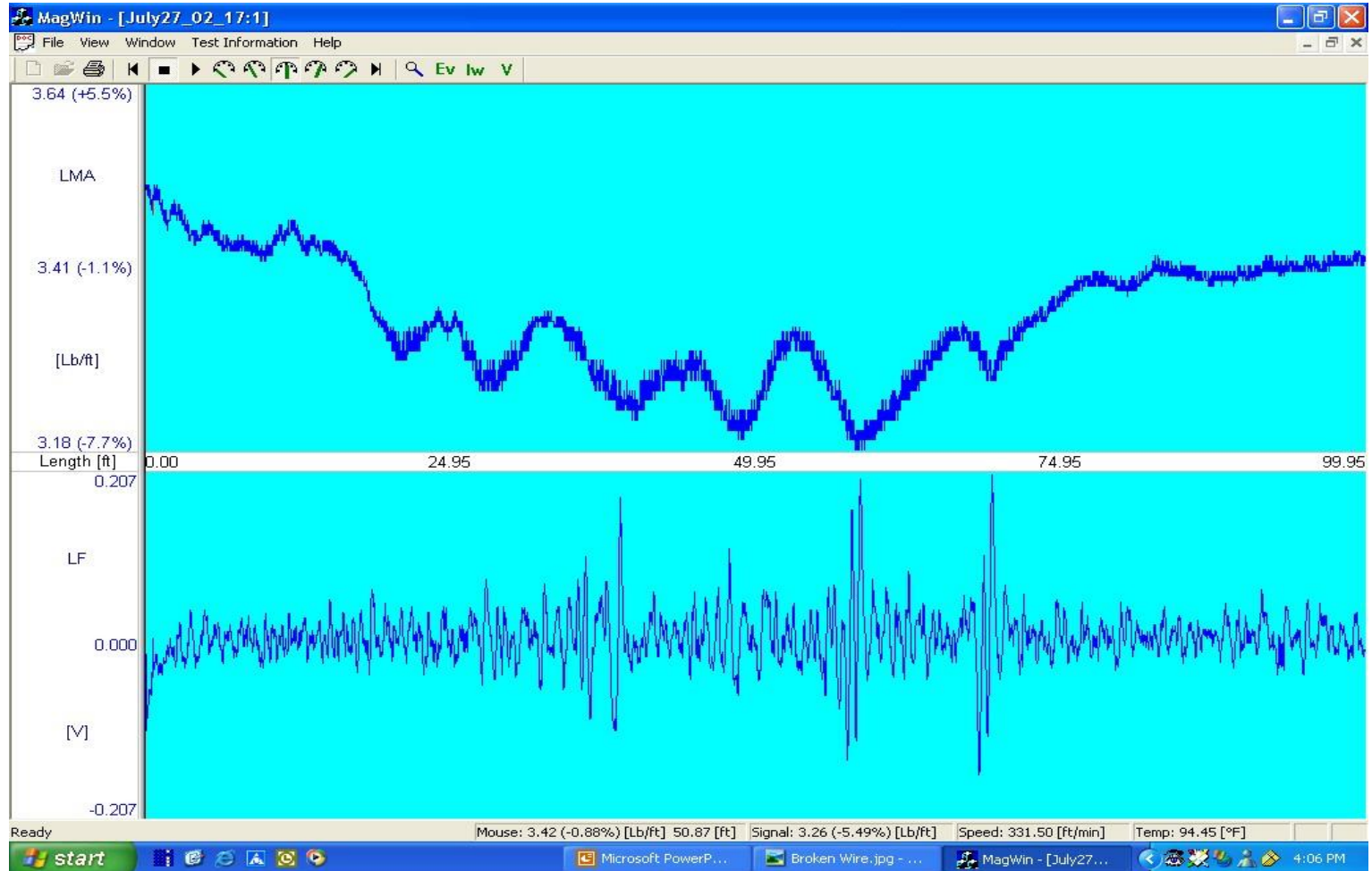
# Actual Broken Wire Depiction



# Pitting Due to Corrosion

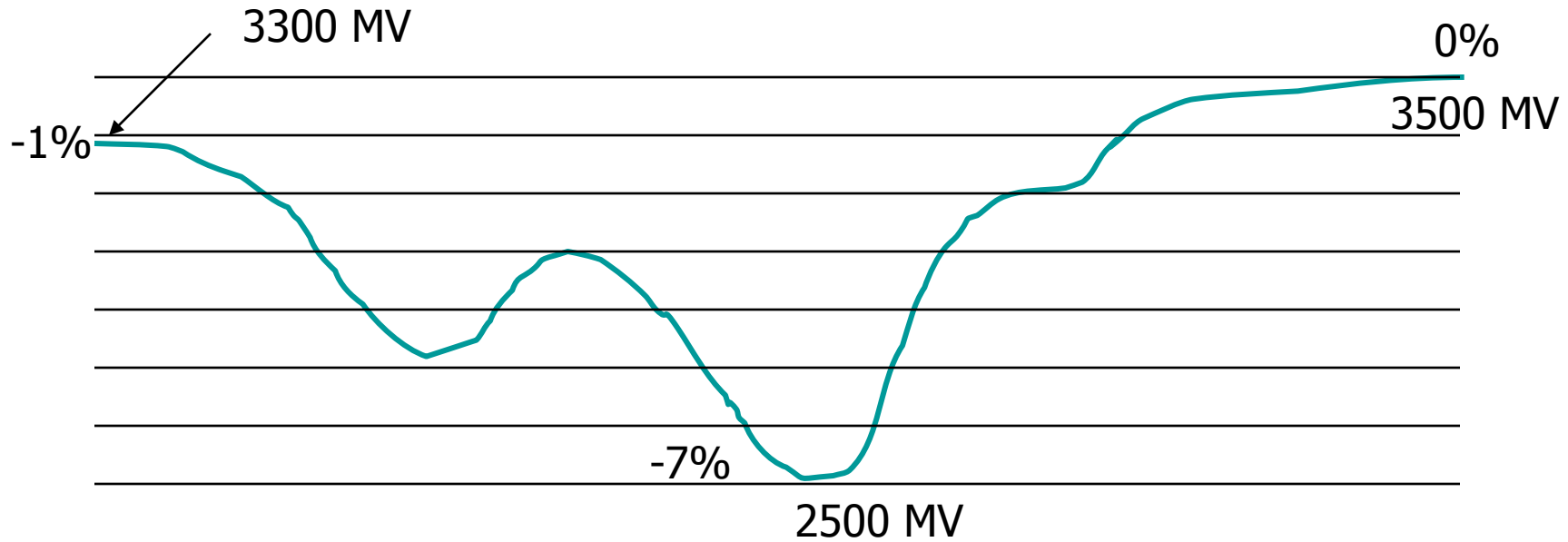


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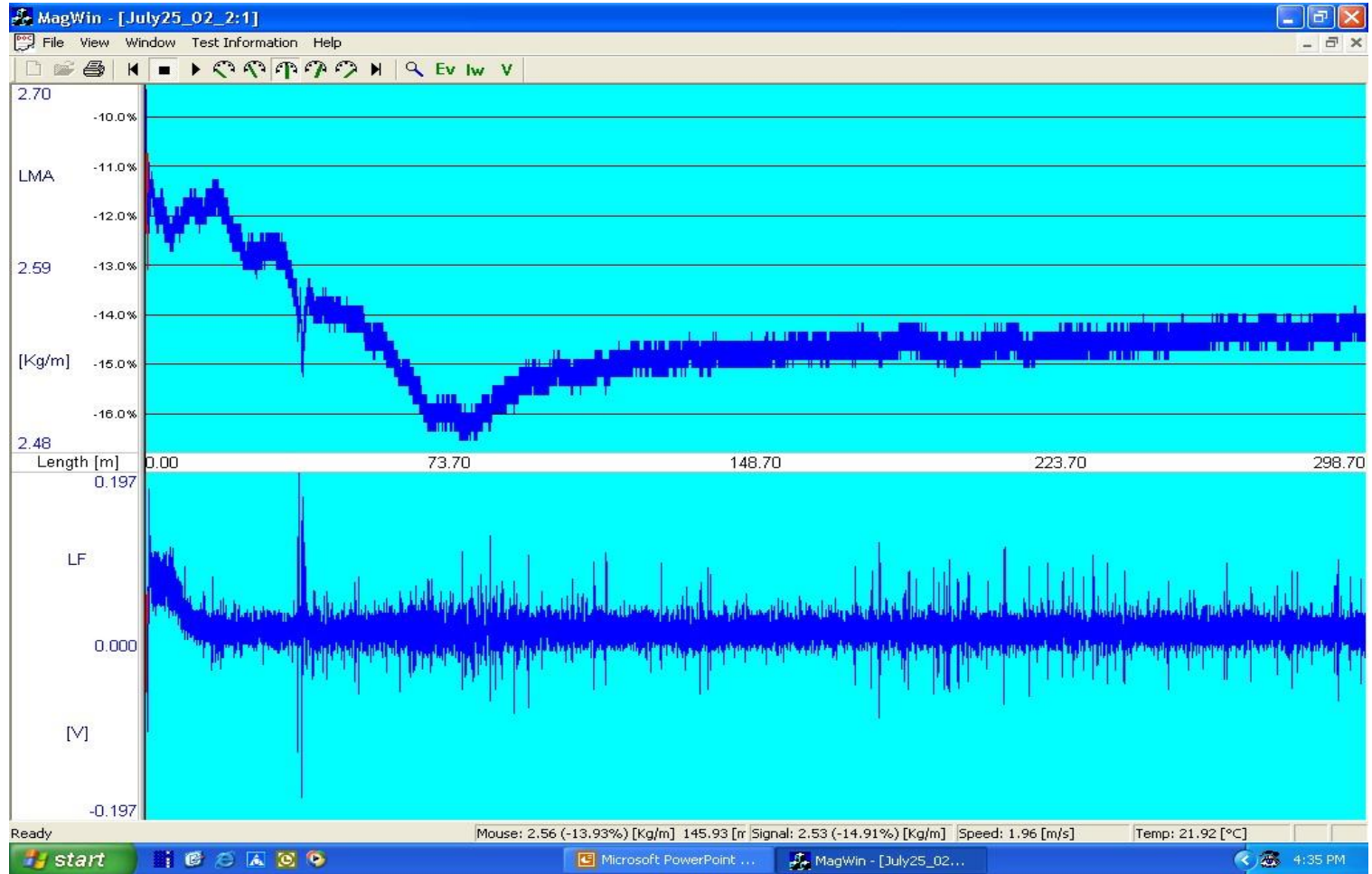


# LMA Voltage From Hall Sensor

- Typical LMA Trace

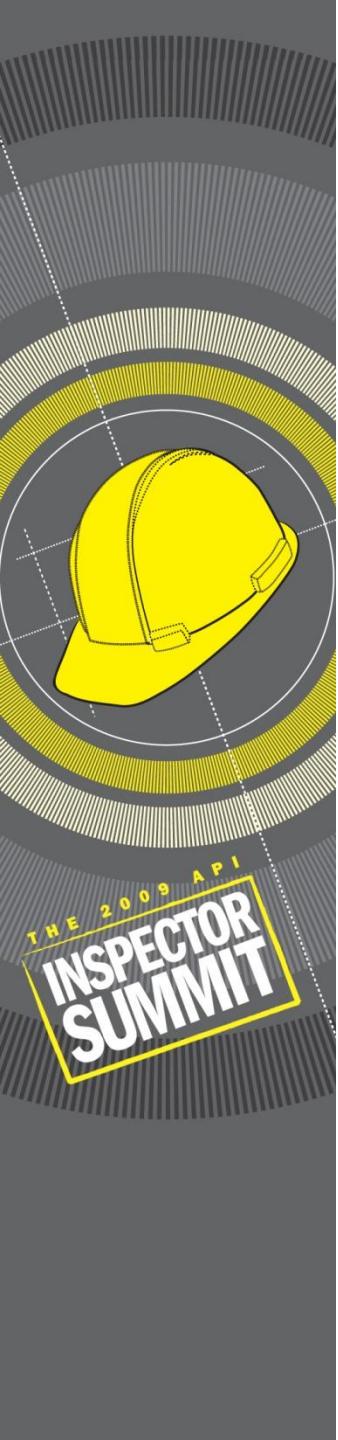


# Localized Damage, Broken Wires and Corrosion



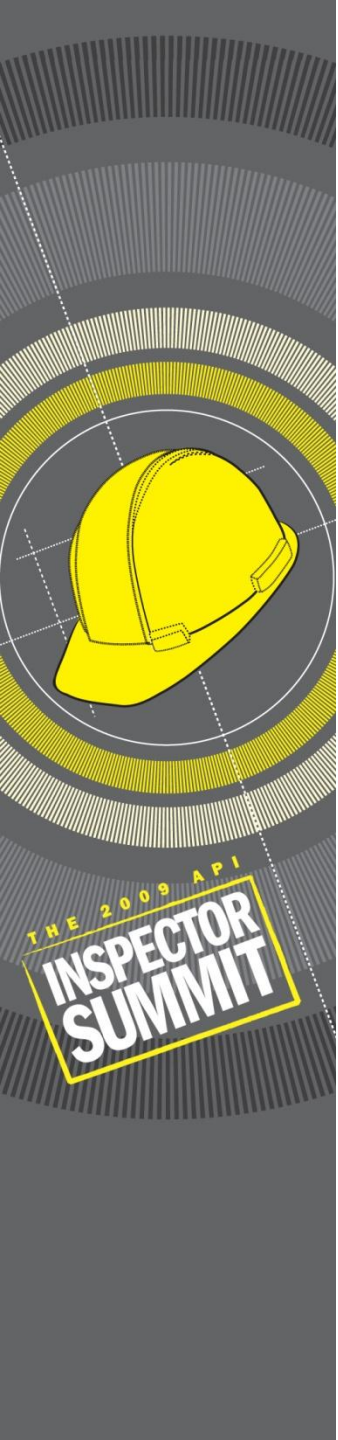
# Data Acquisition

- Control Section
  - Voltages from Sensor Head
  - LF and LMA
- Data Acquisition Box
- Distance Encoder
  - FPM or MPS
  - Sample every 4 mm
  - Time Base – Variable Speeds
- Measures Temperature
  - Temperature Compensation of Data



# File Management

- Laptop Computer
- Magnograph for Windows™
  - Designed by Acuren Inspection
  - Longview Inspection
- File Size
  - 100 KB average file size per test
  - eMail Internet Friendly

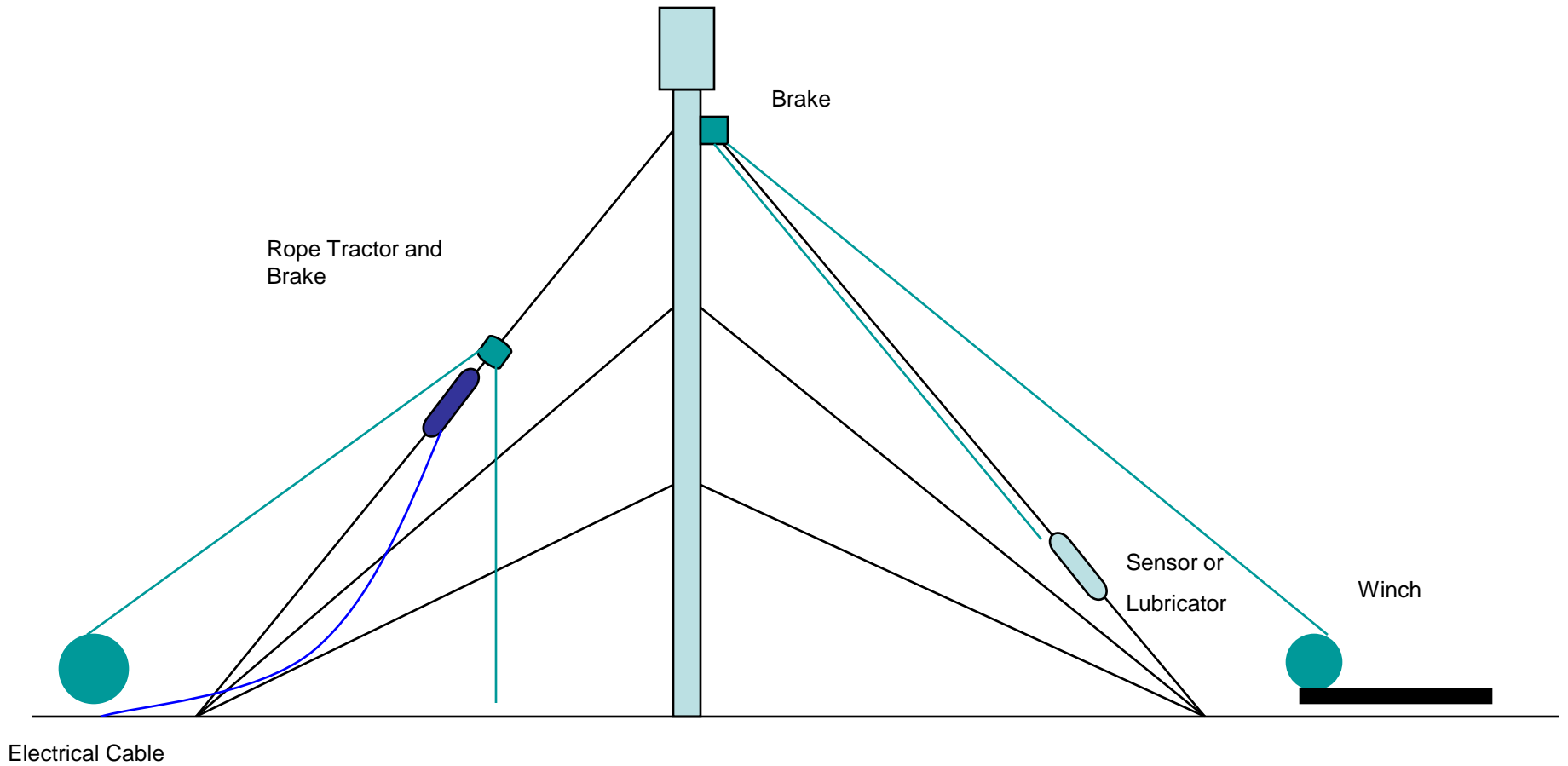


# Access to Guy Wires Flare Stack During Operation

- Rope Tractor
  - Rigging the Stack
    - Inspection
    - Lubrication



# Typical Flare Stack



# Lubrication or Preservatives

- Lightweight Synthetic Lubricant
  - OmniGuard SRI ConocoPhillips Brand
  - Brilube 40 Bridon Wire Rope
    - Easy to Apply
    - Inexpensive
- Engineered Coatings
  - Zinc Rich™
    - Extends life of galvanizing
    - No Penetration
  - Termorust™ - Encapsulating coating
    - External protection – seals rope or strand
    - Some Penetration

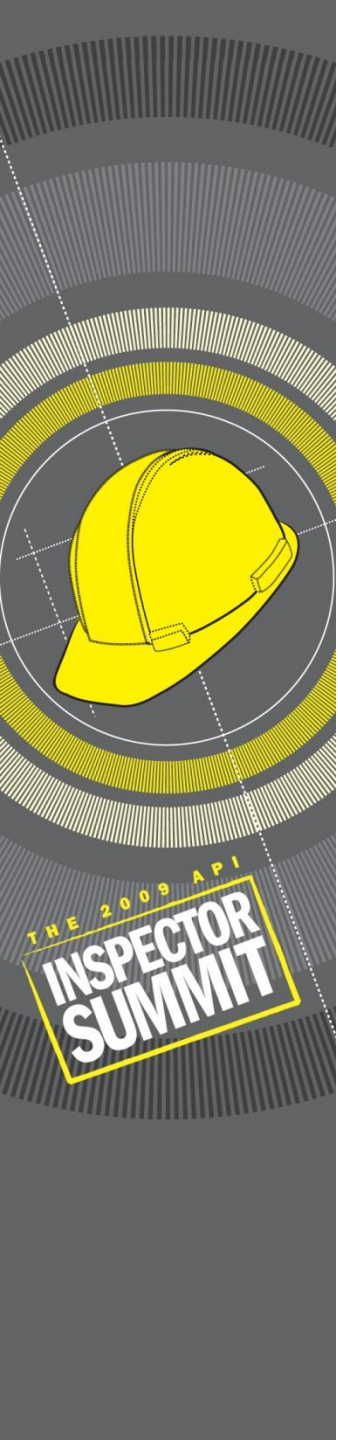


# Lubricator

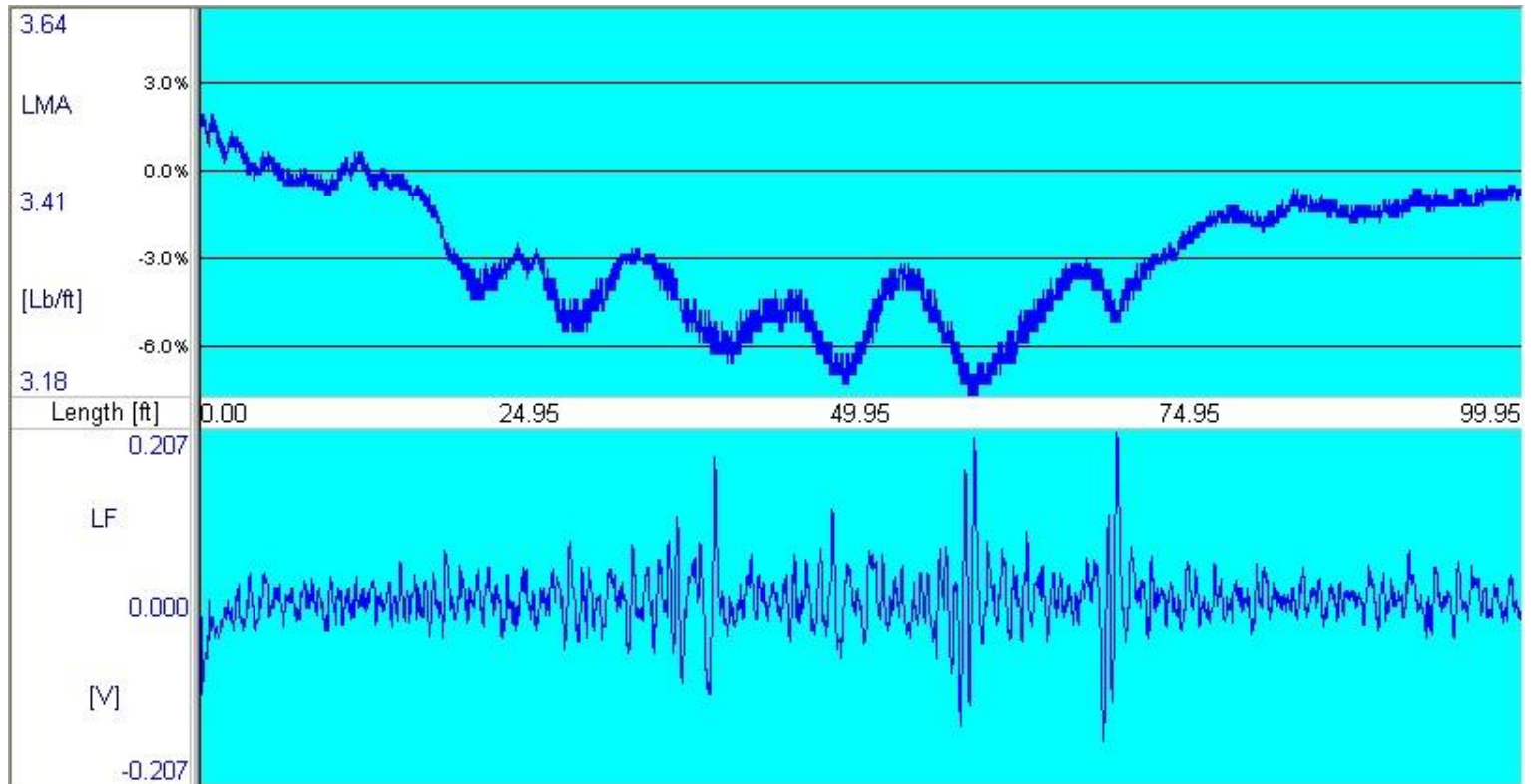


# Final Report

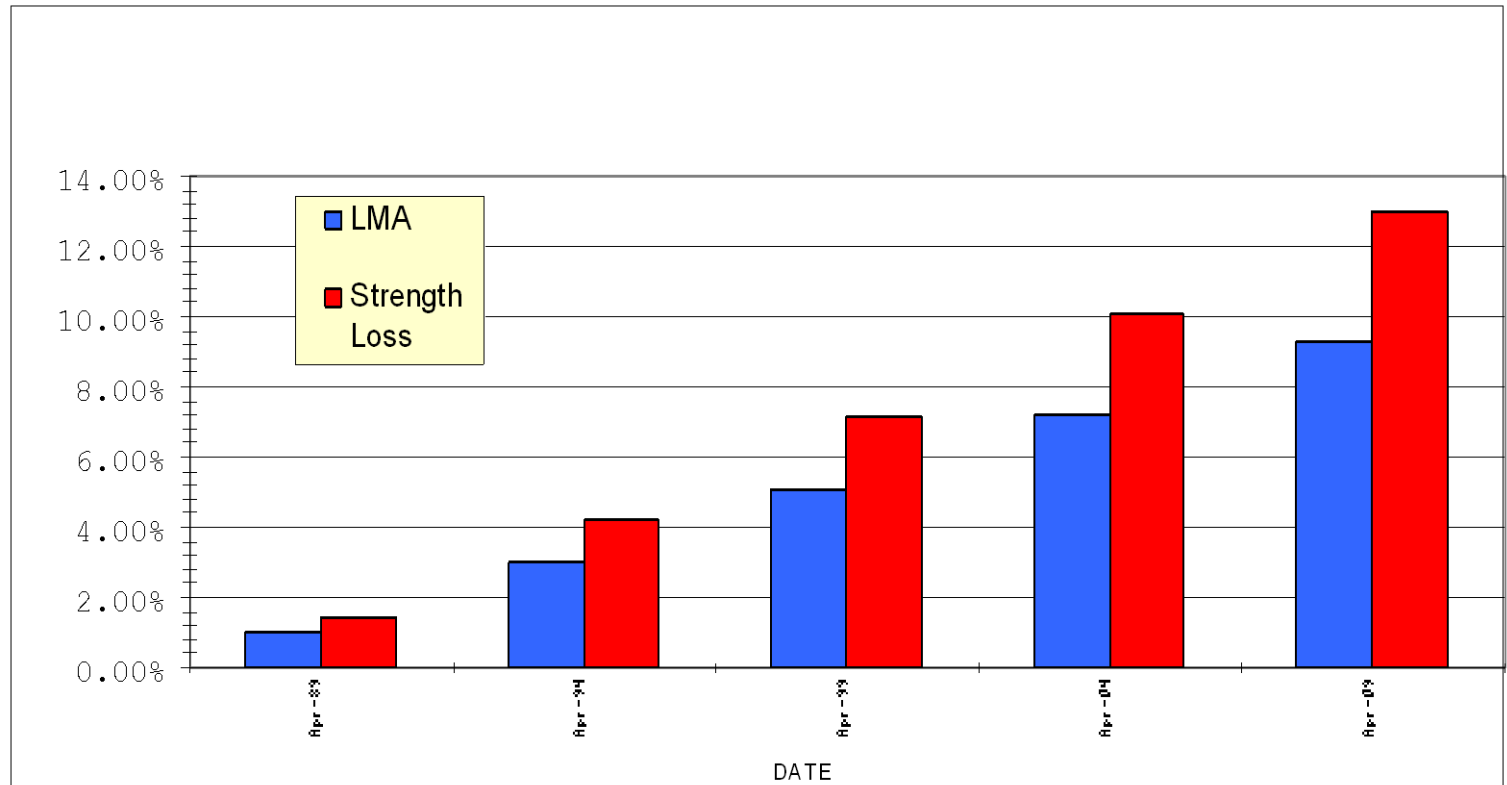
- Client
- Location
- Rope Nomenclature, size and construction
- Retirement Criteria
- Instrument Calibration Data
- Strip Chart
- Extrapolation
- Comment Section



# Strip Chart

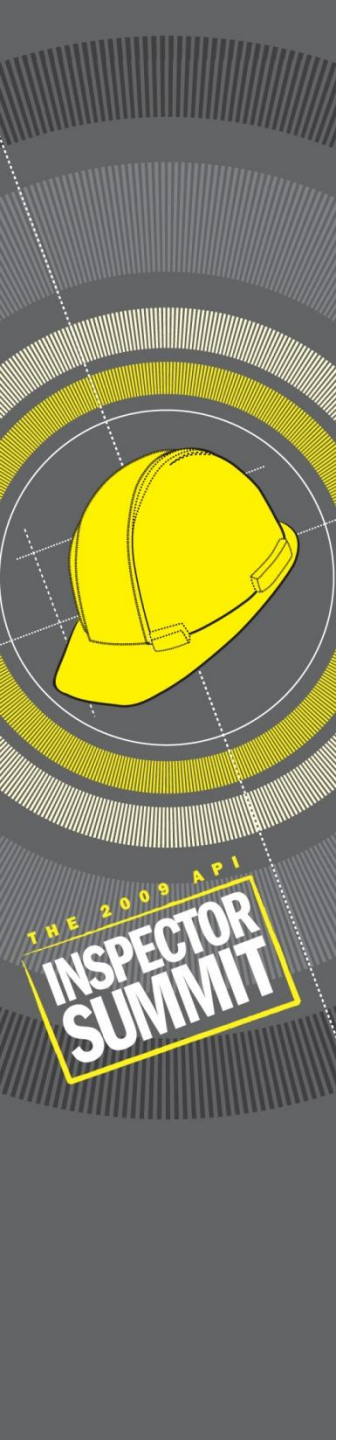


# Extrapolation of Data



# Retirement Criteria

- No Published Criteria for Guy Wires
  - Study with refinery in Joliet, IL
- Typical Designed to 8:1 or more
  - Minimum factor is 4:1
    - 25% Loss of Strength - Typical
- Tension and Load Work Sheet
  - Based on LMA and SL
  - Maximum Expected Wind Load







# Questions??

Electromagnetic Wire Rope  
Inspection (WRT)

