MACHINE VIBRATION STANDARDS: OK, GOOD, BETTER & BEST

Part 2 – Absolute, General Standards

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Different Types Of Vibration Standards

1) ABSOLUTE, GENERAL (OK)

2) ABSOLUTE, MACHINE SPECIFIC (GOOD)

3) COMPARATIVE (BETTER)

4) HISTORICAL STANDARDS (BEST)

Absolute Vibration Standards, General

- These standards represent a starting point or rough gauge to apply to most machinery using an absolute vibration reference level by machine condition that is based on both experience & historical data across many industries and machine types. Some examples are as follows:

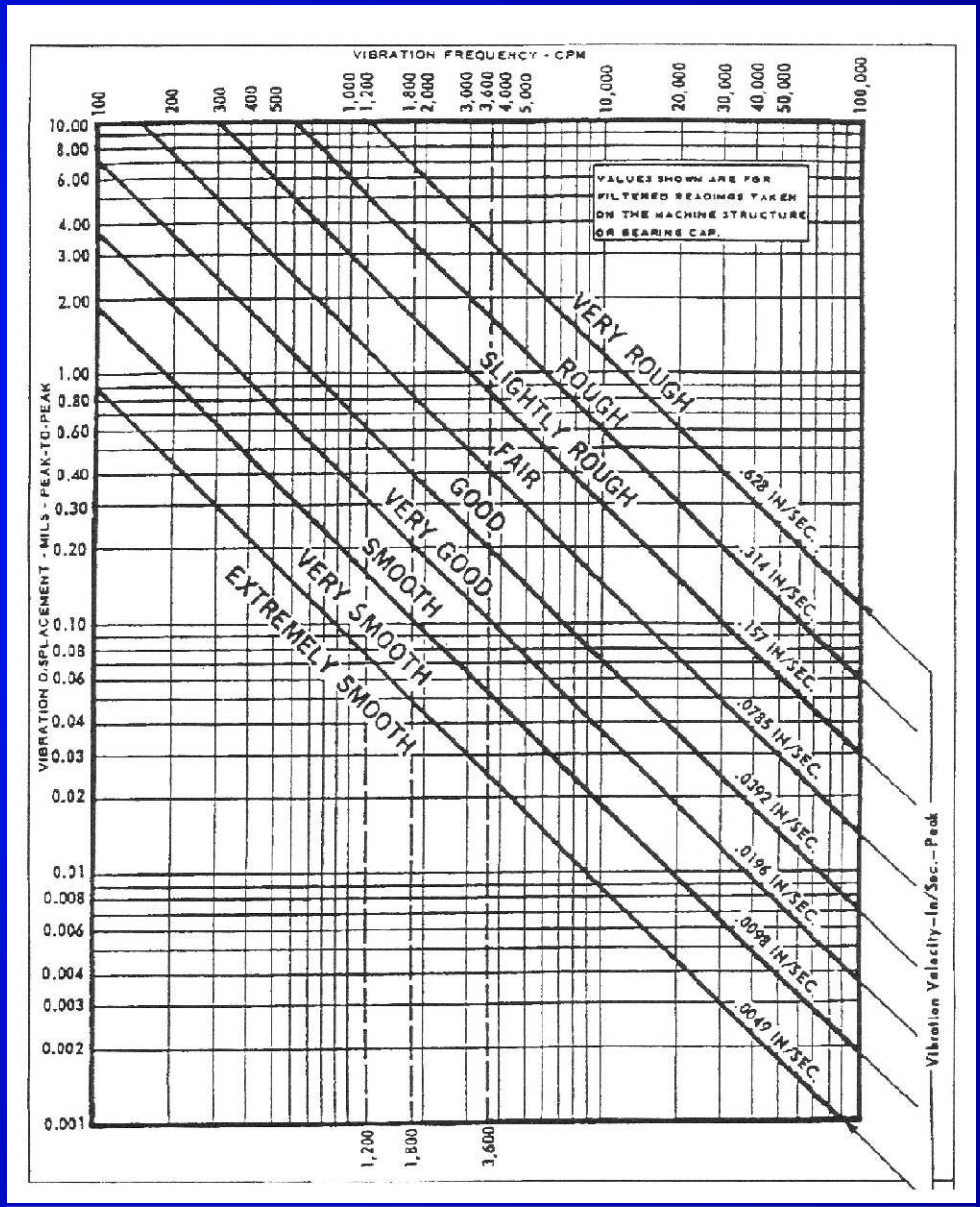
1) IRD 10816 Charts (Casing Measurements)
2) Bernhard Chart (Casing Measurements)
3) Vibration Institute Standards (Casing Measurements)
4) Update International Standards (Casing Measurements)
5) Blake Chart (Casing Measurements)
6) ISO 10816-1 Standard (Casing Measurements)
7) API 612 Standard (Shaft Displacement)
8) Dresser-Clark-Jackson Chart (Shaft Displacement)

- PROS: No prior machine history is required to perform a general assessment of a machine's health.

- CONS: Fail to account for the vast differences between machine types, bearing types, stiffnesses, system mass, base types, machine speeds, loading, etc.

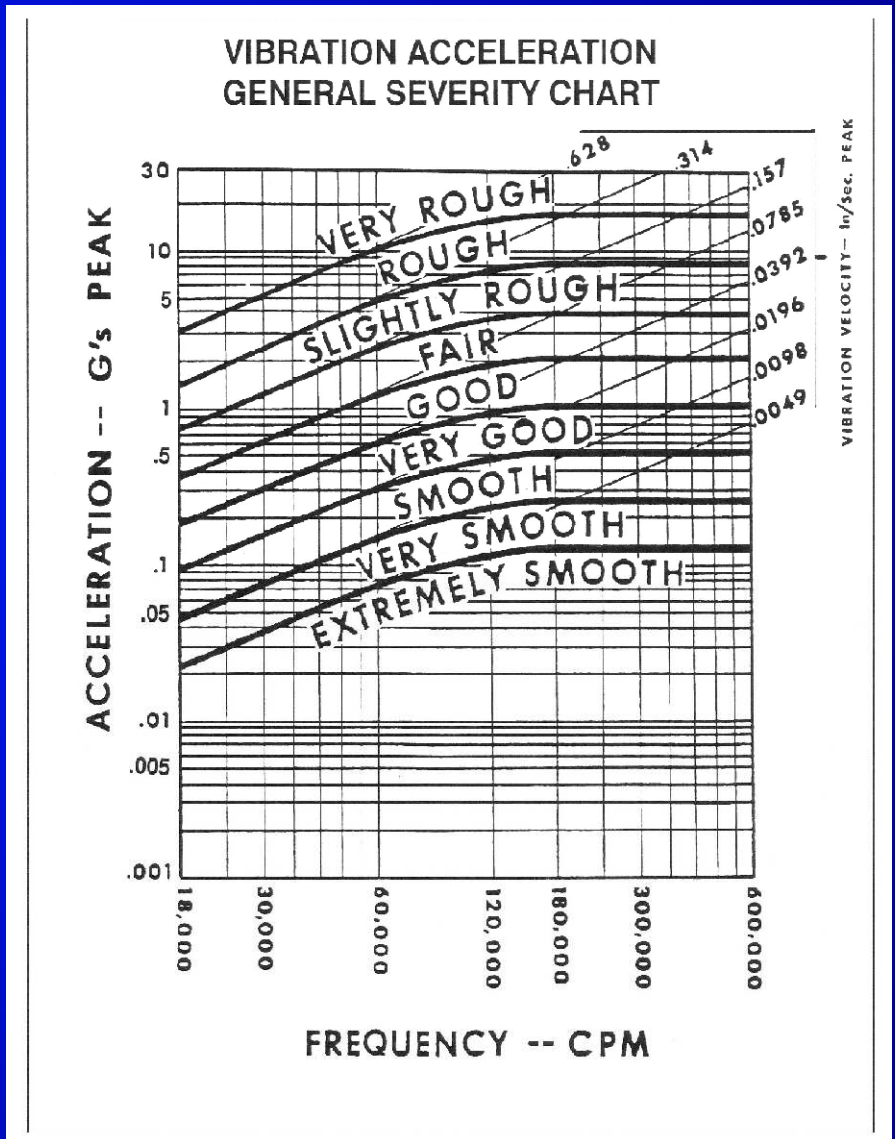
IRD ABSOLUTE VIBRATION STANDARDS[6] (VELOCITY & DISPLACEMENT)

- At or below 0.08 ips-pk is good for general machinery.
- At or above 0.314 ips-pk is rough for general machinery.



IRD ABSOLUTE VIBRATION STANDARDS[6] (ACCELERATION & VELOCITY)

- About 1 g's-pk or below represents good operation for most machinery.
- About 3 to 4 g's-pk represents the limit of good to fair operation for most machinery.



BERNHARD GENERAL STANDARDS[7] (VELOCITY & ACCELERATION)

Velocity:

1) Below 0.20 ips-pk is considered good to fair.
2) Above 0.20 ips-pk is considered rough.

Acceleration:

1) Below 3 to 6 g's-pk is considered good to fair.
2) Above 6 g's-pk is considered rough.

Foundation Type: Suggestion is made to reduce measured levels by 40% to compensate for isolated or weak foundations.

VIBRATION SEVERITY - GENERAL MACHINES

The chart below shows **overall vibration** severity guidelines **for bearing housing or machine casing vibration** for general machinery and **machine tools.** The chart combines several velocity references with one for acceleration.

For **turbines, centrifugal compressors, multistage pumps,** (**machines with heavy cases and light rotors**) multiply measured vibration by 2 to 3.5 before applying the velocity guidelines. Consult manufacturers for specific limits.

For **machines on weak foundations or spring mounts,** multiply measured vibration by 0.6 before applying the guidelines. **Machines operating** near a **critical speed** or with resonance problems will vibrate more. Use a multiplier of 0.7.

OVERALL VIBRATION SEVERITY CHART

GENERAL MACHINERY VIBRATION SEVERITY	VELOCITY RANGE 600 CPM TO 120,000 CPM in/sec	RECOMMENDED ACTION	ACCEL. RANGE 120,000 CPM TO 600,000 CPM g's
EXTREMELY ROUGH	0.6	*Dangerous, shut down is recommended.*	18
	0.5		15
VERY ROUGH	0.4	*Schedule repairs soon or risk major damage.*	12
	0.3		9
ROUGH		*Correct the problems to minimize wear.*	
	0.2		6
FAIR		*Faults are minor, corrections not cost effective. Monitor closely.*	
	0.1		3
SMOOTH		*Machine in good condition. Range for new or overhauled machines.*	
	0.0		0

MACHINE TOOL VIBRATION DISPLACEMENT SEVERITY GUIDELINES	DISPLACEMENT LIMITS FOR SPINDLE BEARING HOUSING VIBRATION IN THE DIRECTION OF CUTTING
Thread Grinders	0.01 to 0.06 mils
Profile or Contour Grinders	0.03 to 0.08 mils
Cylindrical Grinders	0.03 to 0.10 mils
Surface Grinders	0.03 to 0.20 mils
Centerless Grinders	0.04 to 0.10 mils
Boring Machines	0.06 to 0.10 mils
Lathes	0.20 to 1.00 mils

Limits vary depending on size and finish tolerances.

Vibration Institute & Update International General Standards

Vibration Institute, General Standards[8]

Machine Condition	Overall Vibration, RMS Velocity (ips-rms)	Overall Vibration, Peak Velocity (ips-pk)
Acceptance of new or repaired equipment	< 0.08	< 0.16
Unrestricted operation – normal	< 0.12	< 0.24
Surveillance	0.12 – 0.28	0.24 – 0.7
Unsuitable for operation	> 0.28	> 0.7

Update International, General Standards[9]

Machine Condition	Overall or 1x RPM Vibration Level	Higher Frequency Vibration (Bearing Frequencies)
Dangerous	1	0.4
Very Bad	0.6	0.2
Bad	0.3	0.1
Mildly Rough	0.2	0.07
Good, Acceptable	0.1	0.04
Very Good	0.05	0.02
Precision, Very Smooth	0.01-0.02	0.005

BLAKE CHART[8] (DISPLACEMENT, VELOCITY & ACCELERATION)

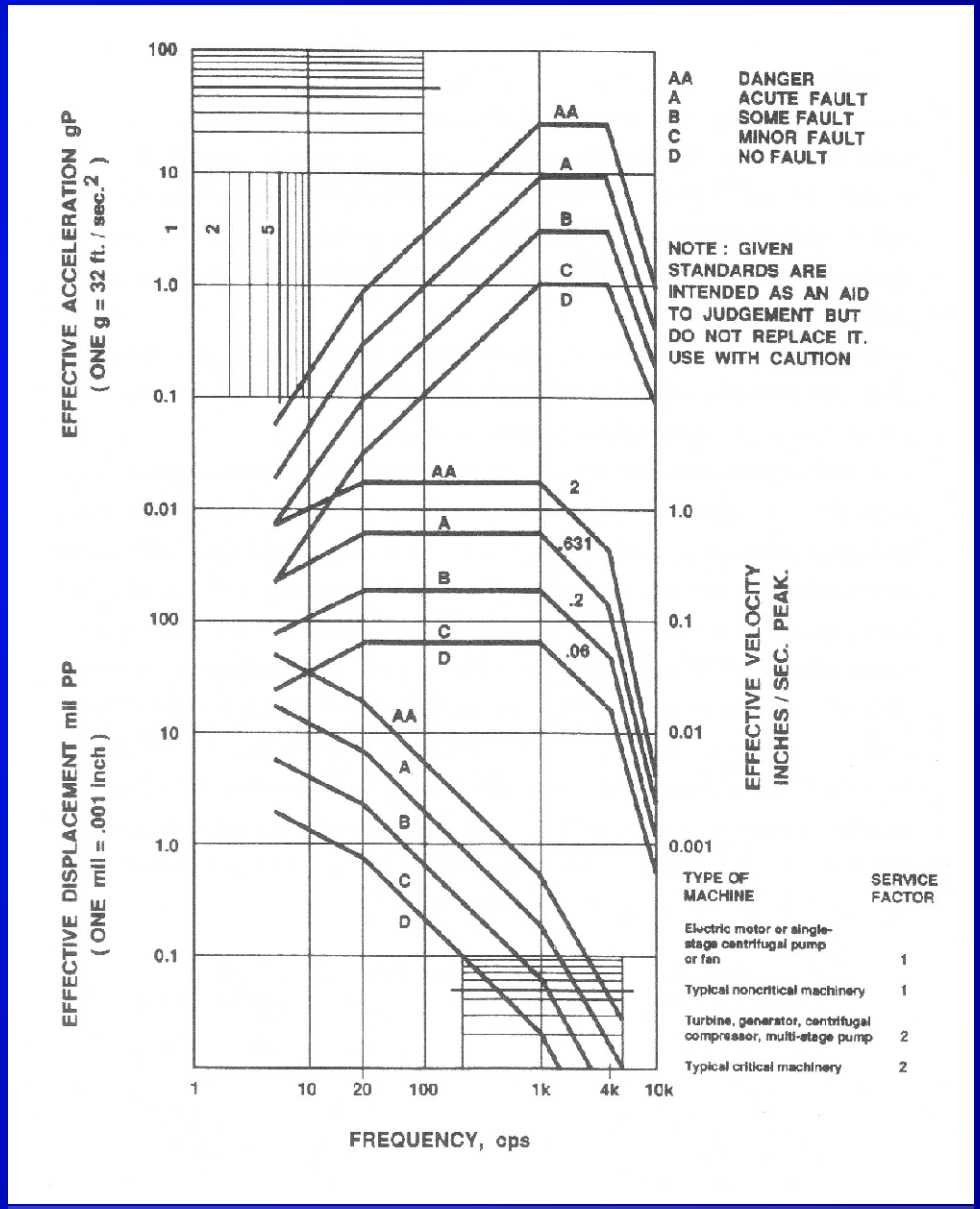
Velocity:

1) Below 0.06 ips-pk → No Fault.
2) Below 0.20 ips-pk → Minor Fault.
3) Above 0.20 ips-pk → Some Fault.
4) Above 0.63 ips-pk → Acute Fault.
5) Above 2 ips-pk → Danger.

Acceleration (Freq. Dependent):

1) Below 1 g's-pk → No Fault.
2) Below 2-3 g's-pk → Minor Fault.
3) Above 10 g's-pk → Acute Fault to Danger.

Service Factor provides a way to adjust levels for machine criticality.



ISO General Standards (10816-1:1995)[10]

RMS Vibration Velocity (mm/s)	RMS Vibration Velocity (ips-rms)	"Derived Peak" Vibration Velocity (ips-pk)	Class 1	Class 2	Class 3	Class 4
0.28	0.01	0.02	A	A	A	A
0.45	0.02	0.03	A	A	A	A
0.71	0.03	0.04	A	A	A	A
1.12	0.04	0.06	B	A	A	A
1.8	0.07	0.10	B	B	A	A
2.8	0.11	0.16	C	B	B	A
4.5	0.18	0.25	C	C	B	B
7.1	0.28	0.40	D	C	C	B
11.2	0.44	0.62	D	D	C	C
18	0.71	1.00	D	D	D	C
28	1.10	1.56	D	D	D	D
45	1.77	2.51	D	D	D	D

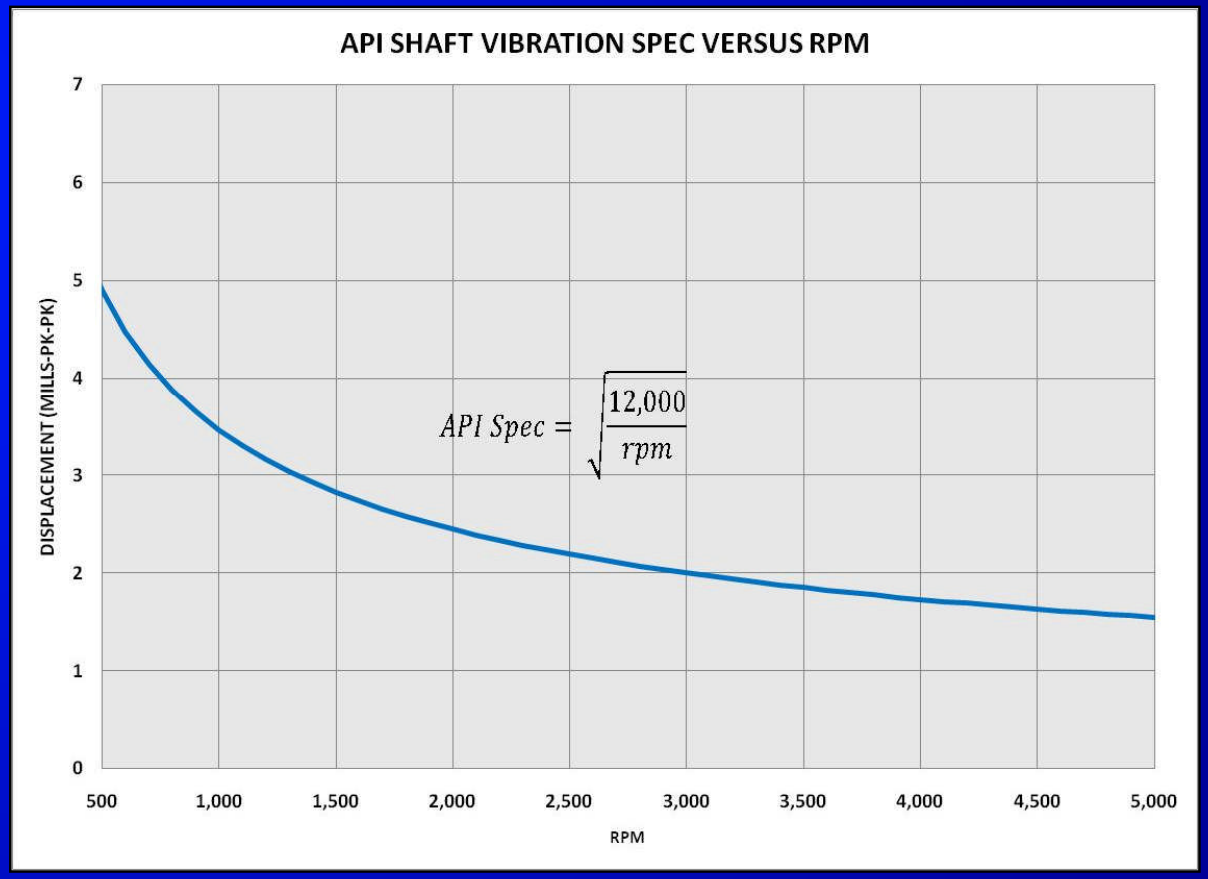
Zone A - Newly commissioned machinery. Excellent Condition.
Zone B - Good. Acceptable for unrestricted, long-term operation.
Zone C - Unsatisfactory for long-term, continuous operation (alert level).
Zone D - Bad. Sufficient severity to cause long-term damage to machine (alarm level).

Class 1 - Very small machinery or parts of machinery (20 HP or below).
Class 2 - Small machinery (20-100 HP) on rigid foundations.
Class 3 - Large machinery mounted on rigid & heavy foundations.
Class 4 - Large machinery mounted on relatively soft foundations.

A complete copy of this vibration standard is available from the ANSI website at the following: **http://webstore.ansi.org/**

API SHAFT VIBRATION SPECIFICATION[11]

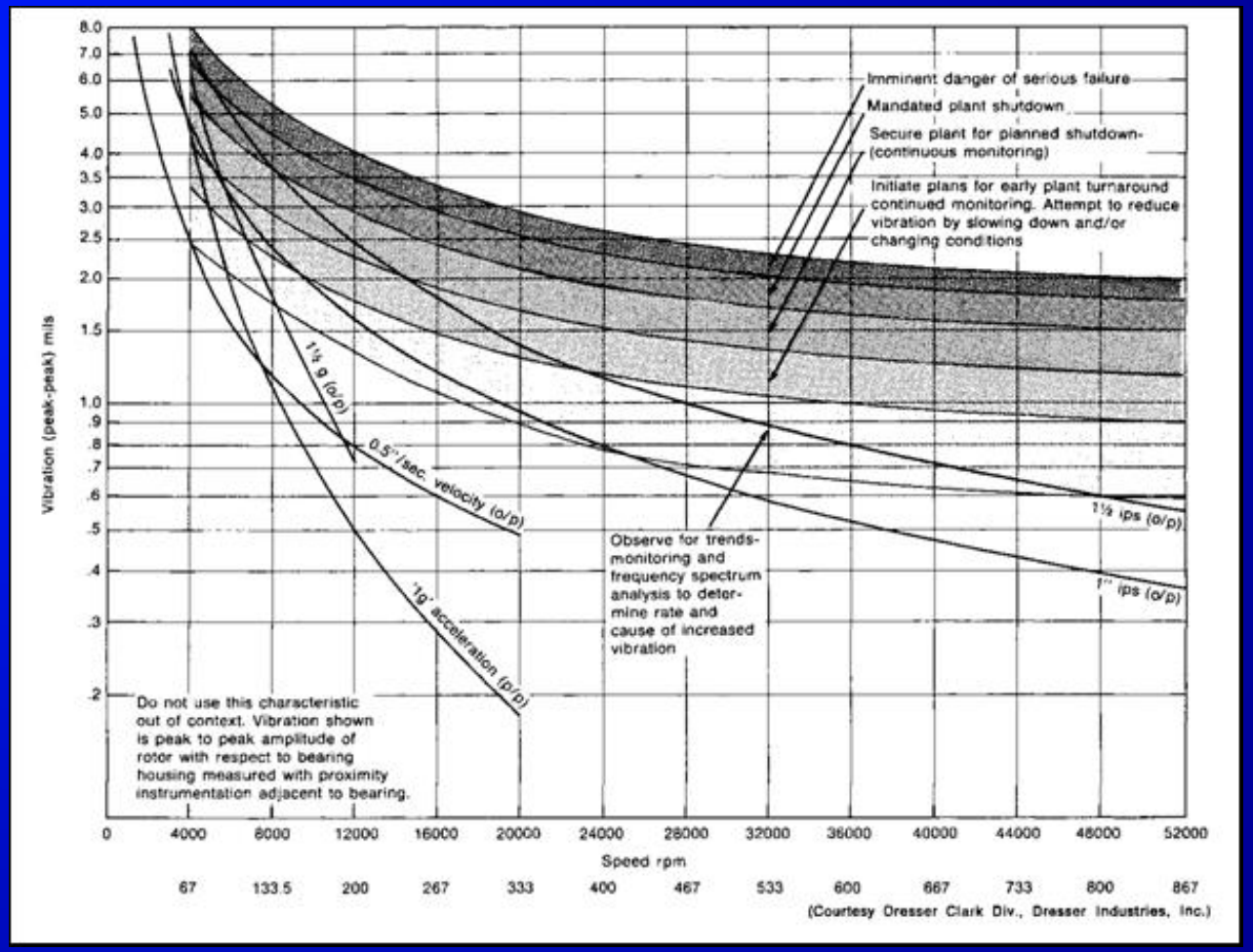
- The API 612 specification offers a quick way to gauge the severity of shaft vibration in displacement (mills-pk-pk).
- Often used when commissioning new equipment for service.
- The spec is simply given by applying the formula shown at right.
- All you need to know is the machine rpm to obtain the spec.



Dresser-Clark-Jackson Chart, Shaft Vibration Of Turbomachinery[8]

- The Dresser-Clark-Jackson chart like the API spec gives a quick, overall assessment of machine condition if the machine rpm is known.

- Results are similar to those from the API spec.



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9) Buscarello, Ralph, Practical Solutions to Machinery & Maintenance Vibration Problems, p. 156, Vibration Tolerances, Update International, CO, 1991

10) ISO 10816-1, Mechanical Vibration – Evaluation Of Machine Vibration By Measurements On Non-Rotating Parts – Part 1: General Guidelines, First Edition 1995-12-15, ISO, Switzerland, 1995

11) American Petroleum Institute, API 612 - Special Purpose Steam Turbines for Refinery Service, Washington, DC, 1987