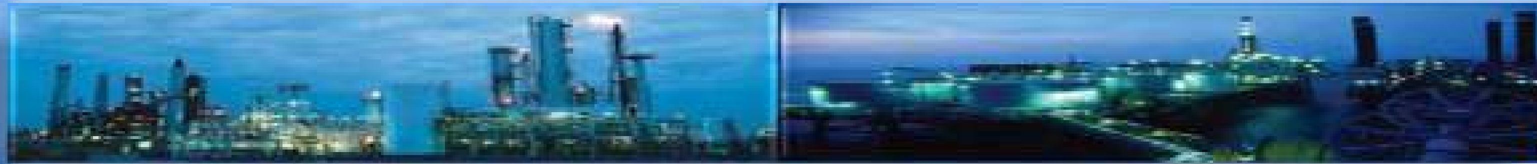


AST

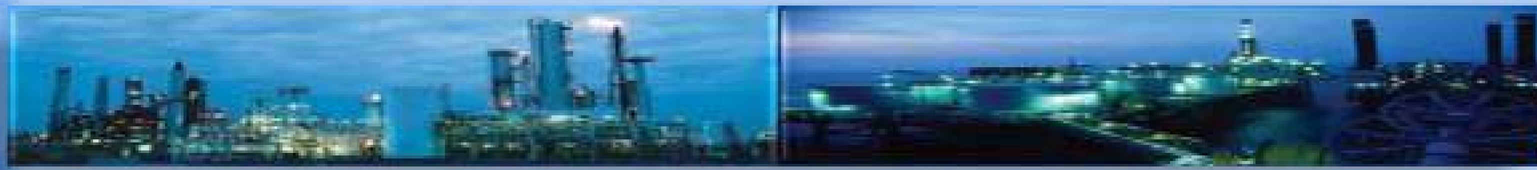
Shaft Vibration
OR
Relative Vibration

AST

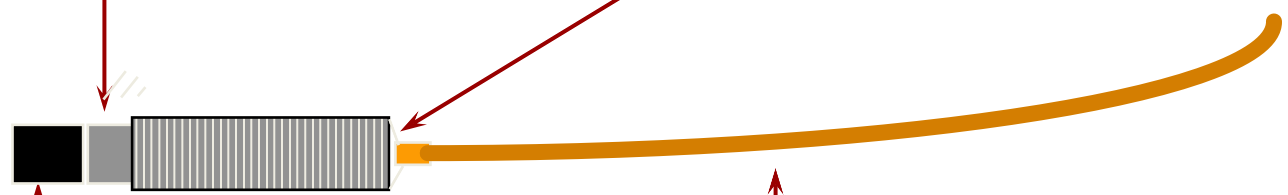
Noncontact Pickup Probe (NCPU)

- Proximity Probe
- Eddy Current Probe

Vibration measurement on rotating parts

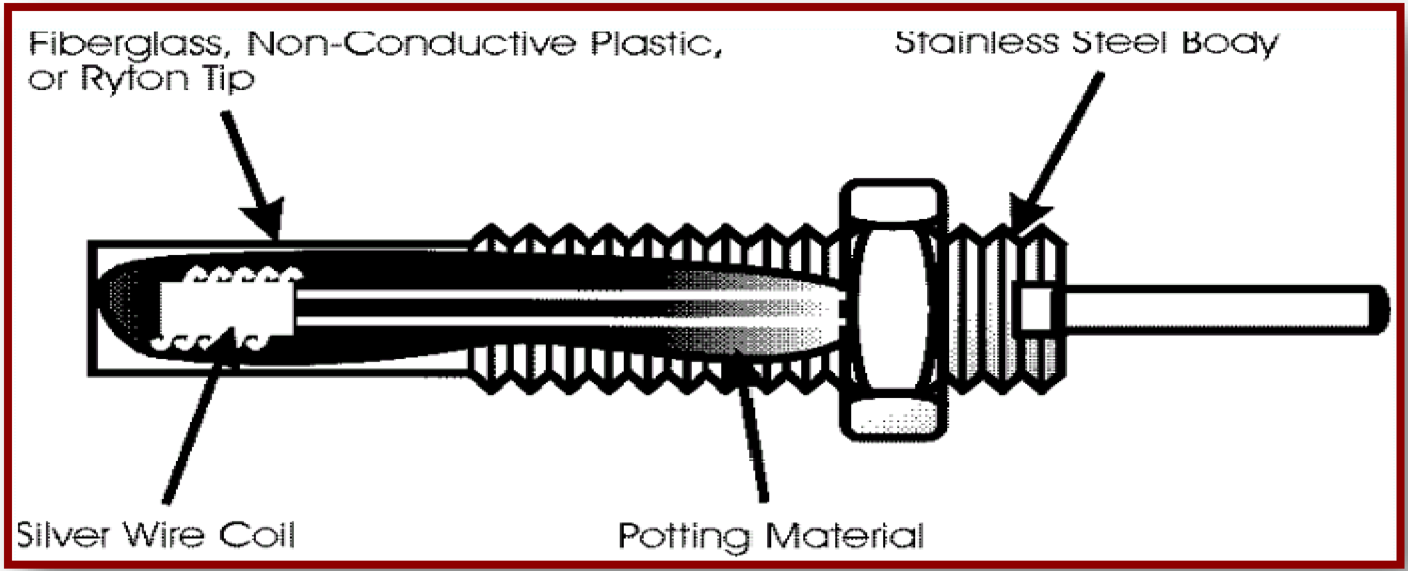


"AB" 2100 Series Probes



AST

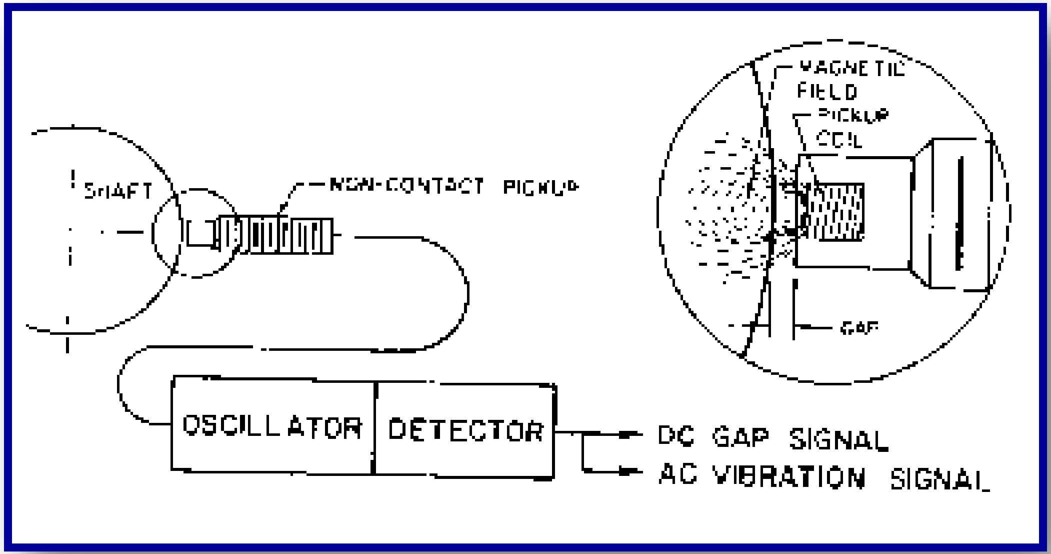
Eddy Current Probe Structure

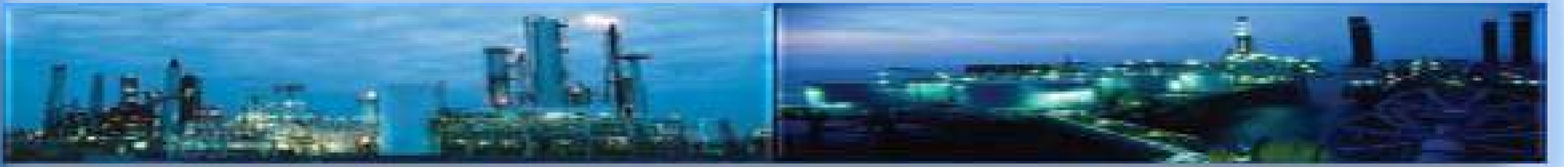


NCPU (Non Contact Pickup Unit)
Eddy Current Probe or Proximity Probe

Displacement = The Distance the machine moved

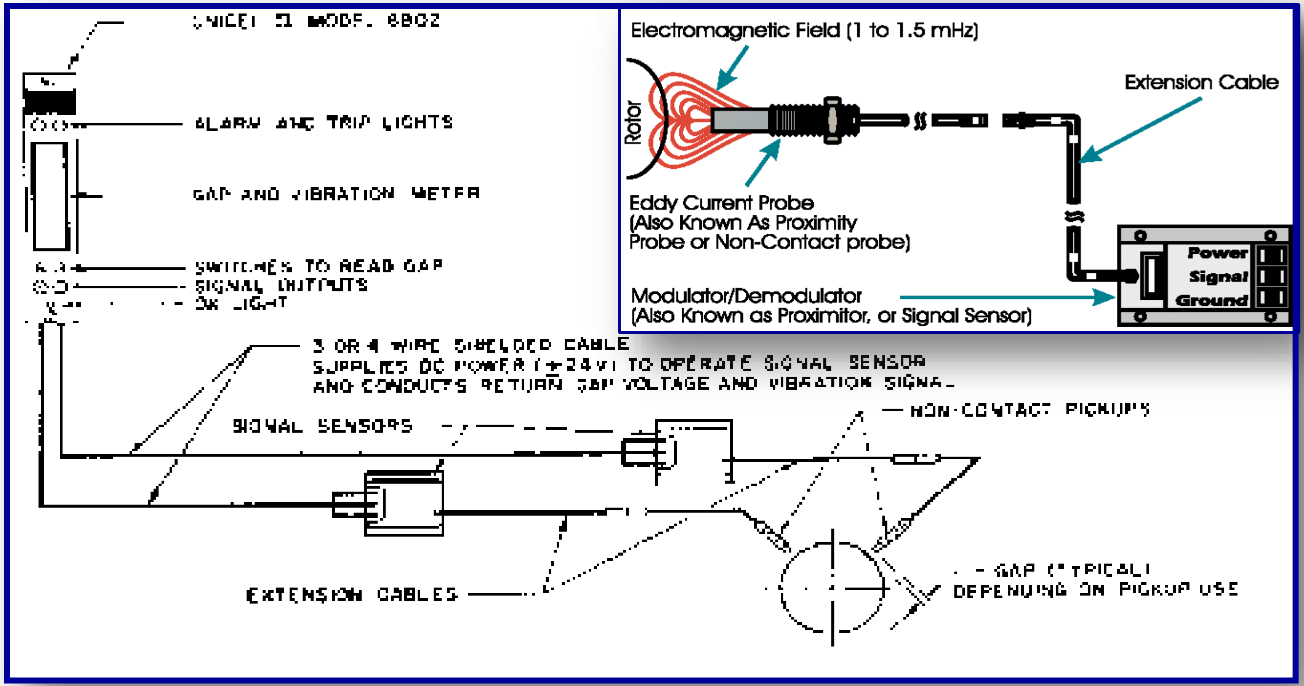
Normal Output is 200 mV/mil, Pk-Pk





AST

Monitoring the bearing of Turbine in sequent, Compressor, Gearbox, Pump with Journal/Plane Bearings to analyze Shaft Roundness, Shaft Run-Out, Unbalance, Misalignment, Shaft Centerline, Rubbing, Looseness and etc.



Most Valued *Global Provider of Predictive Maintenance Solution*

Our Manufacturer is the former BN OEM

CML is the manufacturer for both ENTEK and Bently Nevada model 7200 series, so if you need any spare parts for BN, you can choose the same model from ENTEK which is 30-40% cheaper.

AST

Probe Holder

Conduit Threads
0=M20
1=3/4" NPT

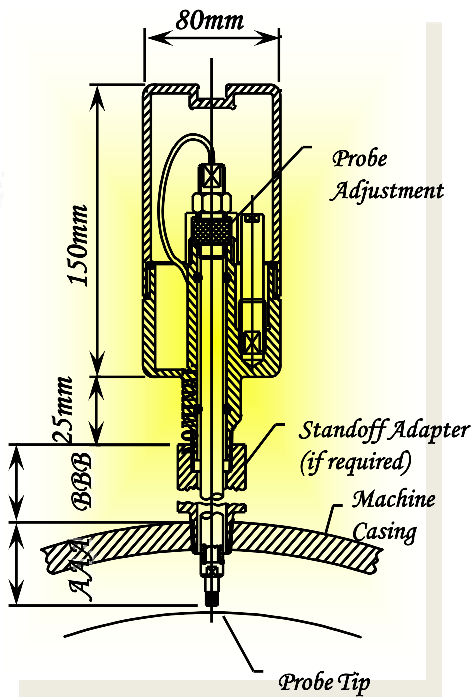
Mounting Threads
0=3/4" NPT
1=M20
2=1/2" NPT

Holder Type
0=Standard (shown)
1=Slim line

MODEL 29XXX AAA BBB

AAA: Distance of target shaft from machine outer surface in mm round to nearest 5 mm

BBB: Nominal length of standoff adapter in mm
BBB=0 if none required
Standoff Adapter=023756/BBB
If required

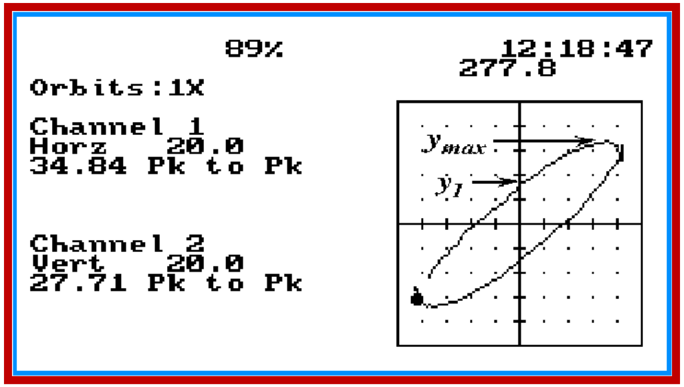


Example: Model 29100/150/000

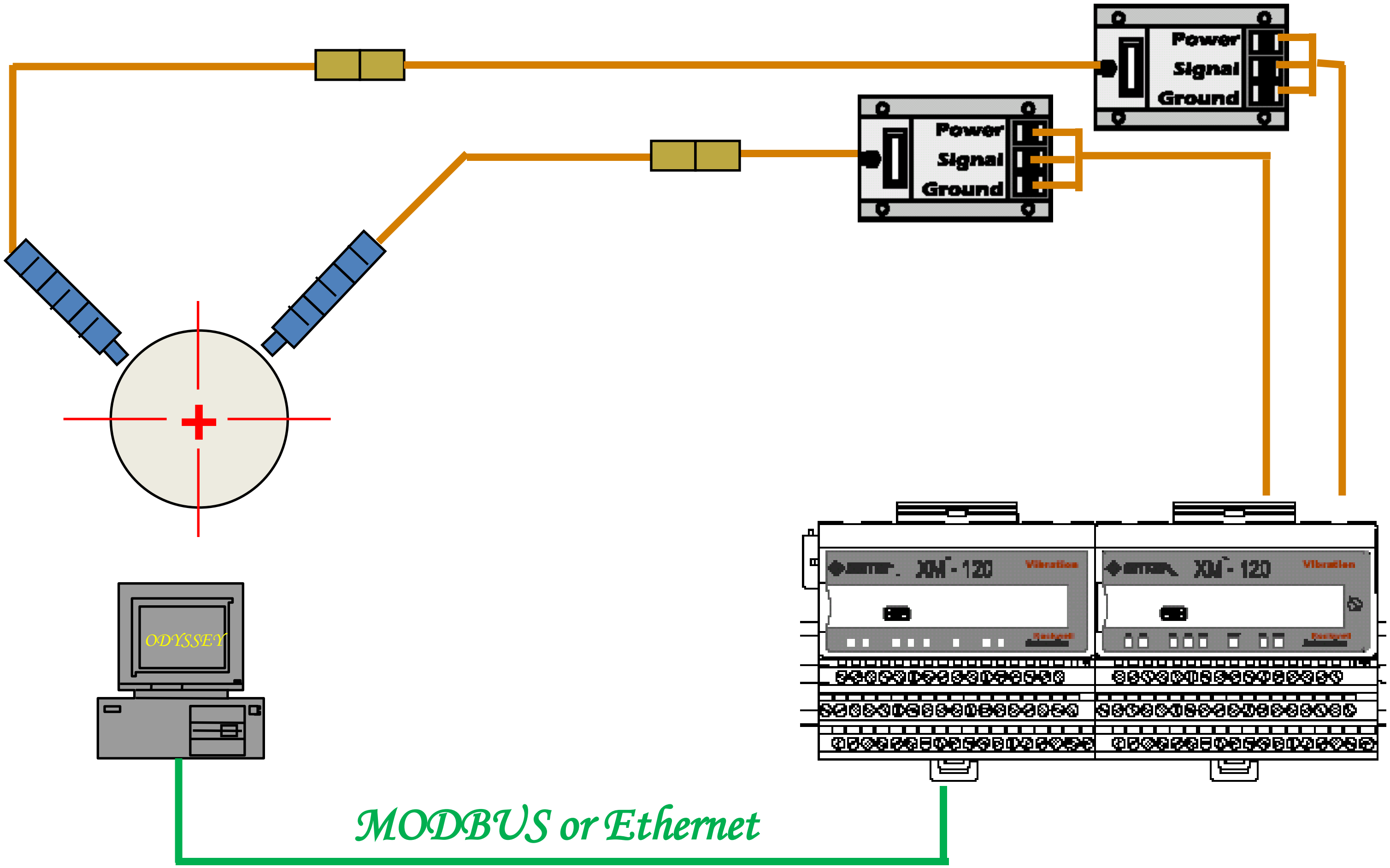
- Standard body
- 3/4" NPT conduit & mounting threads
- 150mm between shaft and case
- No standoff required

Unit of Relative Vibration

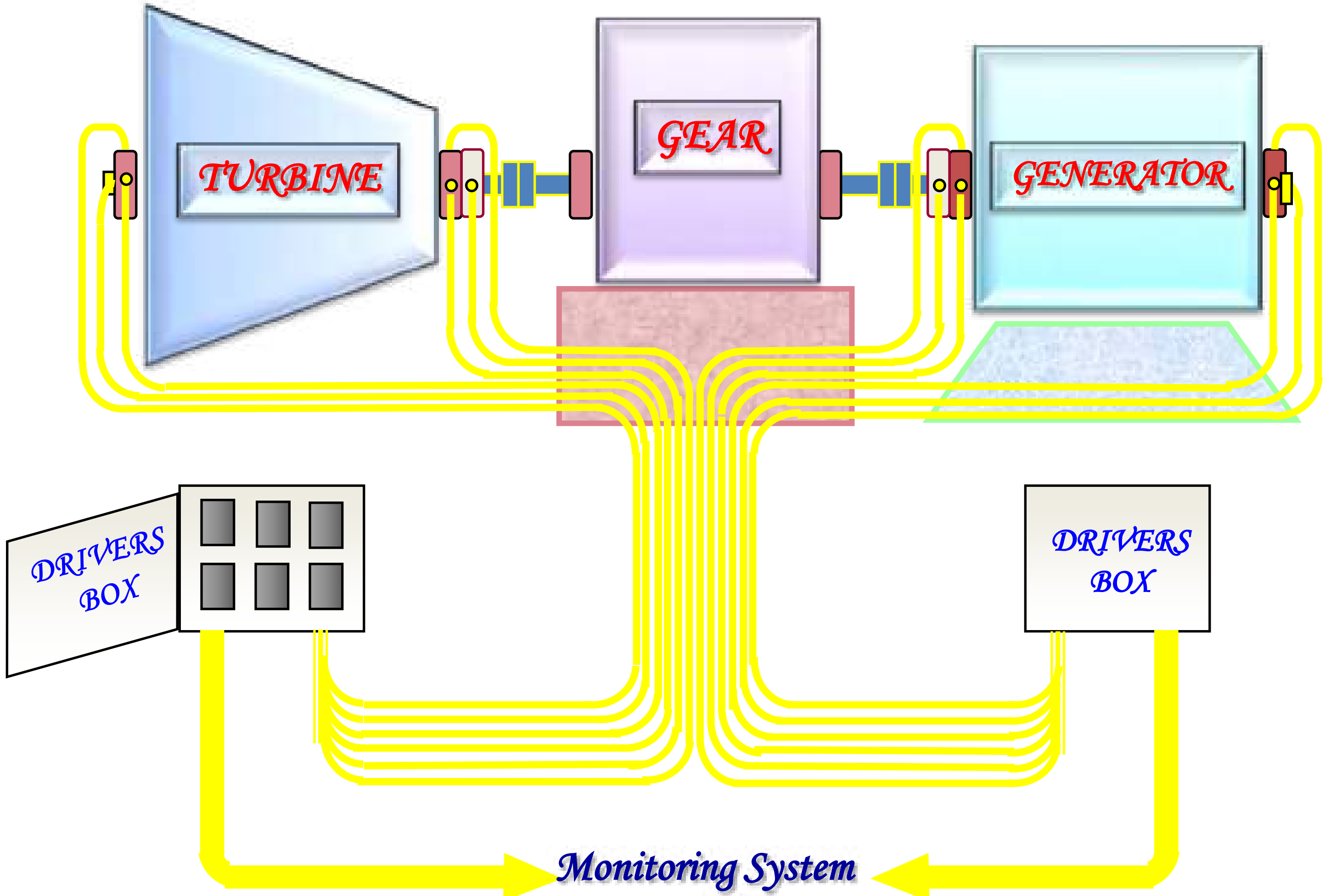
Display in µM, 1/1000 mm. Or in Mils , 1/1000 inch.
Analyze in ORBIT or Phase analysis as Nyquist/Polar Or Bode Plot.



Non Ccontact Probe to a Monitoring System



Typical System



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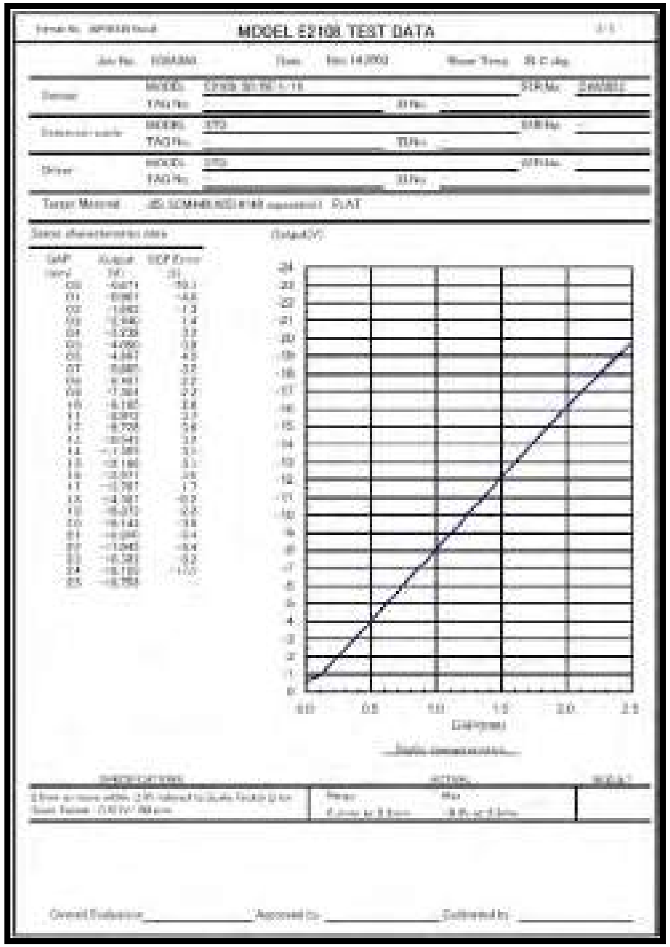
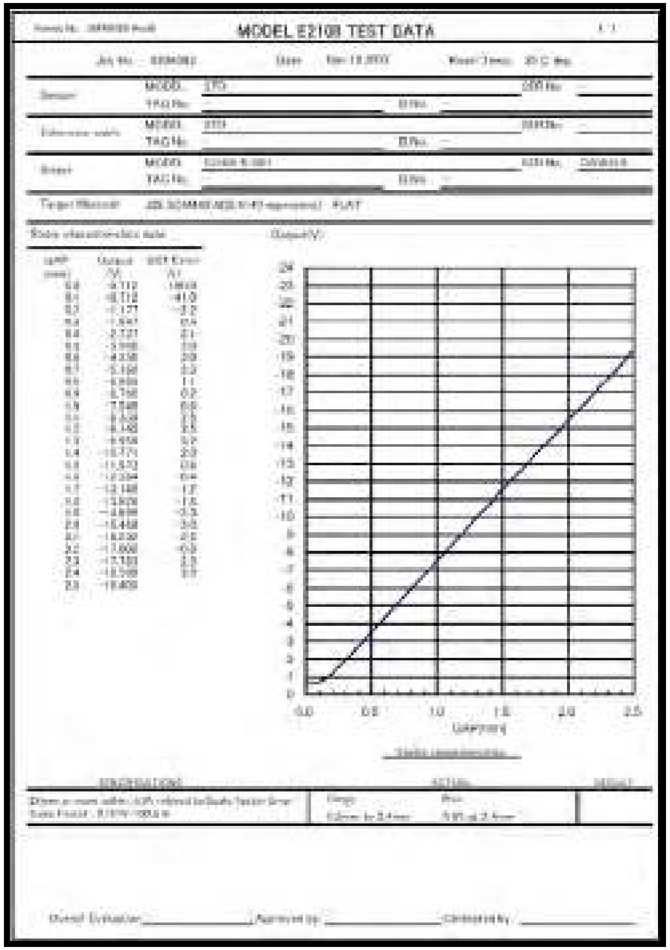
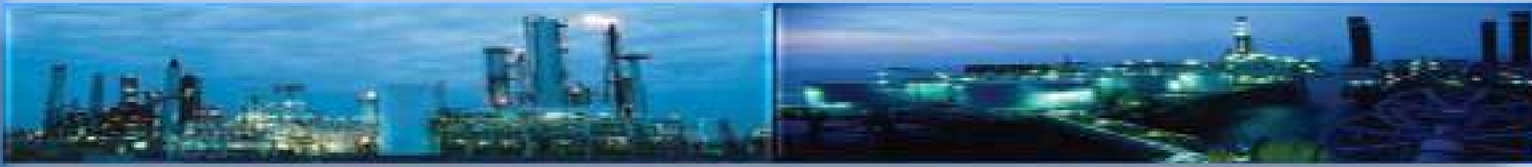
Example of Certification of Calibration







Report Example

EDDY PROBE CALIBRATION REPORT

Machine: P201B | Date of Test: 16/09/02

Calibrated Probe P/N: 1909/30/05/1/05 | Probe position: G-DEX

Calibration Equipment : TK3

Probe Resistance(Ohm) 4.2 Ohm | Probe with Extension 12.2 Ohm

Calibrated with standard Extension Cable | Standard Driver S/N: STDDRV_22-

System Cable Length: 9 m. | Target Material: 4140 Steel

Supply with load: -16.70 Vdc | Output per one mils 1.633 Volts

Supply without load: -19.76 Vdc

GAP (inches)	VOLTAGE	STANDARD	DEVIATION	SLOPE
0.00	0.720	2.00	1.28	N/A
0.01	0.718	2.00	1.282	N/A
0.02	2.017	3.63	1.616	129.9
0.03	3.570	5.27	1.696	155.3
0.04	5.321	6.90	1.578	175.1
0.05	7.168	8.53	1.364	184.7
0.06	8.984	10.17	1.181	181.6
0.07	10.627	11.80	1.171	164.3
0.08	12.301	13.43	1.130	167.4
0.09	13.916	15.06	1.148	161.5
0.10	15.183	16.70	1.514	126.7

Case Vibration
OR
Absolute Vibration

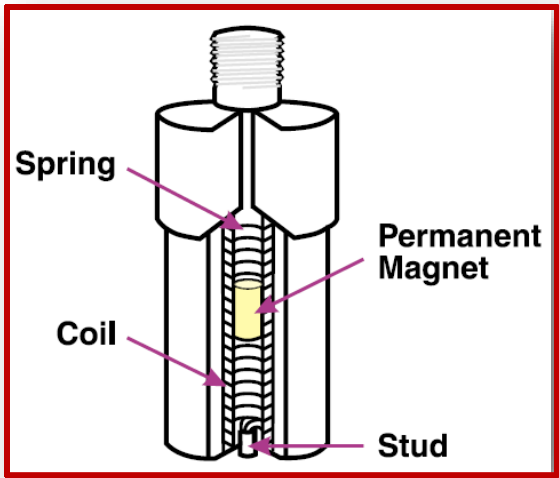
Vibration measurement on non-rotating parts

Seismic Velocity Sensor

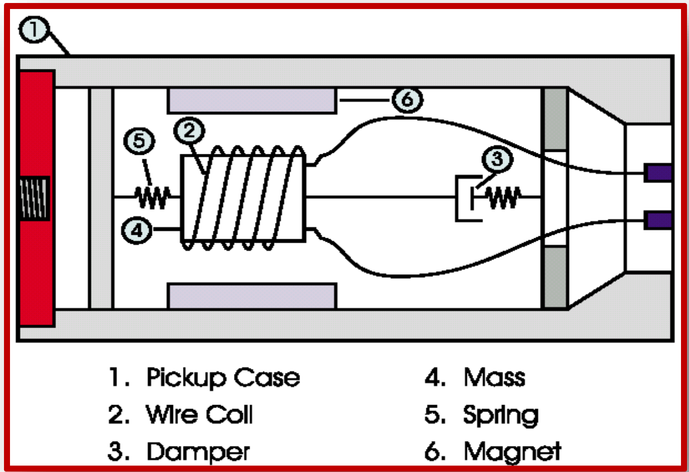
Velocity = The Displacement Per Time,

Normal Output is 100 mV/inch/sec, Pk

1) Magnet inside with Coil outside



2) Magnet outside with Moving Coil inside

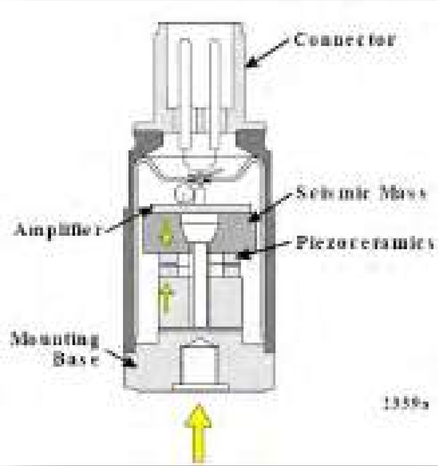


AST

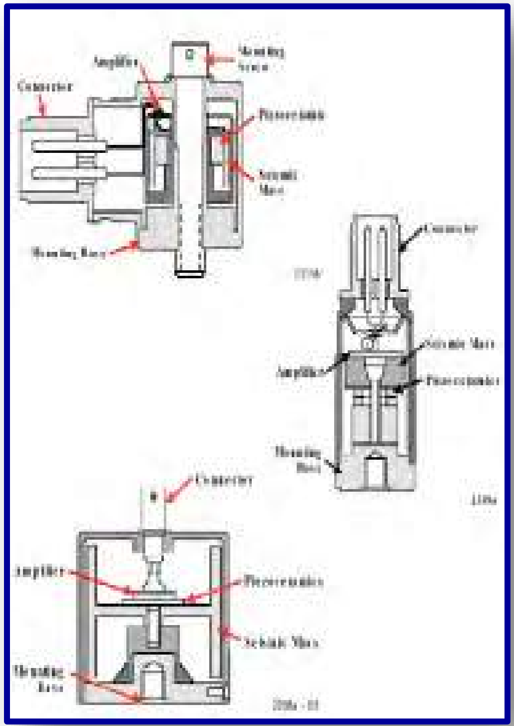
ICP Accelerometer

Acceleration = The Rate of Change of Velocity,
Normal Output is 100 mV/g, Pk

- Piezoelectric material (sensing element) is placed under load using a mass
- As ‘stack’ vibrates, crystal is squeezed or released
- Charge output is proportional to the force (and acceleration)
- Electronics convert charge output into voltage output



Different kinds of ICP Accelerometers



AST

Aaccelerometers, Connector and Cable

Sensor with integral cable

Sensor with integral 2 pin connector or without cable

Connector with integral cable

IP 50 Connector without cable, local fabrication

IP 67 Connector with integral Armored cable

AST

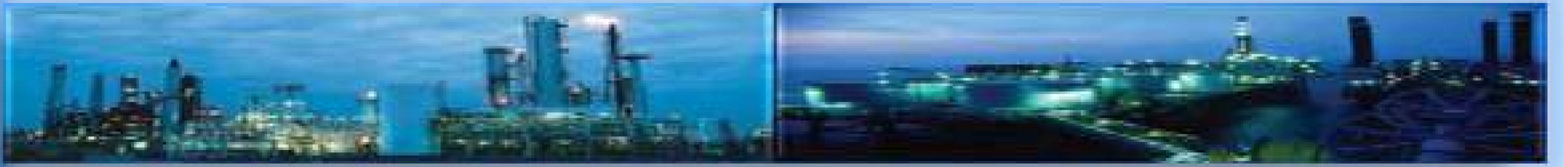
Different Types of Connectors

1	Microdot 10-32
1A	Microdot 10-32, right angle
2	BNC, plug, male
2F	BNC, female
2T	BNC, twinaxial
6	Amphenol, MIL-C-5015 style, 2 socket, metallic **Note: Electrical isolation between shield and transducer housing**
6GSL/6GSLI	MIL-C-5015 style, 3 socket, splash proof, premium GSL: Electrical contact between shield and transducer housing
6GQ/6GQI	MIL-C-5015 style, 3 socket, splash proof, premium GSL: Electrical contact between shield and transducer housing GSLI: Electrical isolation between shield and transducer
6Q/6QI	MIL-C-5015 style, 2 socket, high temperature (200°C / 392°F) Q: Electrical contact between shield and transducer housing QI: Electrical isolation between shield and transducer housing
6QA/6QAI	MIL-C-5015 style, 2 socket, high temperature (200°C / 392°F) Q: Electrical contact between shield and transducer housing QI: Electrical isolation between shield and transducer housing
6SL/6SLI	MIL-C-5015 style, 2 socket, splash proof, premium SL: Electrical contact between shield and transducer housing SLI: Electrical isolation between shield and transducer housing
6W	MIL-C-5015 style, 2 socket, molded **Note: Electrical isolation between shield and transducer housing**
6WR	MIL-C-5015 style, right angle, molded **Note: Electrical isolation between shield and transducer housing**
9W	Bendix, 4 socket, threaded, weatherproof
19SL/19SLI	MIL-C-5015 style, 6 socket SL: Electrical contact between shield and transducer housing SLI: Electrical isolation between shield and transducer housing
20	LEMO, 7 pin

AST

Different Types of Cable

Common cables	Description	C° range	F° range	Diameter in.	pF/ft
J1	Coaxial, low noise, orange PVC jacket	-55 to 80	-67 to 176	0.088	30
J3	Coaxial, low noise, high temperature, red Teflon® jacket	-100 to 260	-148 to 500	0.085	30
J5A	Coaxial, RG 58, black PVC jacket	-40 to 105	-40 to 221	0.190	30
J9T	Coaxial, RG 59, black Teflon® jacket	-80 to 150	-112 to 302	0.190	20
J9T2	Twisted pair, shielded, white Tefzel® jacket	-80 to 150	-112 to 302	0.190	27
J9T2A	Twisted pair, shielded, yellow Teflon® jacket	-80 to 200	-112 to 392	0.190	27
J9T2AS	Twisted pair, shielded, yellow Teflon® jacket with stainless steel braid	-80 to 200	-112 to 392	0.210	27
J9T2S	Twisted pair, shielded, white Tefzel® jacket with stainless steel braid	-80 to 150	-112 to 302	0.210	27
J9T3	Three conductor, shielded, white Tefzel® jacket	-80 to 150	-112 to 302	0.190	27
J9T3A	Three conductor, shielded, yellow Teflon® jacket	-80 to 200	-112 to 392	0.190	27
J9T4	Four conductor, shielded, red Teflon® jacket	-80 to 200	-112 to 392	0.190	30
J9T4A	Four conductor, shielded, yellow Teflon® jacket	-80 to 200	-112 to 392	0.190	27
J10	Twisted pair, shielded, gray Enviroprene jacket	-50 to 125	-58 to 257	0.190	30
J88	Twisted pair, shielded, black Polyurethane jacket	-40 to 80	-40 to 176	0.175	60
J88C	Twisted pair, shielded, black Polyurethane jacket, coiled with 6" straight ends	-40 to 80	-40 to 176	0.175	60
J95	Five conductor, shielded, black Polyurethane jacket	-20 to 90	-4 to 194	0.240	22
J96	Twisted pair, shielded, white Teflon® jacket	-80 to 150	-112 to 302	0.145	35
J9F	Twisted pair, foil shielded with drain wire, red Teflon® jacket	-70 to 200	-94 to 392	0.125	51



Splash proof Connectors require a special tools for Clamping Cable and Connectors

HTKIT

Field Installable, High Temperature R6Q Connector Kit

Note: *Connector & cabling must be ordered separately*

SPKIT

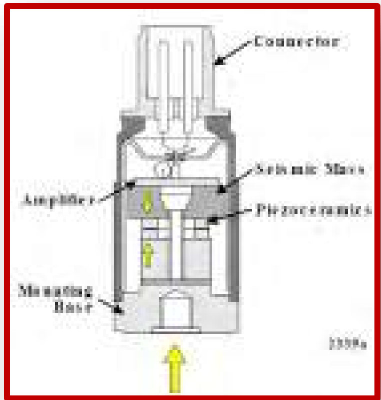
Field Installable, Splash Proof Connector Kits: Each kit contains tools and supplies to assemble 25 "6SL / 6SLI" connectors.

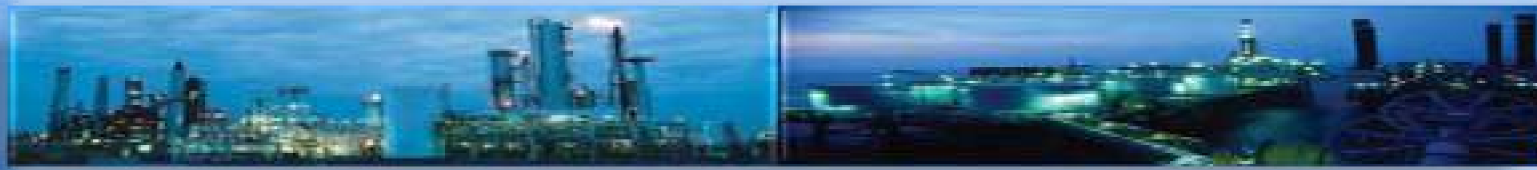
*NOTE: Connectors & Cabling must be ordered separately

Piezoelectric Velocity Sensors

The piezoelectric element in the sensor produces a signal proportional to acceleration. This small acceleration signal can be amplified for acceleration measurements or converted (electronically integrated) within the sensor into a velocity or displacement signal. The piezoelectric velocity sensor is more rugged than a coil and magnet sensor, has a wider frequency range, and can perform accurate phase measurements.

Normal Output is 100 mV/inch/sec, Pk





AST

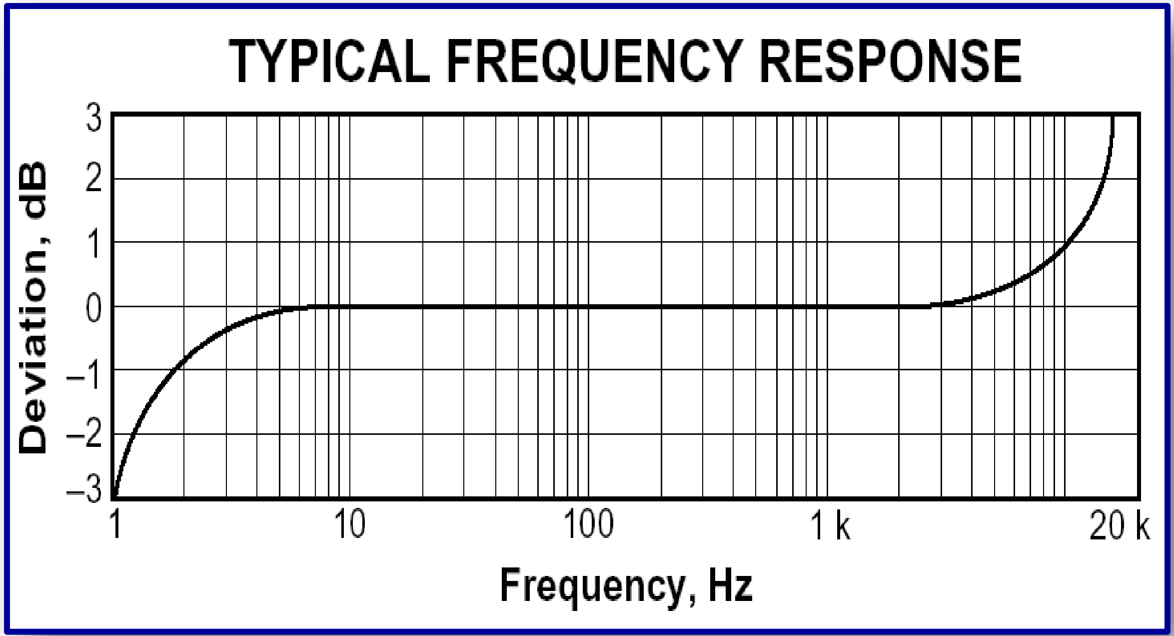
Advantage of Piezoelectric Velocity Sensor to Old Seismic Sensor

Traditional velocity sensors use an electromagnetic (coil and magnet) system to generate the velocity signal. Now, hardier piezoelectric velocity sensors (internally integrated accelerometers) are gaining in popularity due to their improved capabilities. A comparison between the traditional coil with magnetic velocity sensor and the modern piezoelectric velocity sensor is shown in table 1.

	Coil & Magnet Velocity Sensor	Piezoelectric Velocity Sensor
Flat Frequency Response		
20 - 1,500 Hz	Yes	Yes
2 - 5,000 Hz	No	Yes
Phase Fidelity		
2 - 5,000 Hz	Poor	Excellent
Low Off-Axis Sensitivity	No	Yes
Reduced Noise at High Frequencies	No	Yes
Linearity	Good	Good
Mounting in Any Orientation	No	Yes
Operation to 120□C	Yes	Yes
EMI Resistance	Poor	Excellent
Mechanical Durability	Fair	Excellent

Table 1. Electromagnetic Velocity Sensors vs. Piezoelectric Velocity Sensors

Frequency vs Amplitude accuracy example



What's the Bias Output Voltage

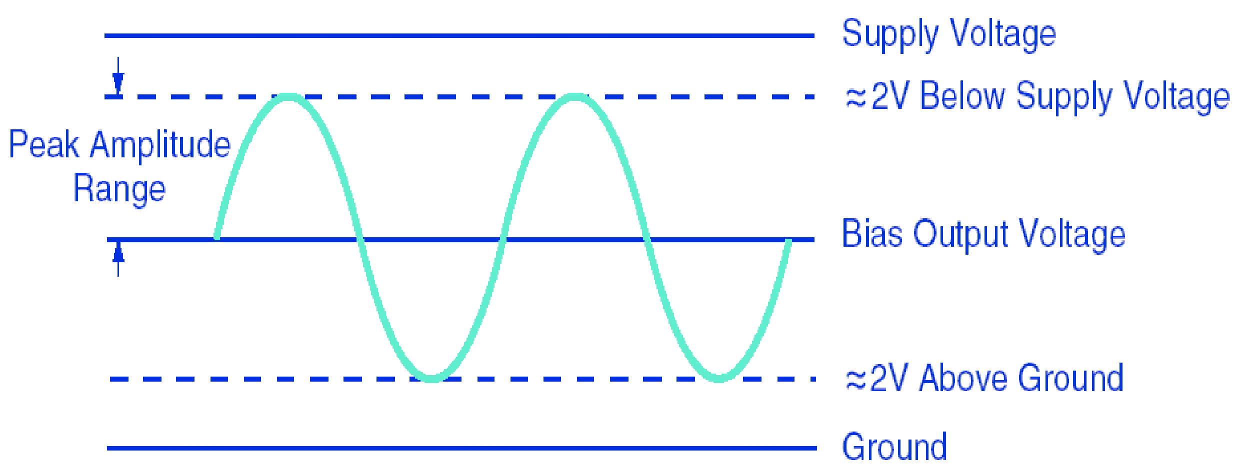
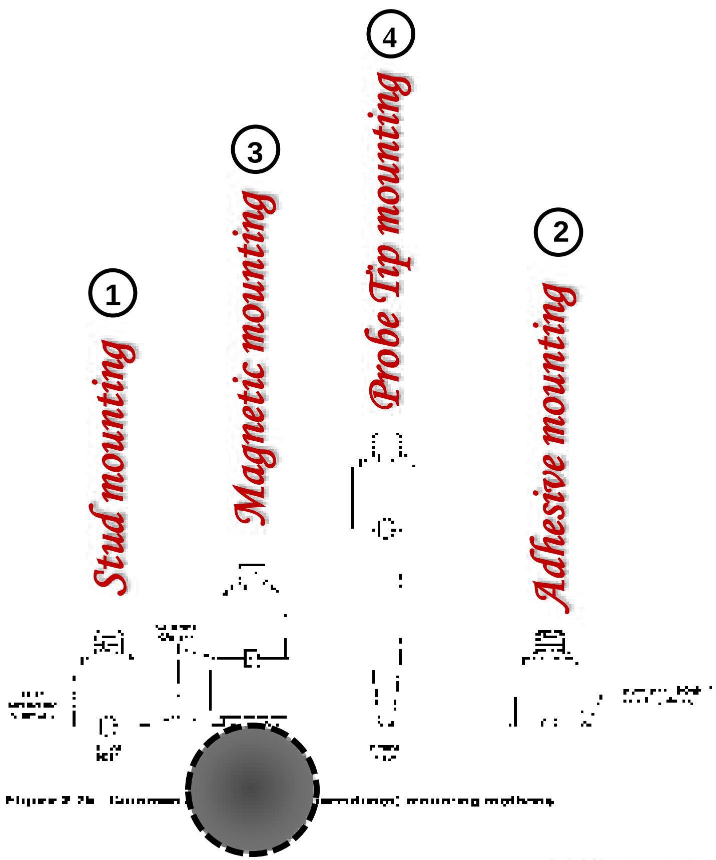


Figure 2: Range of Linear Operation

Typical Recommended maximum frequency ranges for common accelerometer mounting methods



Transducer Mount Usable Frequency Range			
	Mounting Type	Maximum Acceptable Frequency (CPM)	Mounting Natural Frequency (CPM)
1	Stud Mounting	975,000	1,900,000
2	Adhesive Mounting	540,000	Non Observed
3	Stud Mount on Rare Earth Magnet	450,000	724,500
4	Probe Tip Mounting	48,000	88,500

Amplitude Units – What You See

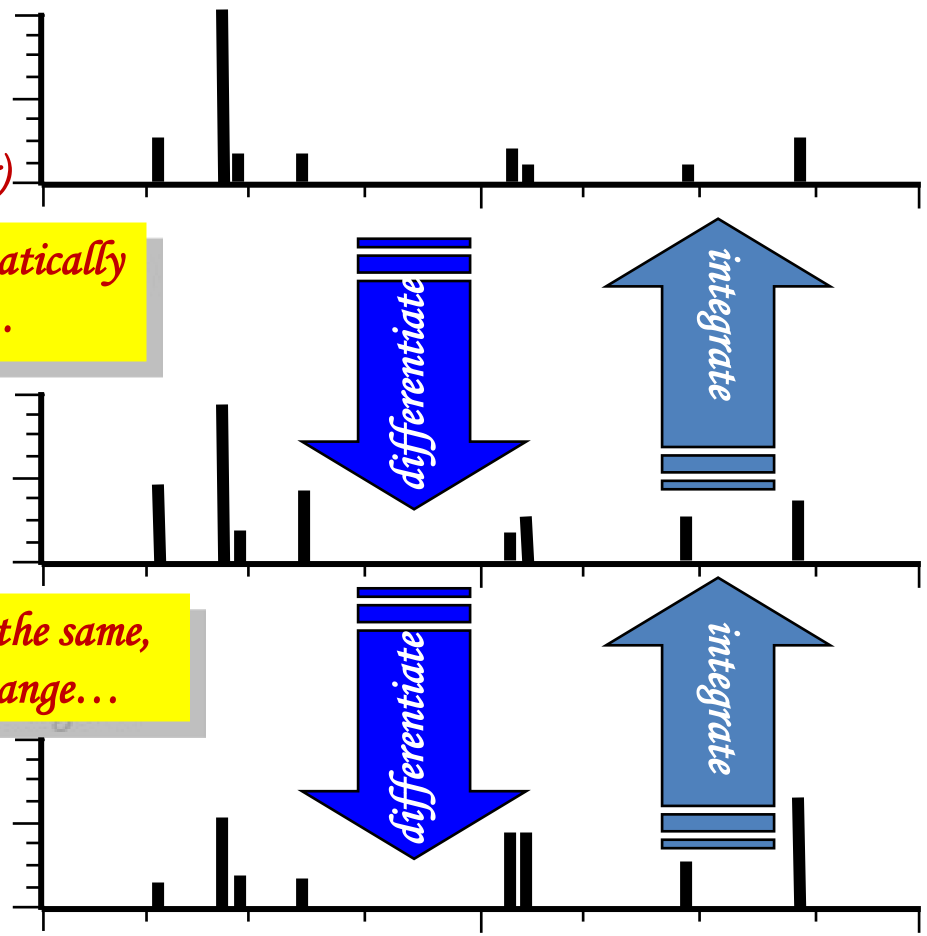
Displacement
mils (0.001 inch)
µm (0.001 millimeter)

The units are all mathematically related such that…

Velocity
ips (inches/sec)
mm/s (millimeters/sec)

The frequencies remain the same, but the amplitudes change…

Acceleration
g's
m/s^2 ($meters/sec^2$)



Unit Conversion

$$A = 64\, f V \times 10^{-5}$$

$$A = 202 f^{2} D \times 10^{-8} \quad \text{G, Pk}$$

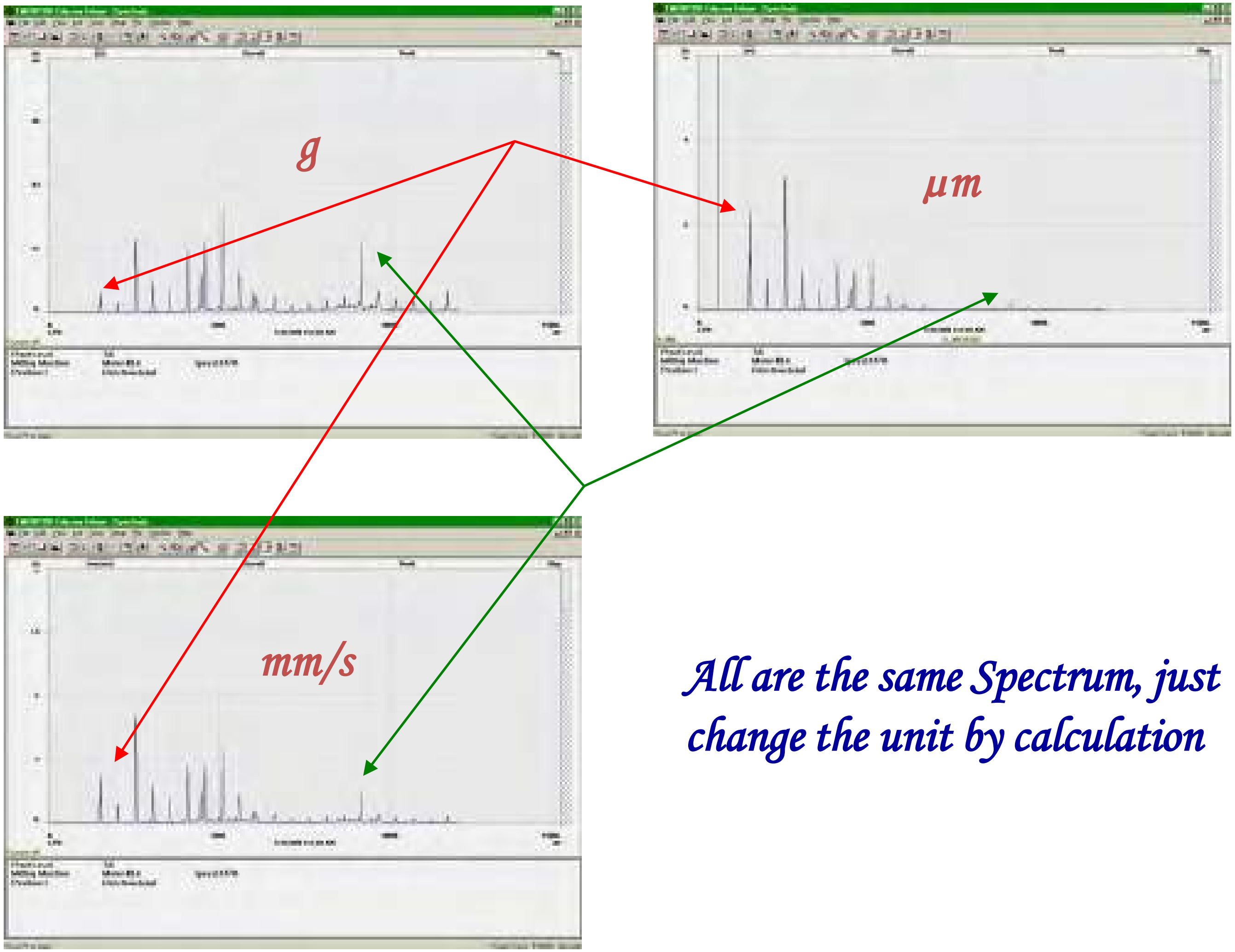
$$V = 1562 \frac{A}{f}$$

$$V = 315 f D \times 10^{-5} \quad \text{mm/s, Pk}$$

$$D = 495050 \frac{A}{f^{2}}$$

$$D = 317 \frac{V}{f} \quad \mu\text{m, Pk-Pk}$$

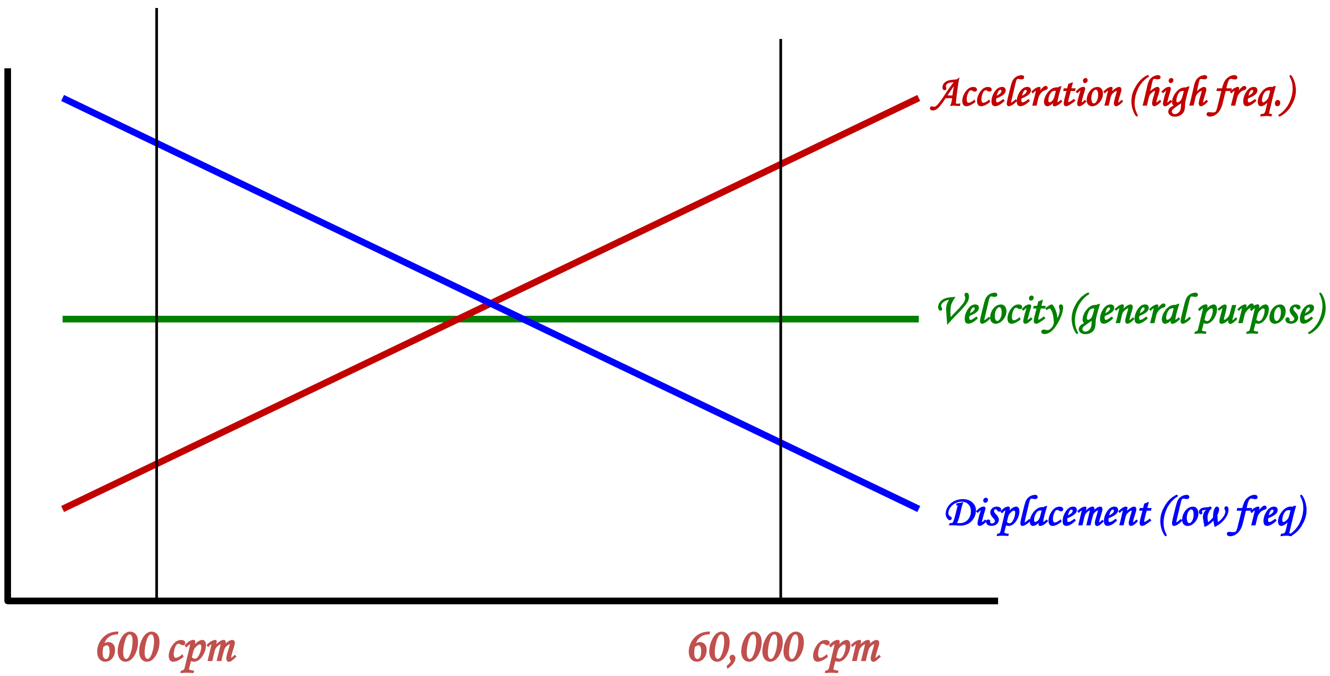
AST

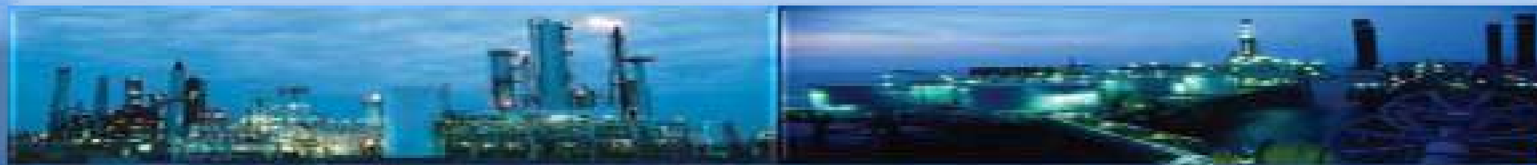


All are the same Spectrum, just change the unit by calculation

What's the difference? Acceleration, Velocity, & Displacement

The frequency range of interest





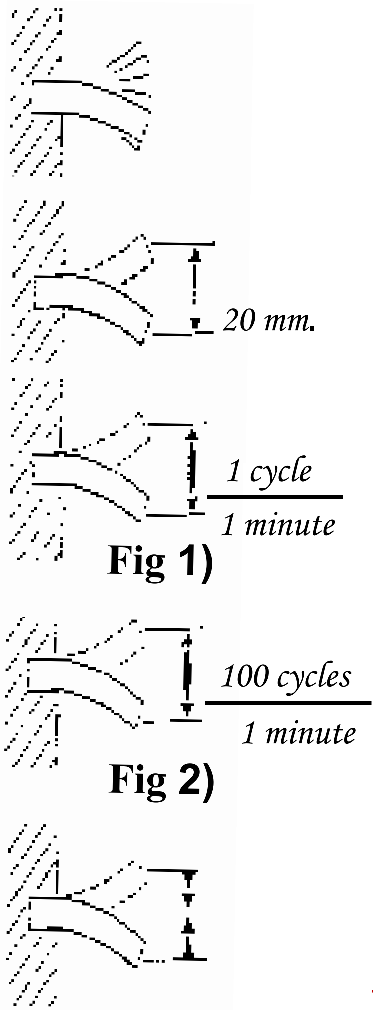


Fig 1)

Fig 2)

Frequency
Hz or CPM

Displacement in mm **=** *Machine's Stress*
For Example; 20 mm. Amplitude,
What's it tell us? Just Stress

Velocity in mm/s **=** *Machine's Fatigue*
For Example ; the same displacement amplitude as 20 mm.
Machine can be bent as 1,000,000 times.
as Fig 1) the velocity amplitude is 20 mm/min
= 0.33 mm/s, broken in 1,000,000 min.

as Fig 2) the velocity amplitude is 20 mm/1/100 min
= 2,000 mm/min = 33.3 mm/s, broken in 10,000 min.

Acceleration in G **=** *Impact Force from Bearing or Gear*
* *Rate of Change of velocity from zero to max. velocity or max. velocity to zero, if the velocity has been changed so fast, it means high G , as a hammer knock to a rigid table*

Criteria Acceptance for Case Vibration

Definition of machine classes according to ISO 2372

The following text is a quotation from ISO 2372 (1974, E, page 6, Annex A). This ISO Recommendation has also been published as British Standard (BS 4675, part I). A similar vibration classification of industrial machinery can be found in VDI 2056.

In order to show how the recommended method of classification may be applied, examples of specific classes of machines are given below. It should be emphasized, however, that they are simply examples and it is recognized that other classifications are possible and may be substituted in accordance with the circumstances concerned. As and when circumstances permit, recommendations for acceptable levels of vibration severity for particular types of machines will be prepared. At present, experience suggests that the following classes are appropriate for most applications.

Class I

Individual parts of engines and machines, integrally connected with the complete machine in its normal operating condition. (Production electrical motors of up to 15 kW are typical examples of machines in this category.)

Class II

Medium-sized machines, (typically electrical motors with 15 to 75 kW output) without special foundations, rigidly mounted engines or machines (up to 300 kW) on special foundations.

Class III

Large prime movers and other large machines with rotating masses on rigid and heavy foundations which are relatively stiff in the direction of vibration measurement.

Class IV

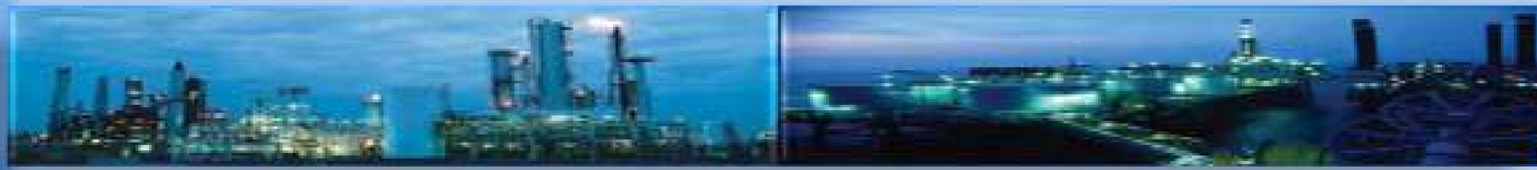
Large prime movers and other large machines with rotating masses on foundations which are relatively soft in the direction of vibration measurement (for example turbo-generator sets, especially those with lightweight substructures).

Class V

Machines and mechanical drive systems with unbalanceable inertia effects (due to reciprocating parts), mounted on foundations which are relatively stiff in the direction of vibration measurement.

Class VI

Machines and mechanical drive systems with unbalanceable inertia effects (due to reciprocating parts), mounted on foundations which are relatively soft in the direction of vibration measurements; machines with rotating slack-coupled masses such as beater shafts in grinding mills; machines, like centrifugal machines, with varying unbalances capable of operating as self-contained units without connecting components; vibrating screens, dynamic fatigue testing machines and vibration exciters used in processing plants.



ISO 2372

Limit, mm/s, rms	Class I	Class II	Class III	Class IV	Class V
71	D	D	D	D	D
45.0 - 71.0	D	D	D	D	D
28.0 - 45.0	D	D	D	D	D
18.0 - 28.0	D	D	D	D	C
11.2 - 18.0	D	D	D	C	C
7.1 - 11.2	D	D	C	C	B
4.5 - 7.1	D	C	C	B	B
2.8 - 4.5	C	C	B	B	A
1.8 - 2.8	C	B	B	A	A
1.12 - 1.8	B	B	A	A	A
0.71 - 1.12	B	A	A	A	A
0.3 - 0.71	A	A	A	A	A
0 - 0.3	A	A	A	A	A

Remark: 1) *Amplitude in mm/s*

2) *Detection type in rms.*

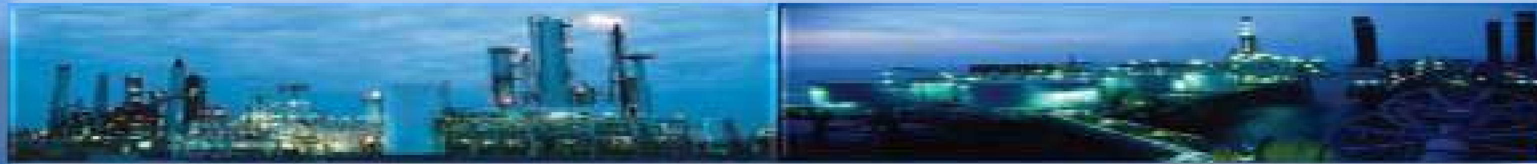
3) *Band Pass Filter as 10-1000 Hz.*

ISO 10816 Part 3

Industrial Machines with nominal power above 15 kW and nominal speeds between 120 rpm and 15,000 rpm when measured insitu

Velocity 10 -1000 Hz, r > 600 rpm 2 - 1000 Hz, r < 600 rpm	Pumps > 15 kW Radial , Axial, Mixed Flow				Medium Size Machines 15 kW < Power < 300 kW		Large Machines 300 kW < Power < 50 MW	
	Group 4		Group 3		Group 2		Group 1	
	Integrated Driver		External Driver		160 mm < Motor Height < 315 mm		315 mm < Motor Height	
Limit, mm/s, rms	Rigid	Flexible	Rigid	Flexible	Rigid	Flexible	Rigid	Flexible
> 18.0	D	D	D	D	D	D	D	D
11.0 - 18.0	D	D	D	D	D	D	D	D
7.1 - 11.0	D	D	D	C	D	D	D	C
4.5 - 7.1	D	C	C	B	D	C	C	B
3.5 - 4.5	C	B	B	B	C	B	B	B
2.8 - 3.5	C	B	B	A	C	B	B	A
2.3 - 2.8	B	B	B	A	B	B	B	A
1.4 - 2.3	B	A	A	A	B	A	A	A
0.7 - 1.4	A	A	A	A	A	A	A	A
0.0 - 0.7	A	A	A	A	A	A	A	A

Newly Commissioned
Unrestriced long-term operation
Restriced long-term operation
Vibration causes damage



ISO 10816 Part 3

Industrial Machines with nominal power above 15 kW and nominal speeds between 120 rpm and 15,000 rpm when measured insitu

Displacement 10 -1000 Hz, r > 600 rpm 2 - 1000 Hz, r > 120 rpm	Pumps > 15 kW Radial , Axial, Mixed Flow				Medium Size Machines 15 kW < Power < 300 kW		Large Machines 300 kW < Power < 50 MW	
	Group 4		Group 3		Group 2		Group 1	
	Integrated Driver		External Driver		160 mm < Motor Height < 315 mm		315 mm < Motor Height	
Limit, micron, rms	Rigid	Flexible	Rigid	Flexible	Rigid	Flexible	Rigid	Flexible
> 140	D	D	D	D	D	D	D	D
113 - 140	D	D	D	D	D	D	D	C
90 - 113	D	D	D	D	D	C	D	C
71 - 90	D	D	D	C	D	C	C	B
56 -71	D	D	D	C	C	B	C	B
45 -56	D	C	C	B	B	B	B	B
36 -45	D	C	C	B	B	B	B	A
28 -36	C	B	B	B	B	A	B	A
22 -28	C	B	B	A	B	A	A	A
18 -22	B	B	B	A	A	A	A	A
11 -18	B	A	A	A	A	A	A	A
0 - 11	A	A	A	A	A	A	A	A

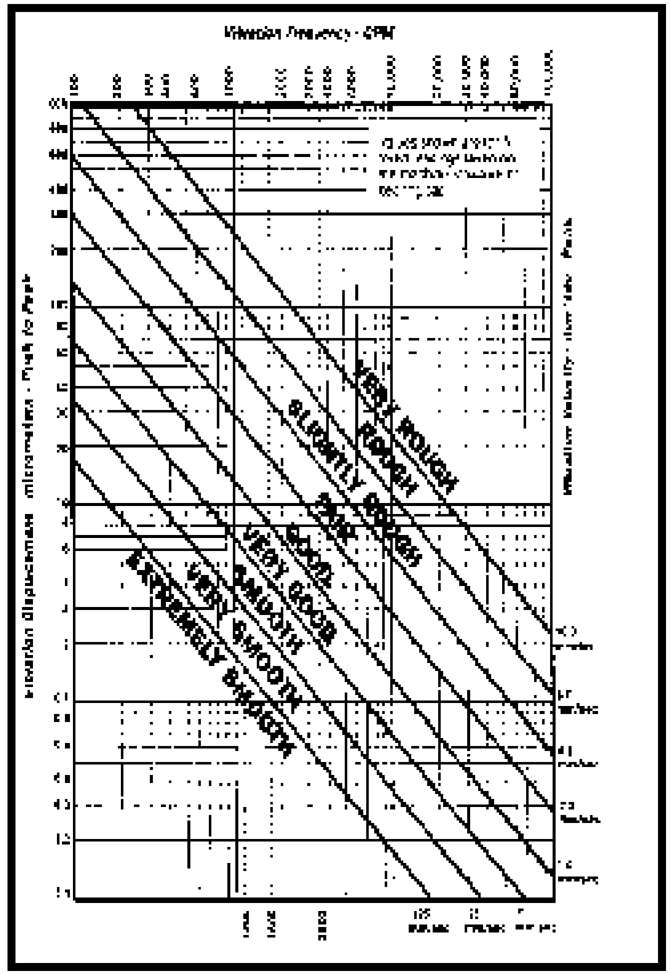
Newly Commissioned

Unrestriced long-term operation

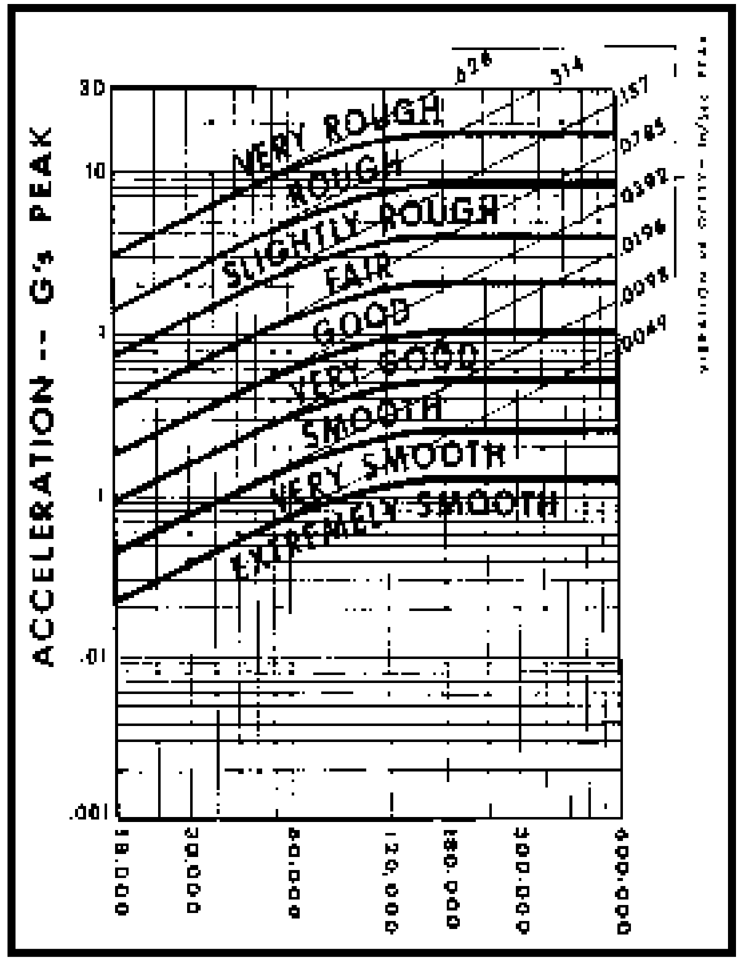
Restriced long-term operation

AST

General Machinery Vibration Severity Chart



Vibration acceleration (G's) Severity chart



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