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RATS - ROTATING & TURBOMACHINERY SOCIETY

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MRO 2023

MAINTENANCE
RELIABILITY
OPERATIONS

TECHNICAL CONFERENCE & WORKSHOPS

Installation and Commissioning

How to flatten the Infant Mortality curve

Roman Megela
Easy-Laser AB

EASY-LASER®

Wednesday October 25, 2023
DOW Centennial Centre - Fort Saskatchewan

What does reliable machinery mean?

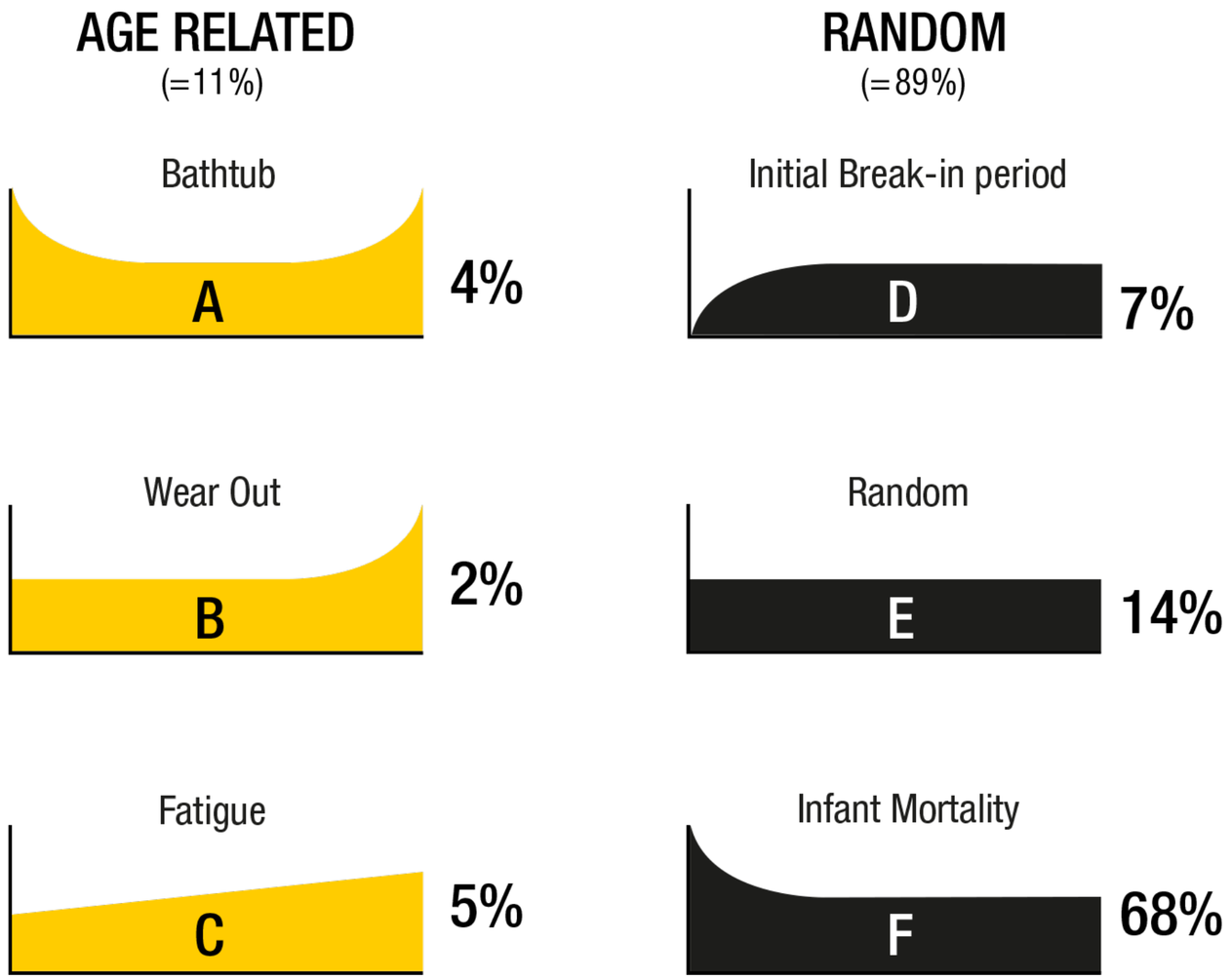
The ability of a machine, or system to consistently perform its intended or required function or mission, on demand and without degradation or failure.

Why is machinery installation so important to achieve Reliability?

The installation has direct impact on machinery.

It will determine operating conditions, performance and life cycle cost.

P to F curve

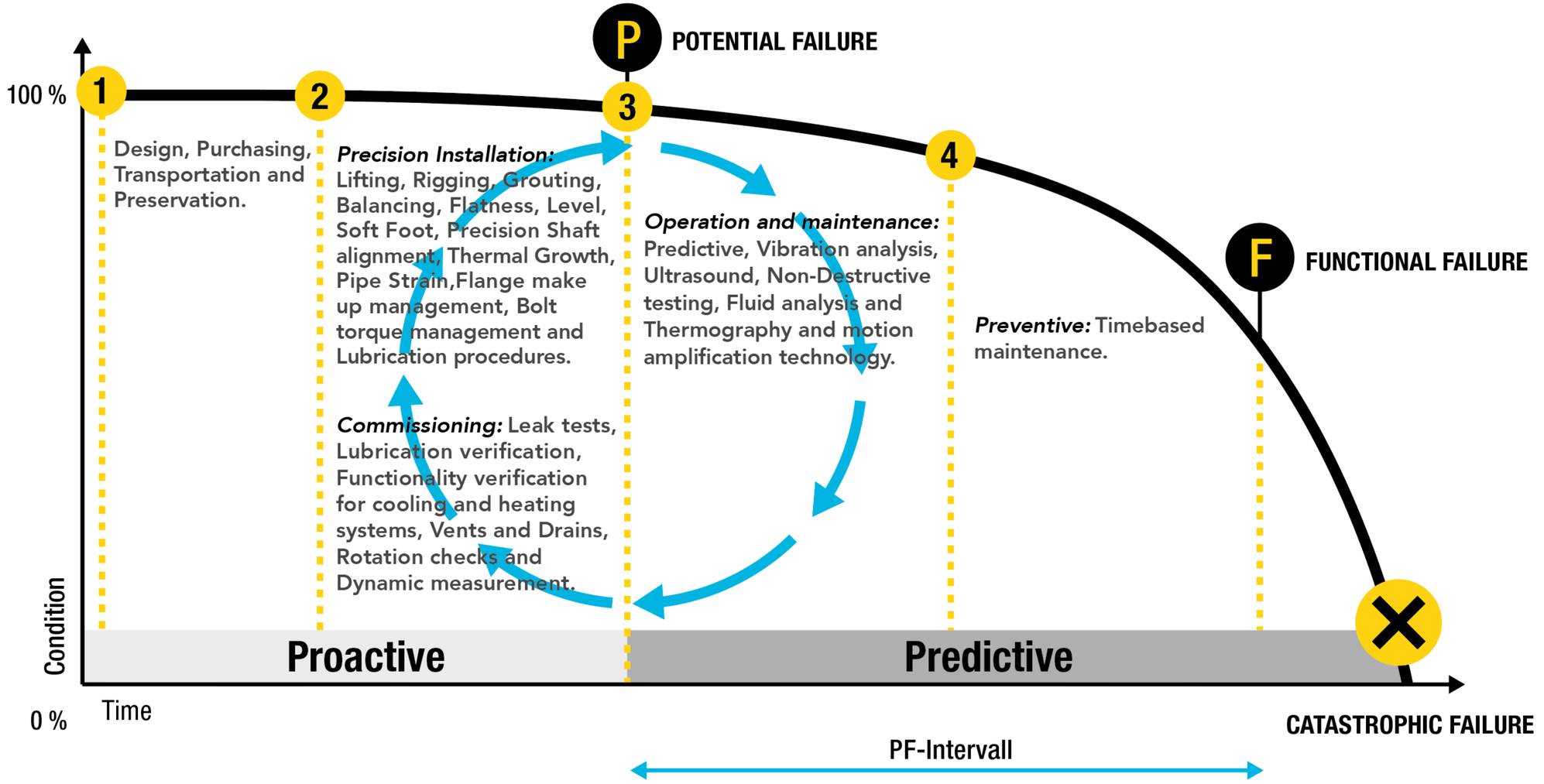

AGE RELATED
(=11%)
RANDOM
(=89%)
Bathtub
A
4%
Initial Break-in period
D
7%
Wear Out
B
2%
Random
E
14%
Fatigue
C
5%
Infant Mortality
F
68%

Infant Mortality, dead-on-arrival

An early or rapid machine failure usually due to flawed components or an incorrect installation procedure.

Relatively high conditional probability of failure during the period immediately after an item returns to service.

Nowlan and Heap 1960



Start with the foundation

Flatness

Flatness definition:

A geometric condition where the surface has no variations in the plane.

Base Flatness

Why do we need the base to be flat?

Most machinery is designed to work on a flat surface. When the base is not flat the machine casing is getting disturbed. Unintended forces are applied on the casings and consequently on the shafts, bearings, seals and piping.

To avoid any distortion to the machine case, the machine needs to rest on the flat base.

Level

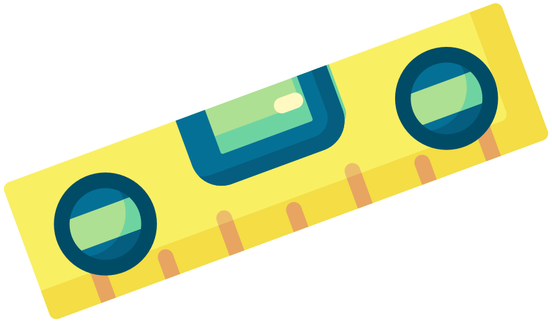
A geometric condition of a line or surface which is at 90 degrees to the center of gravity.

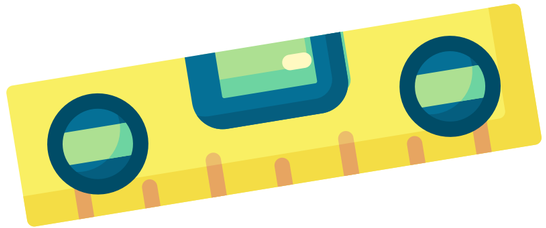
Why is Level important ?

Most machinery is designed to operate on a level surface.

It seriously affects lubrication.

It changes the load forces with respect to the bearings and affects their operating life.





Flatness tolerances according to ANSI standards

Machinery type	Recommended levelness	Recommended foot flatness	Coplanar surface deviation (shimmed)
General process machinery up to 400kW or 500HP	<0.8 µm/mm (0,0008mm) / 0.8 mm per meter	<0,4 µm/mm (0,0004mm) /0.4 mm per meter	<50 µm (0,05mm)
General process machinery 400kW or 500 HP or above	<0.4 µm/mm (0,0004mm)/ 0.4 mm per meter	<0.2 µm/mm (0,0002mm)/ 0.2 mm per meter	<50 µm (0,05mm)

What is soft foot?

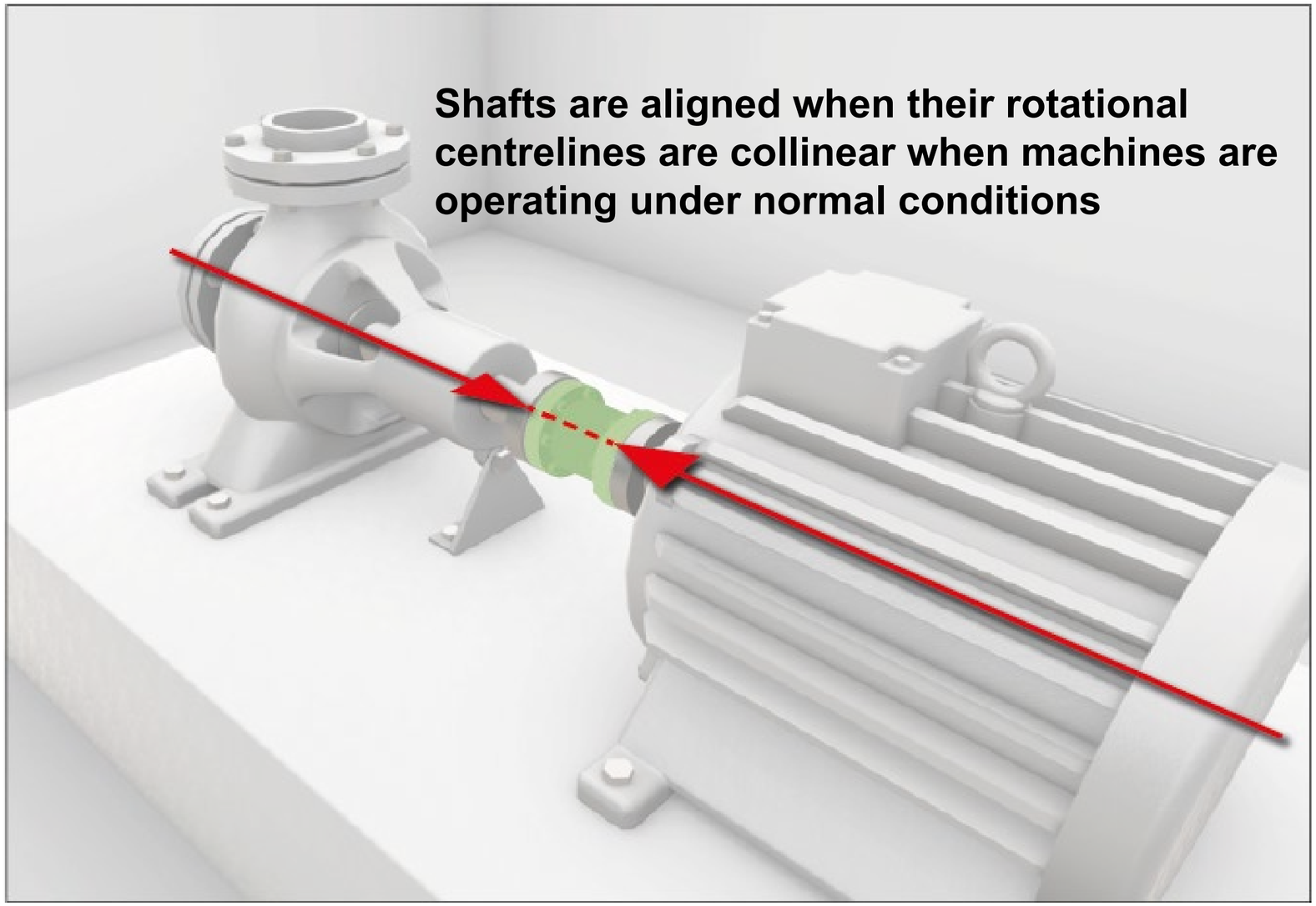
Rotating machinery is generally installed on a flat surface.

The surface of the “foot" of the machine rests on the surface of the base. It is essential that this surface is in full contact with the surface of the base.

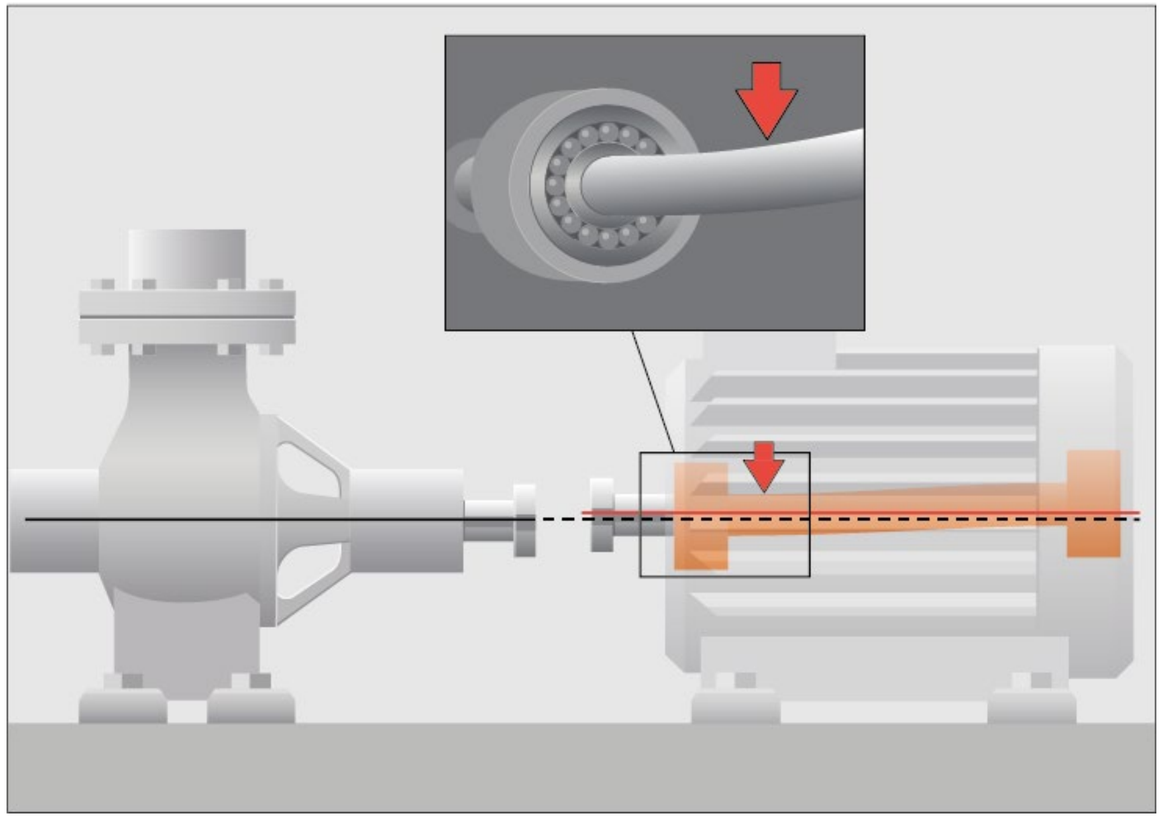
Soft foot consequences

- Modification of the housing geometry
- Stress induction in the casing
- Modification of loads on bearings
- Modification of the lubrication film
- Modification of the position of the seals
- Eccentricity in the couplings

What is shaft alignment?



Misalignment is responsible for up to 50% of failures in rotating machinery



Alignment tolerances

	Excellent		Acceptable	
RPM	OFFSET (mm)	ANGLE (mm/100 mm)	OFFSET (mm)	ANGLE (mm/100 mm)
0–1000	0.07	0.06	0.13	0.10
1000–2000	0.05	0.05	0.10	0.08
2000–3000	0.03	0.04	0.07	0.07
3000–4000	0.02	0.03	0.04	0.06
4000–5000	0.01	0.02	0.03	0.05
5000–6000	<0.01	0.01	<0.03	0.04

Pipe strain / Nozzle load

Static pipe strain

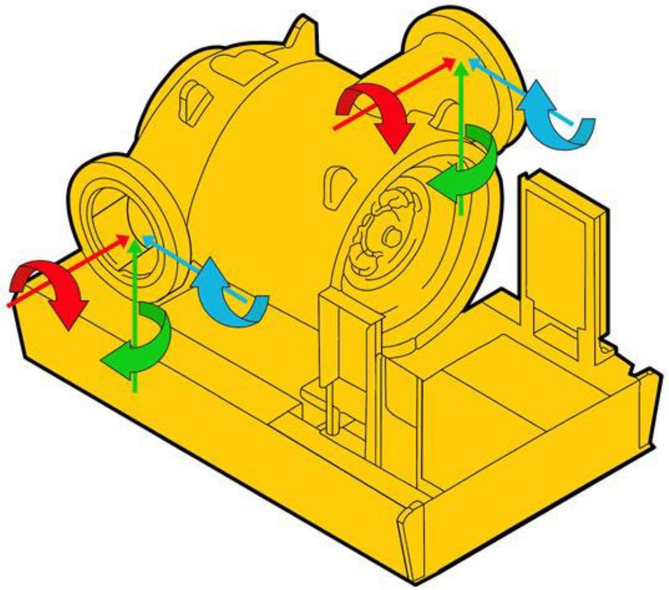
- Occurs when pipes are misaligned
- Occurs when the pipe supports are improperly constructed forcing the pipes connections.
- Tension generated in the connections is being transmitted to the machine's casing, specially to their Nozzles.

Dynamic strain

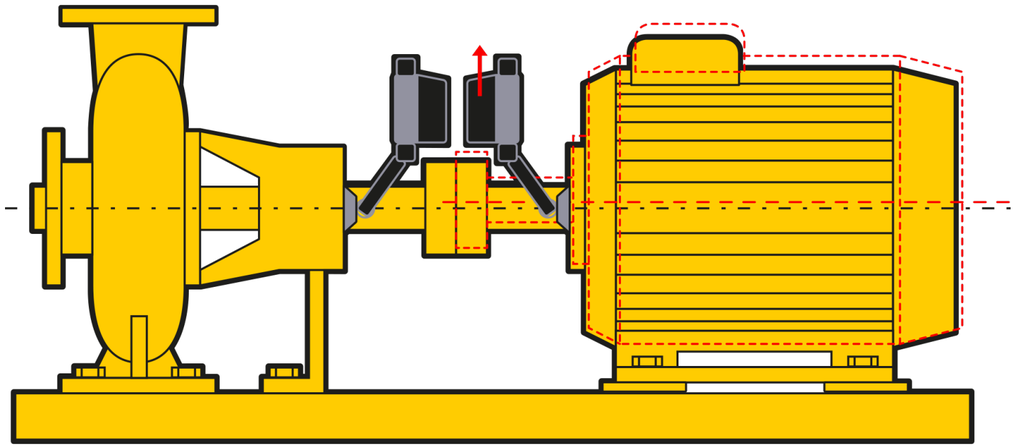
- Occurs when the temperature of the process fluid or gas expands or contracts the walls of the piping, thus forcing the connections.
- Occurs when the dynamics of the flow or weight of the process fluid displace the pipes.

Consequences of pipe strain

- Generating nozzle load
- Geometrical modification of the machine casing
- Stress induction in the casing
- Bearings load modification
- Lubrication film modification
- Seals position modification
- Eccentricity in the couplings



Thermal expansion

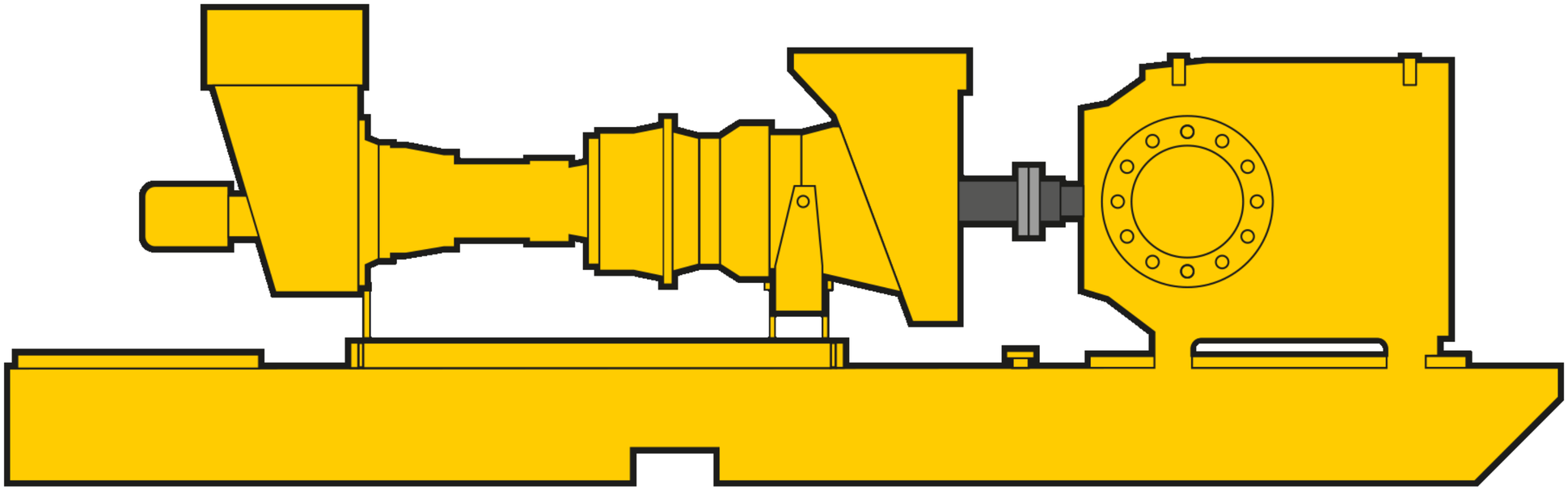


The temperature between the equipment is different due to the transported media or environmental conditions.

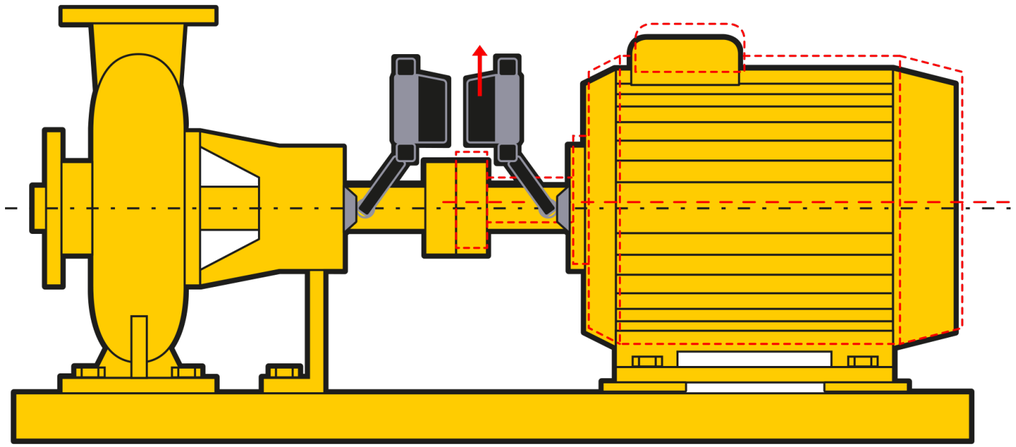
One of the assets expands more than the other affecting the shaft alignment.

Unwanted forces affect the shaft bending it and consequently the bearings, seals and other internal parts, creating internal stress.

Dynamic movement



Dynamic measurement, the ultimate test



- Flatness
- Level
- Soft foot
- Precision shaft alignment
- Pipe strain
- Thermal expansion

Thank You To Our Sponsors

RATS is a non-profit organization, run by a volunteer board of directors. The founding premise of RATS is in the social networking and community building of people within the rotating equipment and turbomachinery industries.

RATS

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