



# **STRAIN GAGES FOR HOSTILE ENVIRONMENTS**

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# HISTORY

**Late 1950's**....First field application strain gages manufactured

**Mid 1960's**....First high temperature field applications manufactured

**1976**....Coast Guard commissions to develop under-sea sensors

**1976**....First strain gages built and tested in Gloucester Harbor

**1977**....4 models manufactured for underwater and civil applications

**1980**....Over 100 models offered for marine, civil, and industrial applications

**1989**....Special sensors manufactured for covert applications

**1990**....Amplified versions offered for direct data acquisition applications

**2000**....Over 200 models offered for marine, civil, and industrial applications

**2008**....Wireless concepts and prototypes

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# ● APPLICATIONS

**RAILROAD**....Rails, Cars, Wheels

**SHIPBOARD**....Above Decks, Below Decks, Shaft and Motors

**MARINE**....Docks, Locks, Dams, and Buoys

**BRIDGES**....Decks, Structure, Health Monitoring

**CIVIL**....Any Outdoor Structure Including Wood, Concrete  
and Glass Composites



# TYPES OF STRAIN GAGES

**RESISTIVE.....**  $\Delta R / \Delta \epsilon$

**Foil Strain Gages – Room Temperature**  
**Wire Strain Gages – High Temperature**

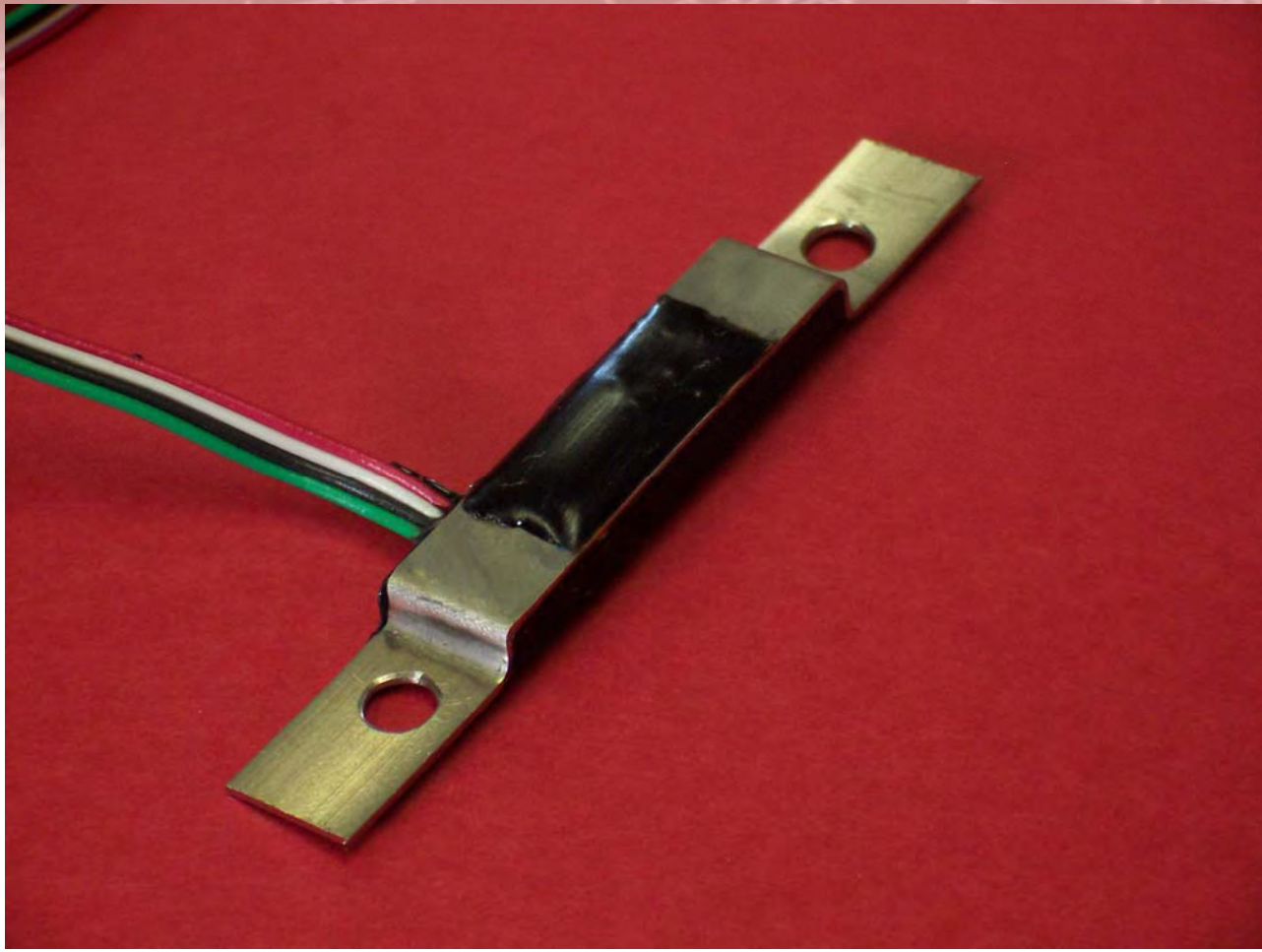
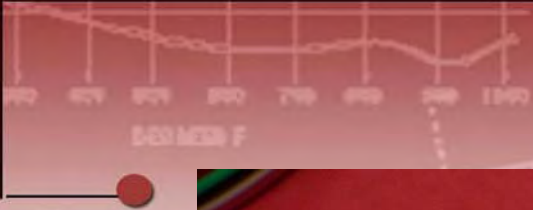
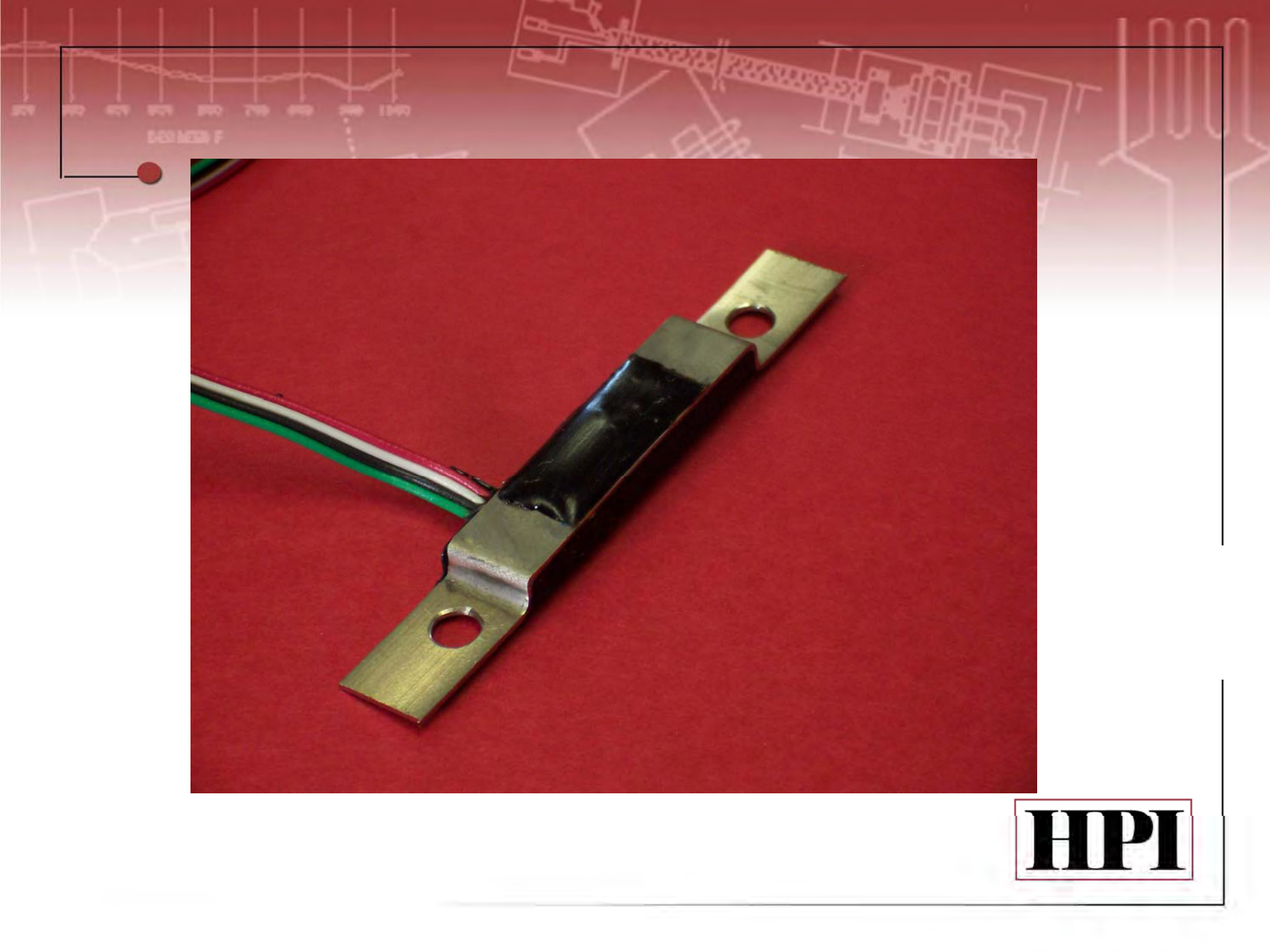
**CAPACITIVE.....**  $\Delta C / \Delta \epsilon$

**High Temperature Applications**  
**Very Long Term Applications**

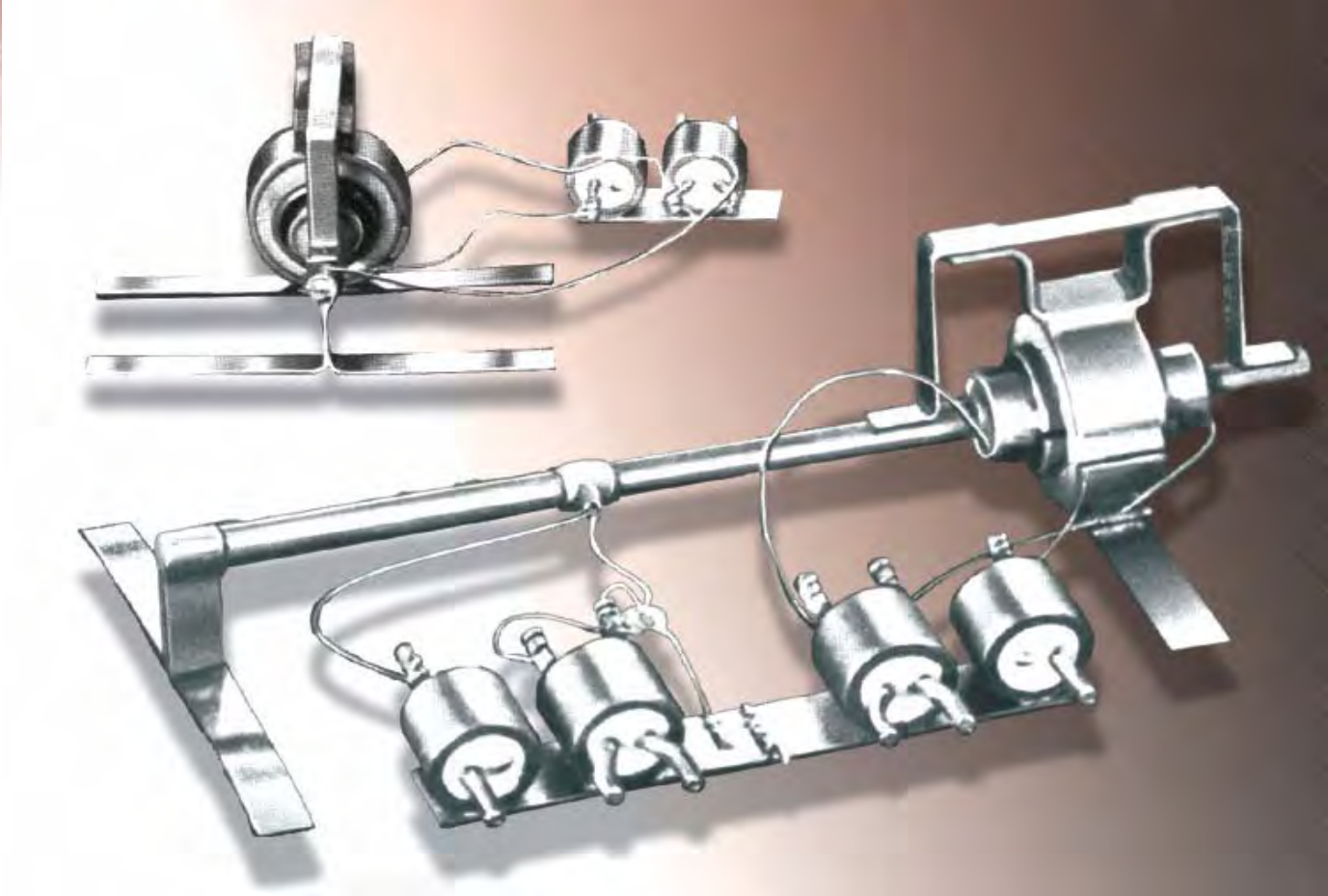
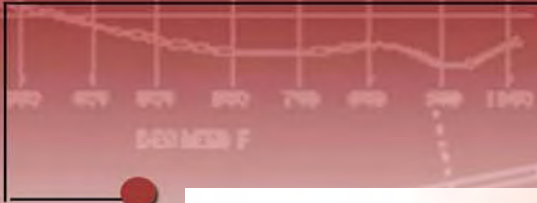
**VIBRATING WIRE .....**  $\Delta F / \Delta \epsilon$

**FIBER OPTIC.....** **Fabry-Poirot**  
**Bragg Grating**





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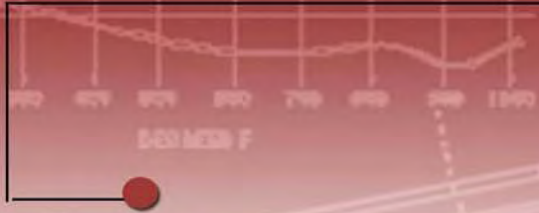
Photos Courtesy of Micron Optics





# THINGS TO CONSIDER WHEN CHOOSING A STRAIN GAGE

- **Minimum and maximum exposure and operating temperature**
- **Material of specimen; Properties of specimen**
- **Humidity/Steam/Water Submersion**
- **Oil and other chemical exposure elements**
- **Pressure of environment**
- **Turbulence of environment**
- **Maximum/minimum strain limits (resolution vs range)**
- **Length of test time required**
- **Static or dynamic test (especially high temperature)**



**Metallic shim to match specimen provides water proof seal top to bottom – easy installation**

**Stainless steel hermetic rugged stress relief**

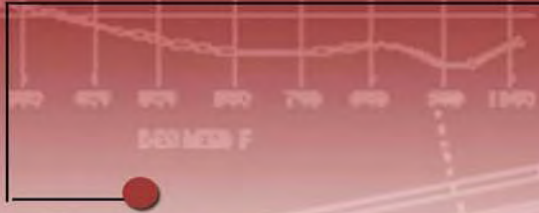
**Large mechanical cable anchor**

**Cable sealed at instrumentation end**

**Cabling to match temp/mech/press environment**

**Complete sensor and cable sealant to 500 PSI**





Wire strain gage  
for optimum  
performance

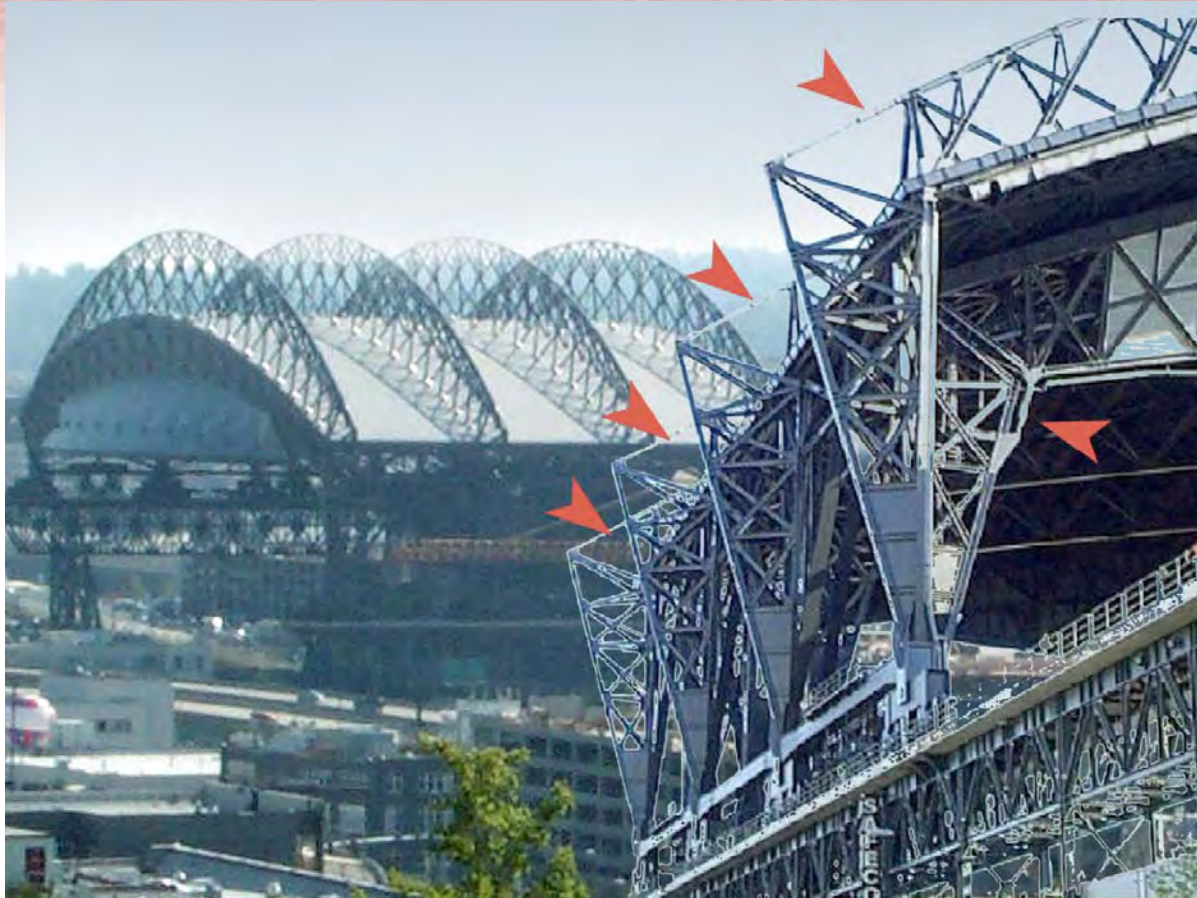
Aerospace quality  
shim for use in  
high temperatures

Ceramic  
installation

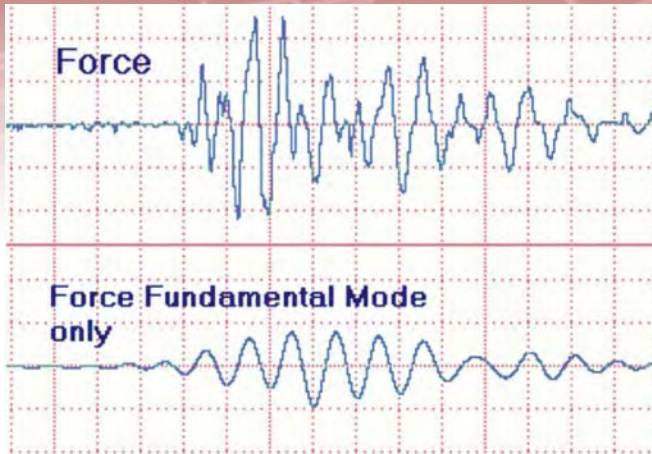
Cable rated to 900°C

- No organic materials
- Useable to 400°C, 550°C, 900°C
- Nuclear approved

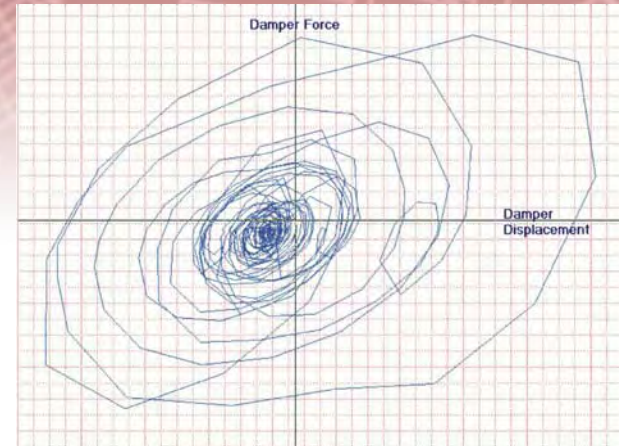




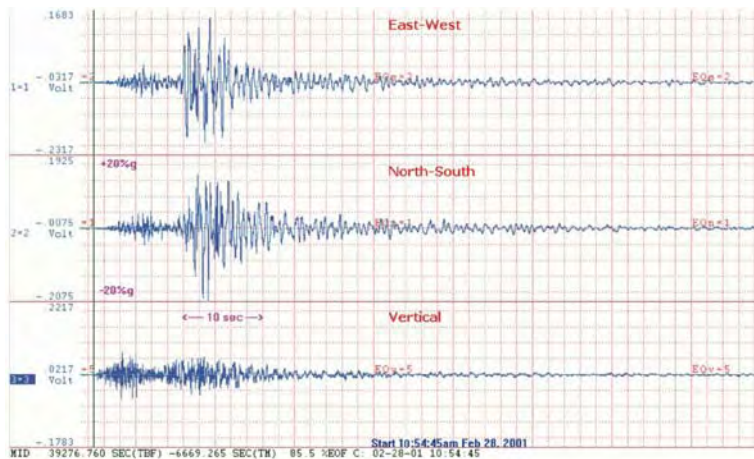
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**Seismic event measurements during earthquake at Safeco Field, Seattle, WA February 28, 2001**



**Force vs. displacement measurements during earthquake at Safeco Field, Seattle, WA - February 28, 2001**



**Ground movement measurements during earthquake at Safeco Field, Seattle, WA February 28, 2001**

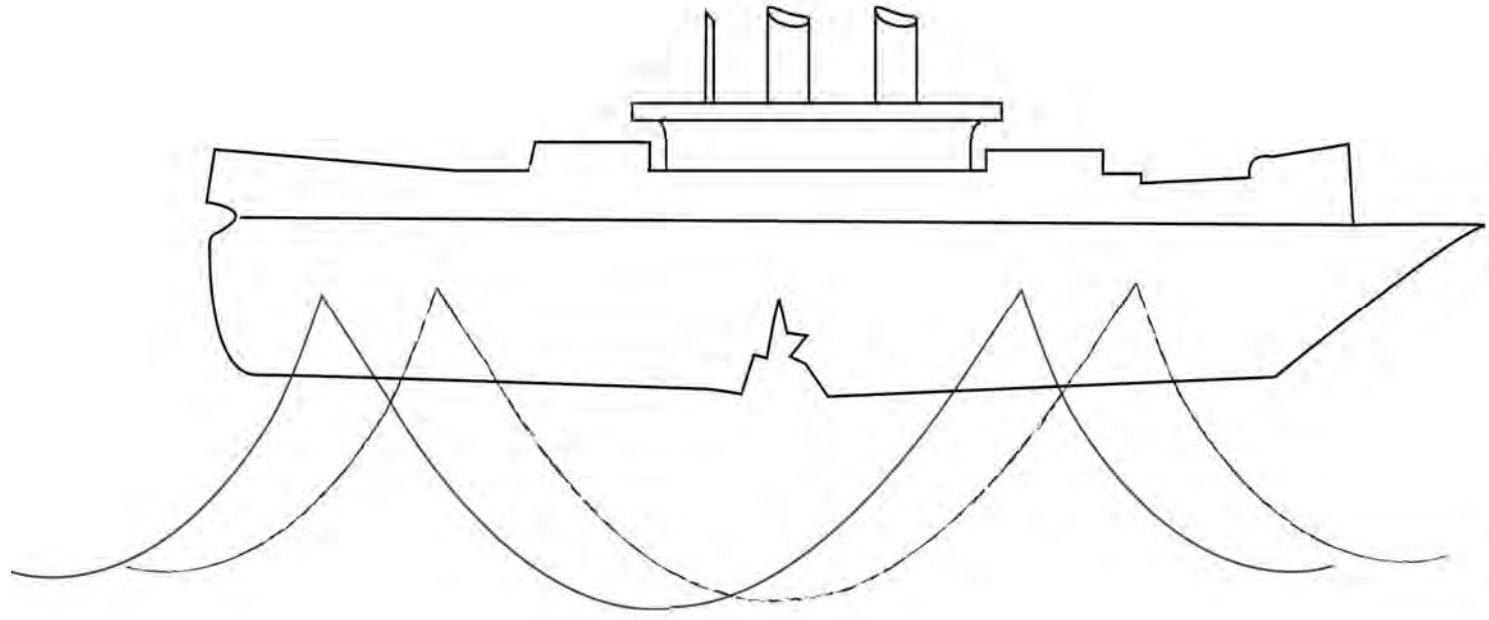




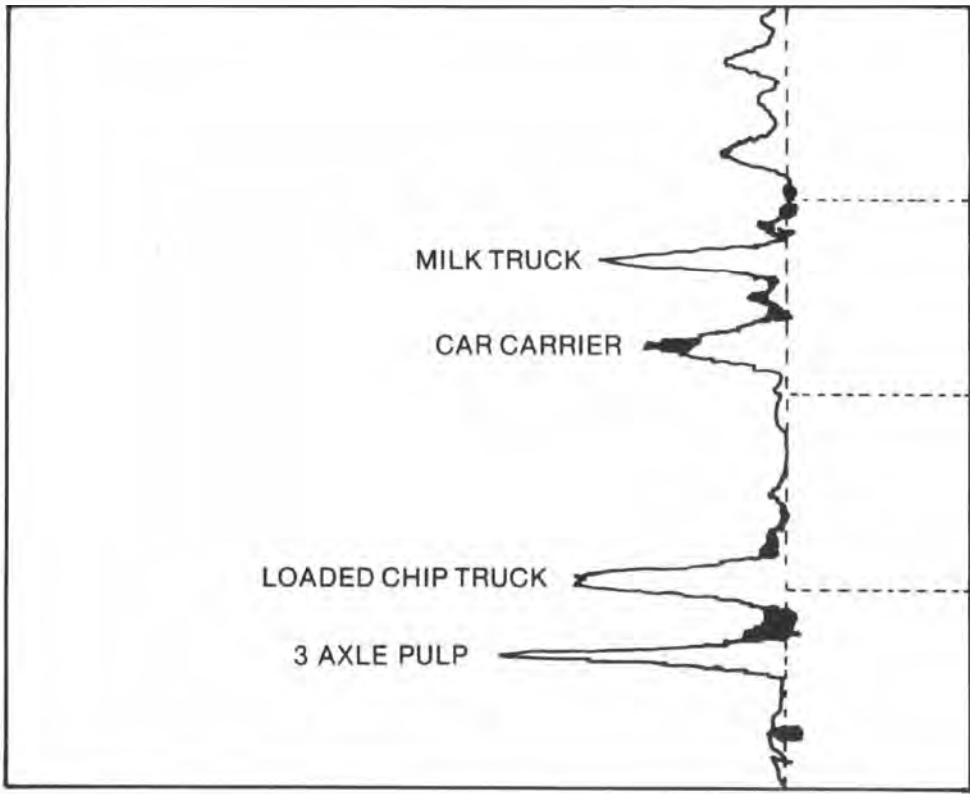
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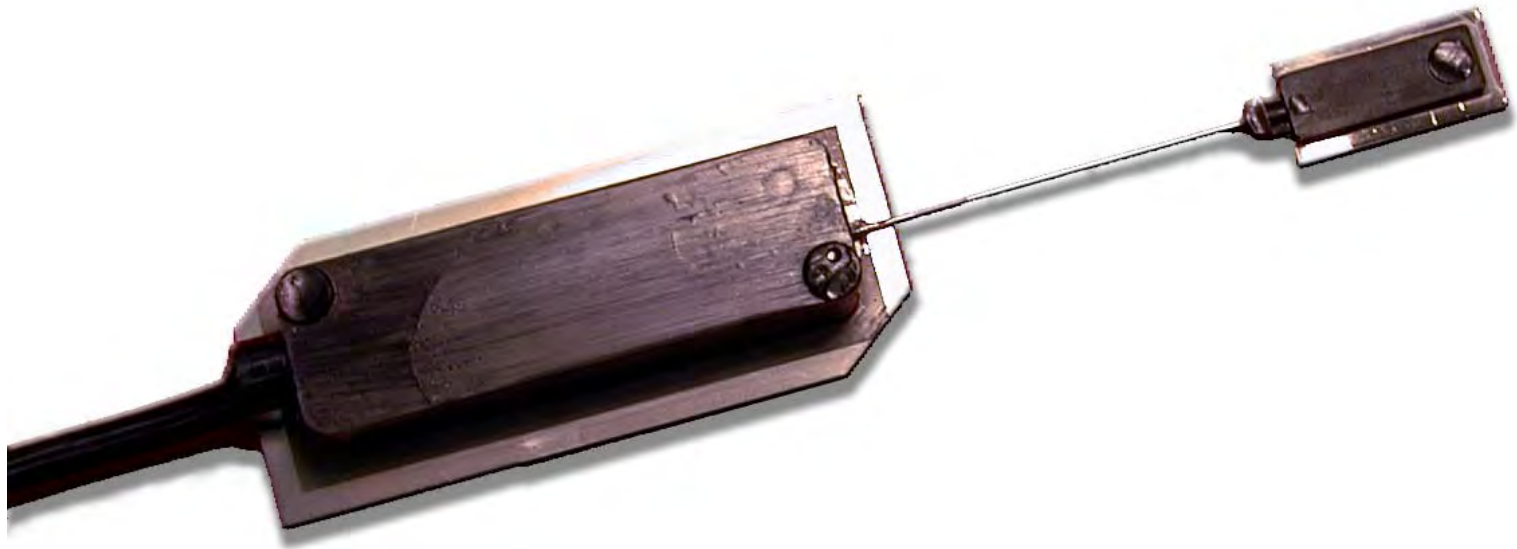
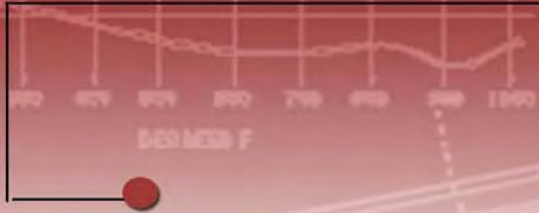


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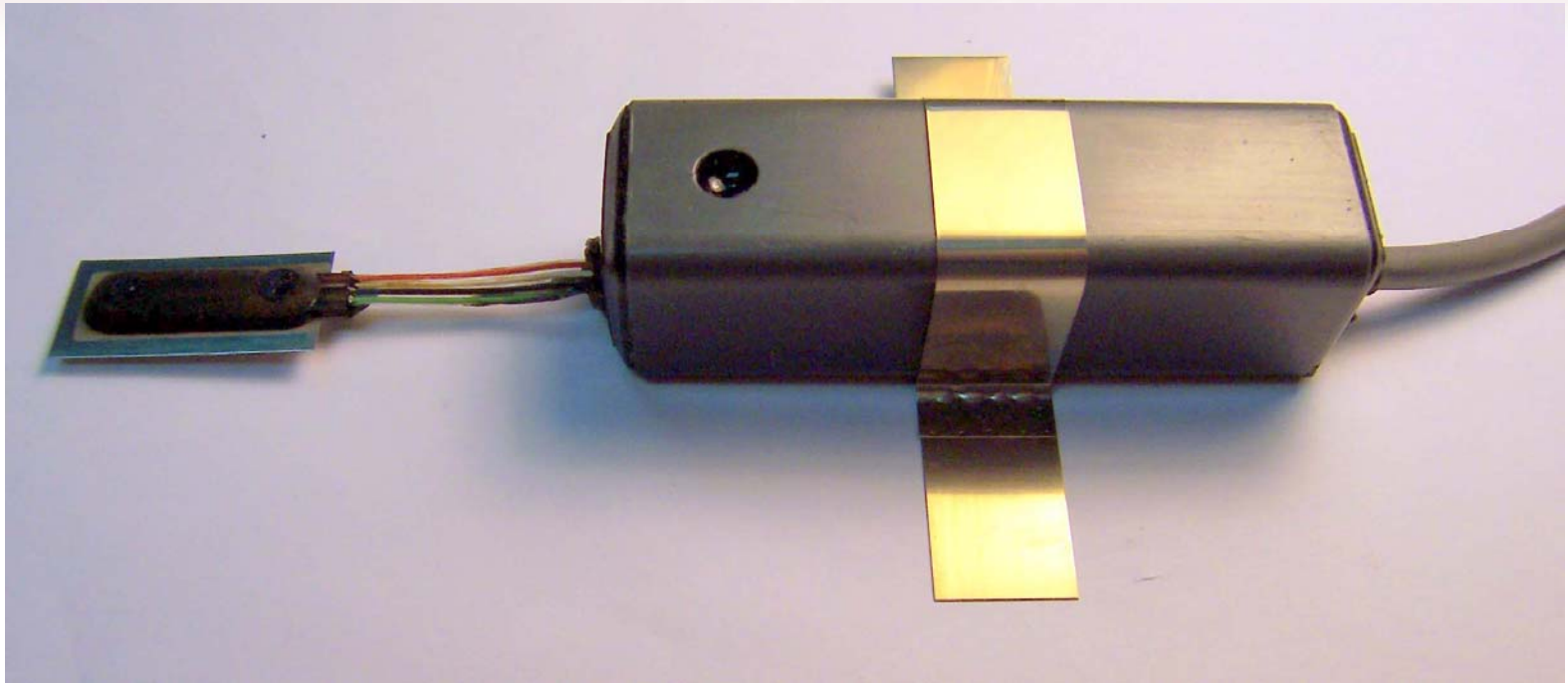




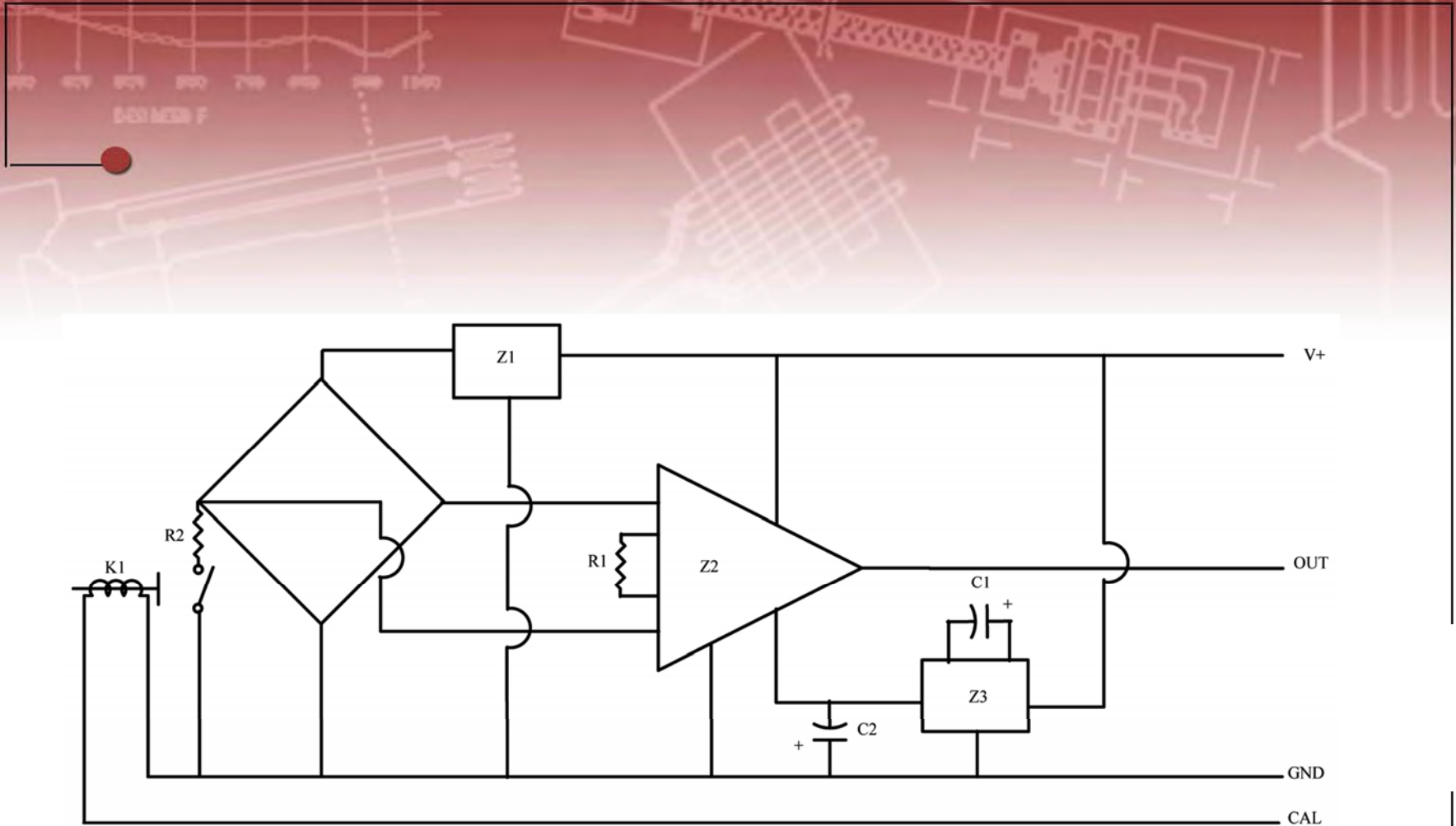
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**HPI**



INPUT POWER: +15 Volts DC  
 EXCITATION: 5 Volts, Factory Set  
 GAIN: 1,000 Factory Set  
 CAL RESISTOR: 349.65K, Across 350 OHM Bridge, Typical  
 OUTPUT: 4.92 Volts/1000  $\mu\text{E}$





The background features a technical drawing of a mechanical component, possibly a shaft or a bracket, with various dimensions and features. Overlaid on the top left is a line graph with a y-axis labeled '500 MESH F' and an x-axis with numerical values: 300, 400, 500, 600, 700, 800, 900, 1000. A red dot is positioned at the start of a line on the graph.

# CONCLUSIONS

- **Strain gages are useable in many extreme environments**
- **Strain gages are fail safe sensors**
- **Strain gages are the most economical way to take field data**