

# The Benefits and Steps to Establish a Proactive Maintenance Strategy

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**REDLIST**



# Presentation Goals

- Define Proactive Maintenance and its benefits
- Describe critical success factors
- Share Example Standards to Operationalize
- Summary/Steps to consider next
- Q&A

Define Proactive Maintenance and its Benefits



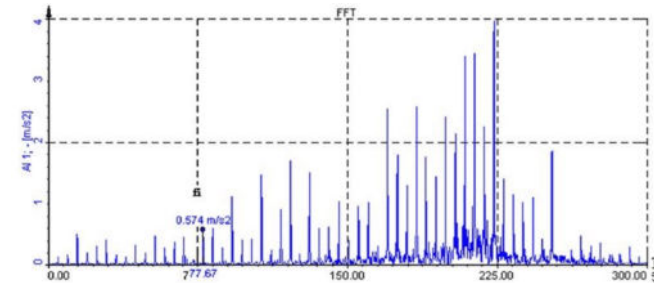
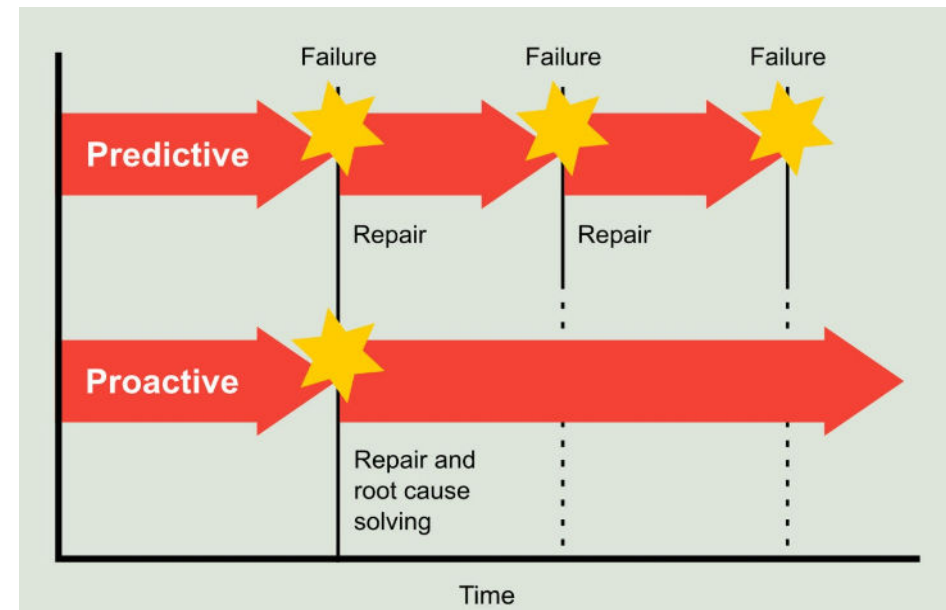
The Benefits and Steps to Establish a Proactive  
~~Maintenance~~

**Asset Management** Strategy

IT TAKES THE VILLAGE;  
NOT JUST MAINTNANCE

Its not just about the equipment  
**PEOPLE ARE THE GREATEST ASSET**

# What is Proactive Asset Management?



Felt Roll Bearing Example

# Benefits of Proactive Maintenance



- Reduced downtime due to fewer instances of malfunctions and breakdowns.
- Improved equipment reliability, availability, and quality.
- Reduced long-term maintenance costs.
- Fewer productivity and safety issues.
- Reduce waste streams and improve environmental impacts

Describe Critical Success Factors

# Main Requirements of a Proactive Approach



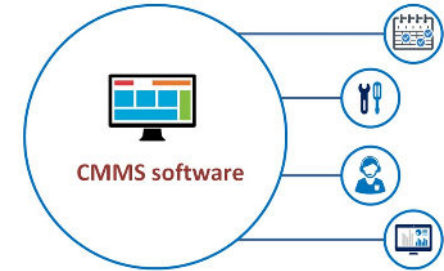
Commitment from Management; Leadership, Promotion, Resources



A Proactive Culture Driven by Desired Behaviors, Leadership, Standards, Processes, Metrics, and Rewards across all functions

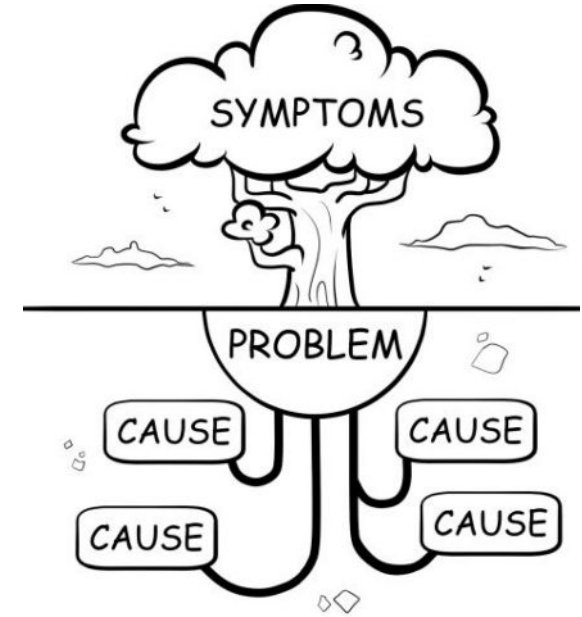


Understanding and applying functional capabilities and equipment conditions; data/root cause driven



Leveraging a CMMS solution and other tools to operationalize the functional standards and processes





# Optimizing the Approaches

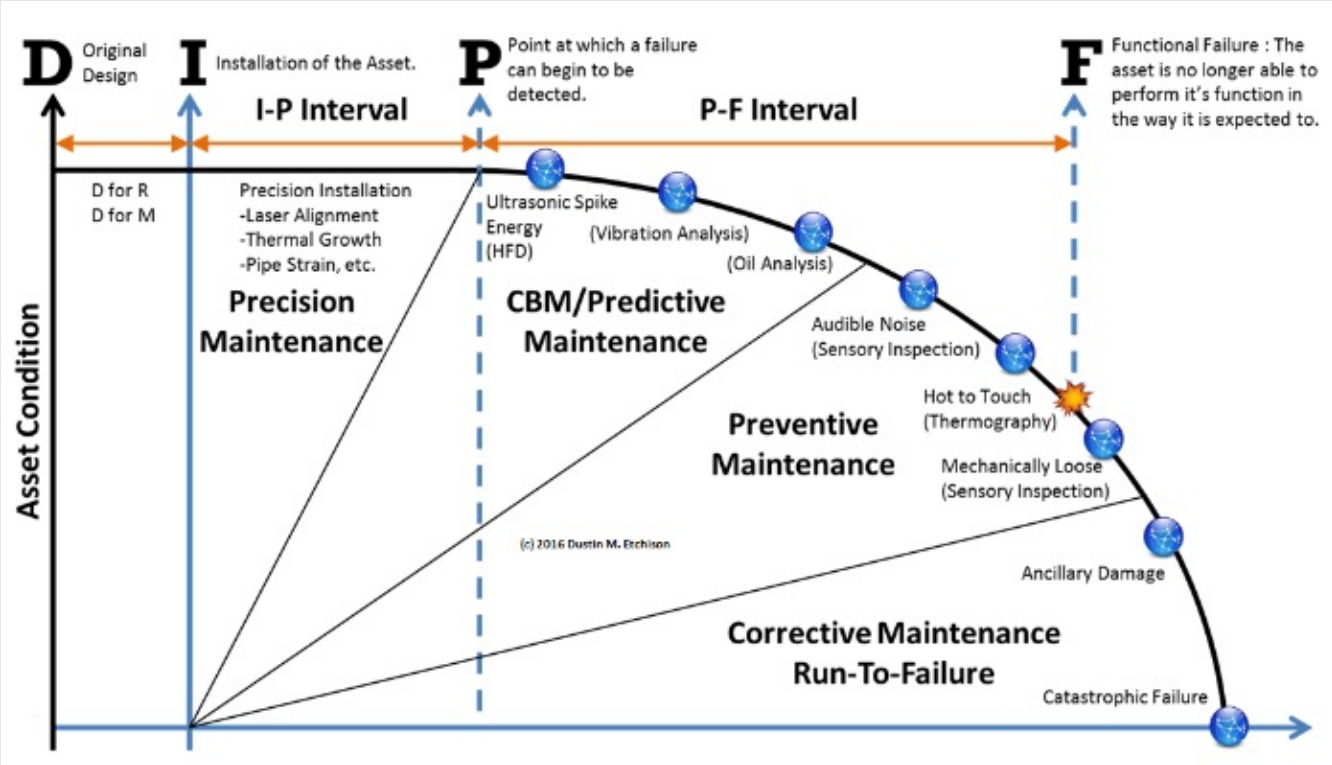
Not All Assets are Equal/One Shoe Does Not Fit All

# Risk Management and Equipment Classification

		Impact				
		Very Low	Low	Medium	High	Very High
Likelihood	Very High					
	High					
	Medium					
	Low					
	Very Low					

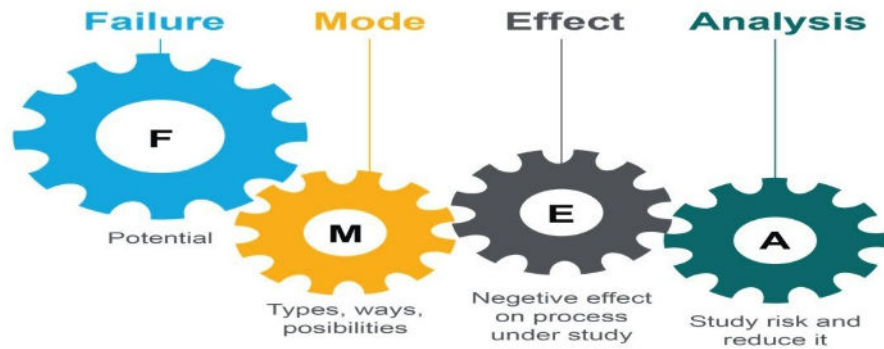
Equipment Number	Description	Criticality Evaluation					Criticality Ranking
		Safety	Environment	Quality	Economical	Total =	
PE-002	Pump xyz	4	4	4	1	64	A
PE-005	Pump ABC	4	4	4	2	128	B
VE-100	Blower YYZ	4	4	4	3	192	C
AG-201	Agitator DBC	0	1	4	4	0	A
CL-403	Air Conditioning	4	4	4	4	256	D

Evaluation Score	Criticality Ranking	
$0 \leq \text{Criticality} \leq 96$	<i>Extreme</i>	= A
$97 \leq \text{Criticality} \leq 145$	<i>High</i>	= B
$146 \leq \text{Criticality} \leq 193$	<i>Moderate</i>	= C
$194 \leq \text{Criticality} \leq 256$	<i>Low</i>	= D



Proactive Approach  
Touches and Impacts  
Curve Optimization

DIPF Curve



# Commitment to FMEA and RCA

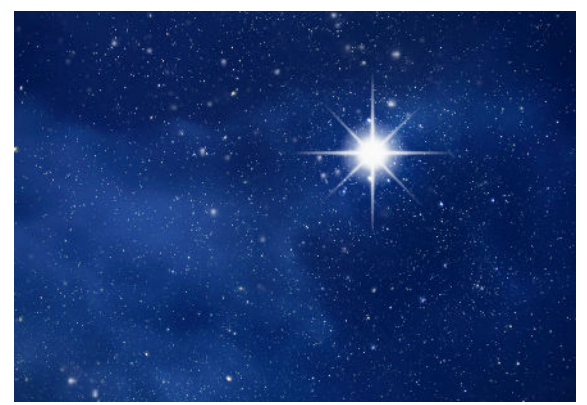
Look for Degradation Cause and Detection Methods

Share Example Standards to Operationalize

# Establish an Asset Management Framework

## North Star to align

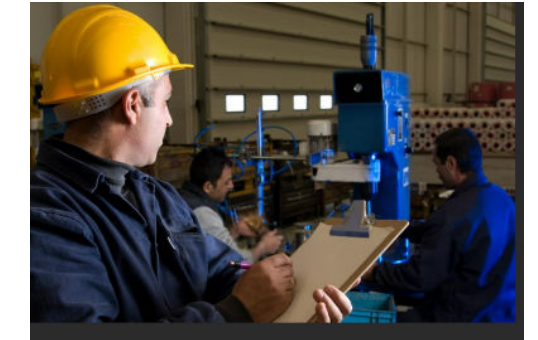
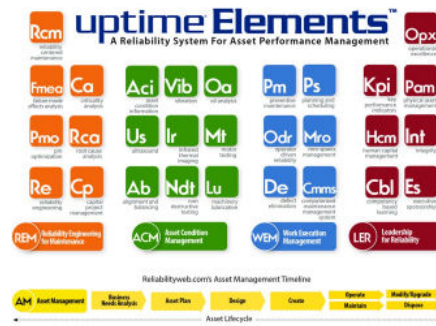
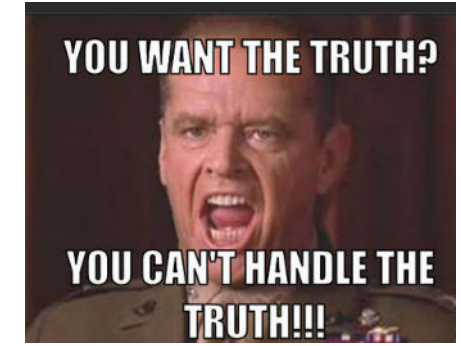
### Assess for Continuous Improvement



Reliabilityweb.com's Asset Management Timeline



# Internal and External Periodic Assessments

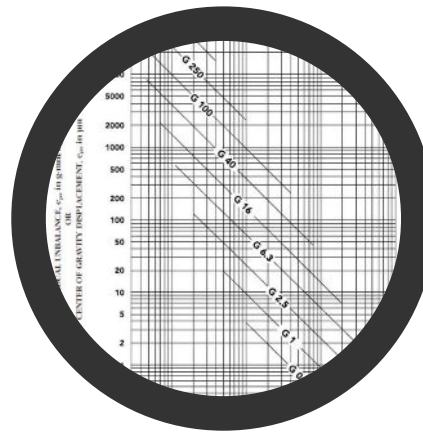


# Gaps Drive Actions


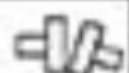


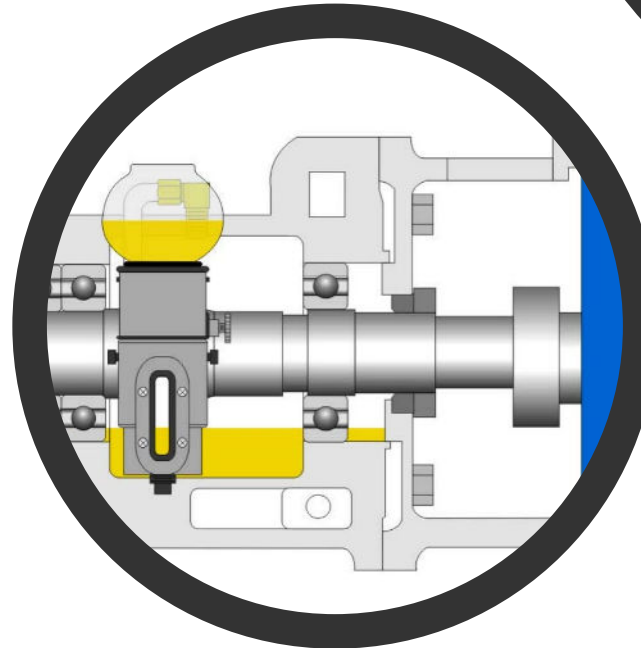
# New/Repair Equipment Design Standards

- Design for Needed Capacity
- $L^3/D^4$  for Shaft Stiffness
- Bases and Foundations
- Balance/Alignment/Fits/Clearances
- Lubrication
- Critical Spares Management
- Vendor selection



### TOLERANCES FOR SHAFT ALIGNMENT

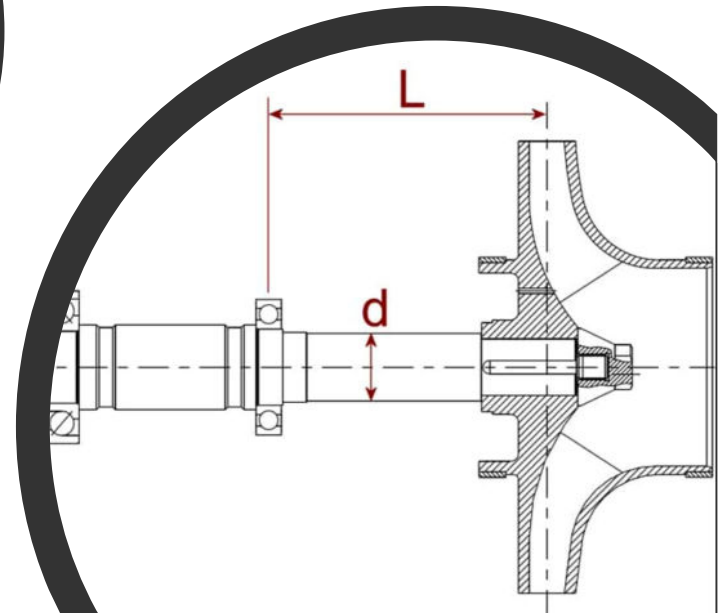
RPM	OFFSET 		GAP 		SPAC SHAFT (mils/10")
	Excellent	Fair	Excellent	Fair	
500	5.0	9.0	10.0	15.0	1.8
1000	3.0	6.0	7.0	10.0	1.2
1500	2.5	4.0	5.0	8.0	0.9
2000	2.0	3.0	3.0	5.0	0.6
3000	1.0	1.5	2.0	3.0	0.3
4000	1.0	1.0	1.0	2.0	



### RADIAL INTERNAL CLEARANCE

#### FOR BALL BEARING - NO LOAD METHOD

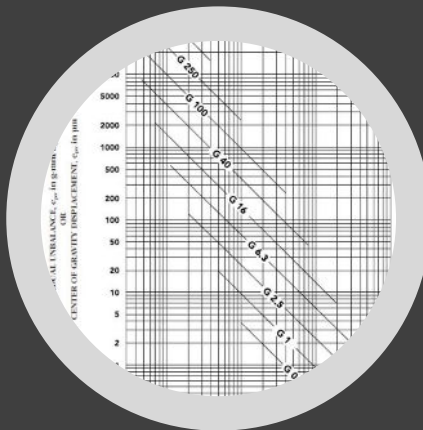
Incl	C2		Standard		C3		Incl
	Low	High	Low	High	Low	High	
10		3	1	5	3	9	6
18	0	3.5	1	7	4	10	7
24		4	2	8	5	11	8
30		4.5	2	8	5	11	9
40	0.5	4.5	2.5	9	6	13	11
50		4.5	3.5	11	9	17	15
65		6	4	12	10	20	18
80		7	4.5	14	12	23	21
100		8	6	16	14	26	24







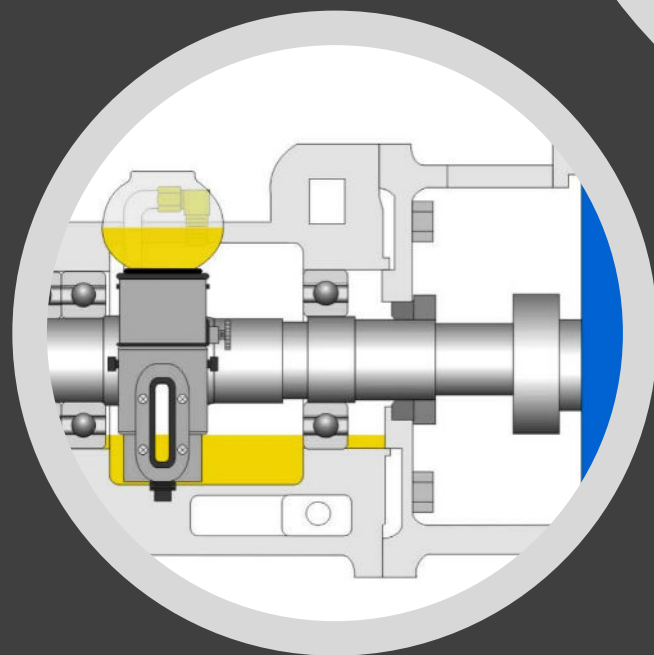
# New/Repair Equipment Installation Standards

- Bases, Foundations, Pipe Strains
- Balance/Alignment/Fits/Clearances/Flows/Pressures
- Spare Part Verification
- Vibration
- Lubrication
- Supervision and Sign off and follow up
- Repair shop expectations

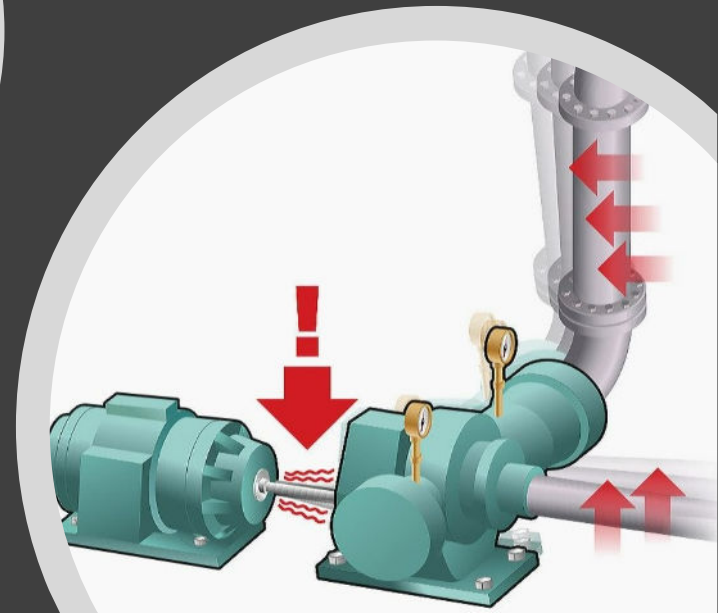


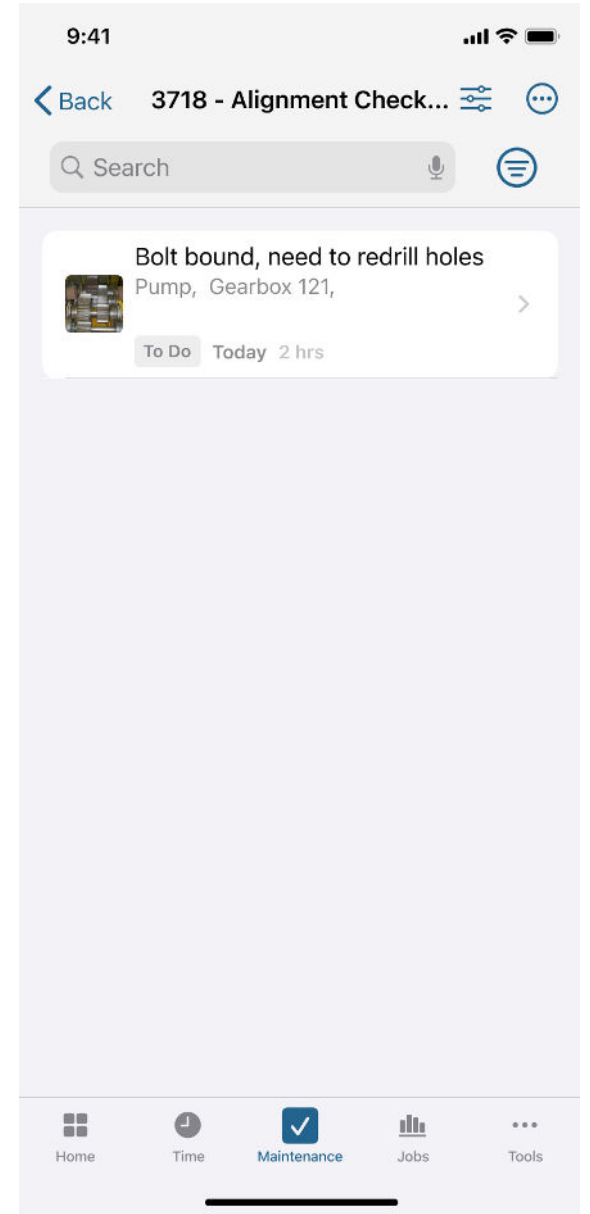
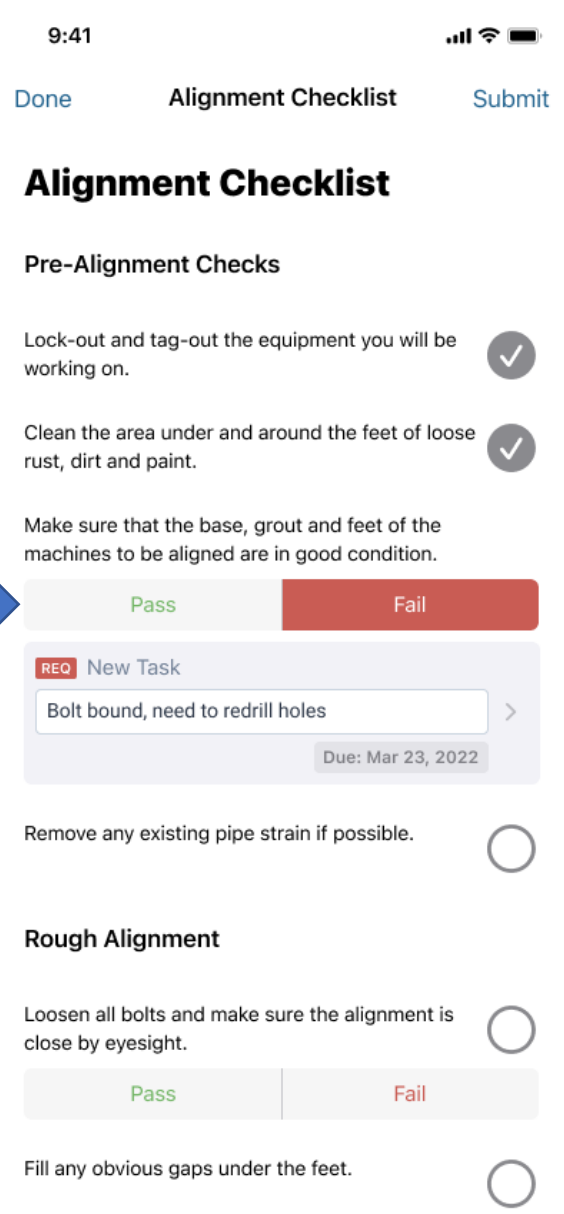
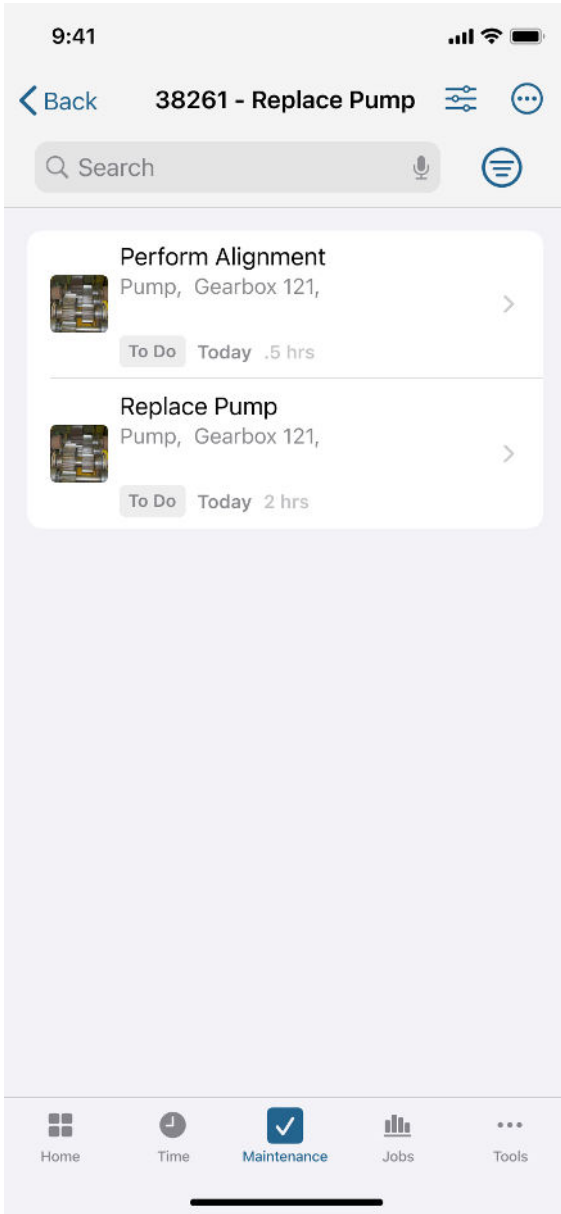
## TOLERANCES FOR SHAFT ALIGNMENT

RPM	OFFSET 		GAP 		SPAC SHA (mils/10")
	Excellent	Fair	Excellent	Fair	
500	5.0	9.0	10.0	15.0	1.8
750	3.0	6.0	7.0	10.0	1.2
1000	2.5	4.0	5.0	8.0	0.9
1500	2.0	3.0	3.0	5.0	0.6
2000	1.0	1.5	2.0	3.0	0.3
3000	1.0	1.0	1.0	2.0	



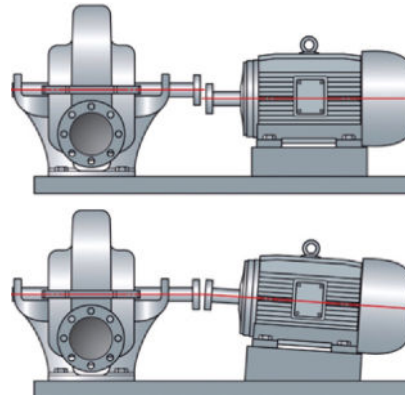
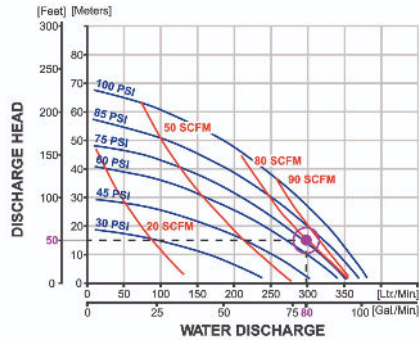
Incl	C2		Standard		C3		Incl	
	Low	High	Low	High	Low	High		
10		3		5	3	9	6	
18	0	3.5	1	7	4	10	7	
24		4	2	8	5	11	8	
24	30	0.5	4.5	2	8	6	13	11
30	40		4.5	2.5	9	7	14	12
40	50		6	3.5	11	9	17	15
50	65		6	4	12	10	20	18
65	80		7	4.5	14	12	23	21
80	100		8	6	16	14	26	24
100	120							



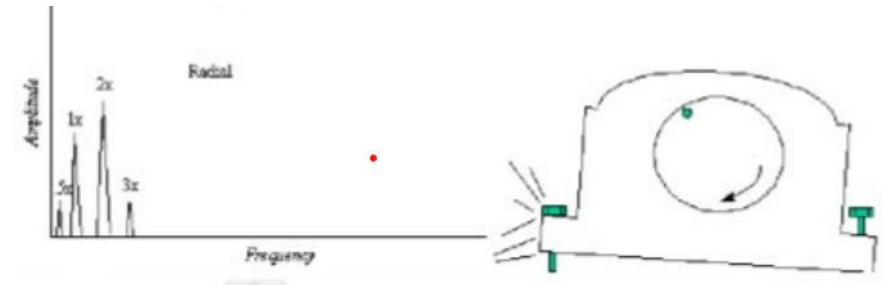


# Condition Monitoring to Attack Forcing Functions

- Performance curve compliance
- Alignment/soft foot
- Balance
- Resonance
- Looseness
- Lube Oil Contamination

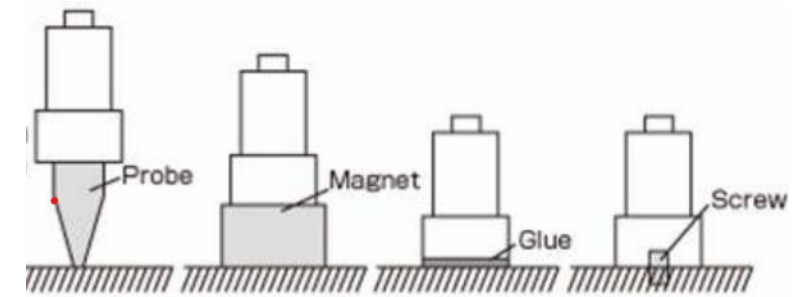
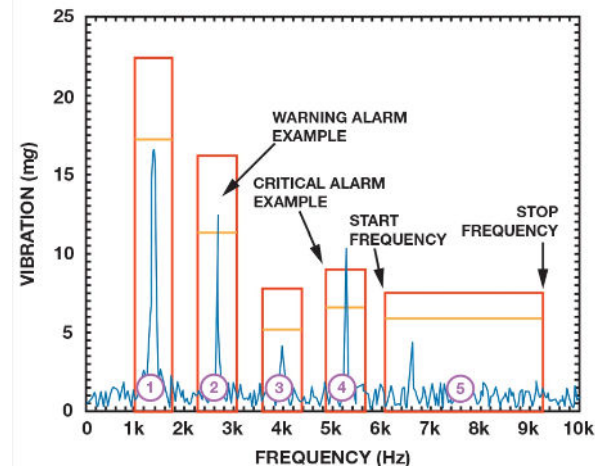
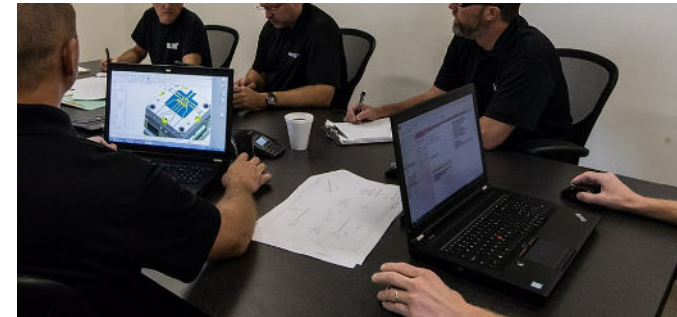
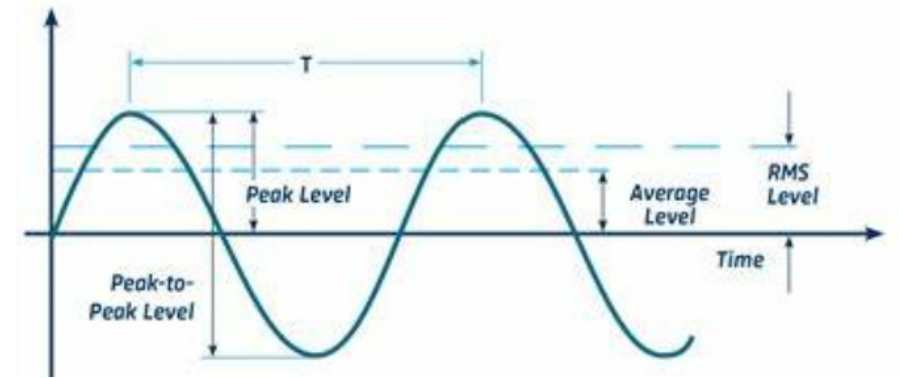
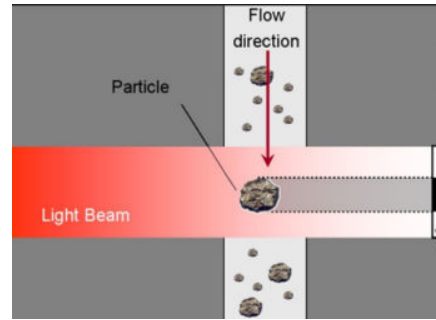


$$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$$



# Condition Monitoring Standards

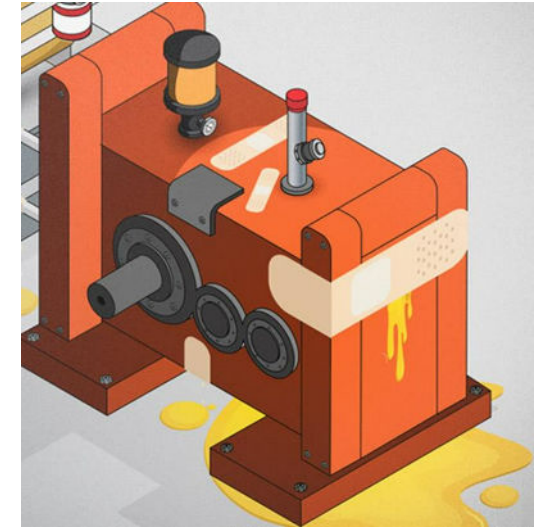
- Parameters Measured
- Data Collection/Analysis Methods
- Frequency of collection
- Data Averaging
- Data Analysis/Alarming
- Communications



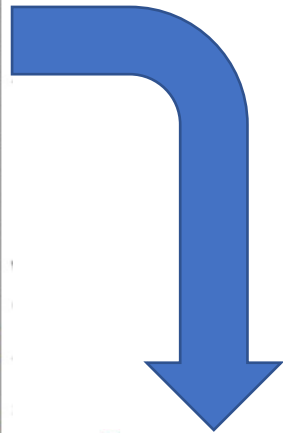
# Lubrication Excellence Standards

- Lube Selection
- Cleanliness (specifications, S&H, system filtration, CC, monitoring)
- Degradation management
- Optimize oils changes/re-lube
- Application (procedures, feed rates, levels, pressures, workflow/routes, etc.)
- Leakage Control
- Audits

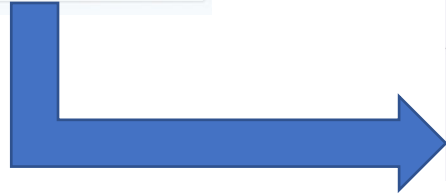
Type of Hydraulic System	Minimum Recommended Cleanliness Level			Minimum Recommended Filtration Level in Microns ( $\beta_x \geq 100$ )
	ISO 4406	NAS 1638*	SAE 749D	
Silt sensitive	13/10	4	1	2
Servo	14/11	5	2	3 to 5
High pressure (250 to 400 bar)	15/12	6	3	5 to 10
Normal pressure (150 to 250 bar)	16/13	7	4	10 to 12
Medium pressure (50 to 150 bar)	18/15	9	6	12 to 15
Low pressure (< 50 bar)	19/16	10	-	20
Large clearance	21/18	12	-	25



Sample Info	Report Status	Alert
	Sample ID	21209199008
	Service Level	Enhanced
	Bottle ID	b051126535
	Tested Lubricant	NIUTO H 46
	Sampled	16 Jul 2021
	Reported	02 Aug 2021
	Equipment Age	
	Oil Age	
	Make-up Volume	
Oil Changed		
Filter Changed		
Lubricant	Contamination Rating	Alert
	Equipment Rating	Normal
	Lubricant Rating	Normal
	Diluted ISO Code (4/6/14)	21/16/13
	Particle Count (Diluted) >4um	64,915
	Particle Count (Diluted) >6um	2,301
	Particle Count (Diluted) >14um	227
	PQ Index	27
	Visc@40C (cSt)	41.6
	Oxidation (Ab/cm)	3
Wear (ppm)	Water (Vol%)	0.023
	Ag (Silver)	2
	Al (Aluminum)	1
	Cr (Chromium)	1
	Cu (Copper)	3
	Fe (Iron)	37
	Mo (Molybdenum)	0
	Ni (Nickel)	0
	Pb (Lead)	1
	Sn (Tin)	0
Contaminant (ppm)	K (Potassium)	0
	Na (Sodium)	4
	Si (Silicon)	10
Additive (ppm)	B (Boron)	53
	Ba (Barium)	1
	Ca (Calcium)	2023
	Mg (Magnesium)	16
	P (Phosphorus)	789
Zn (Zinc)	843	



Task Number	Due Date	Status	Asset ID	Asset Description	Task
438513	2/21/2023	To Do	#21	Hydraulic System	-
438512	2/21/2023	To Do	#21	Hydraulic System	-

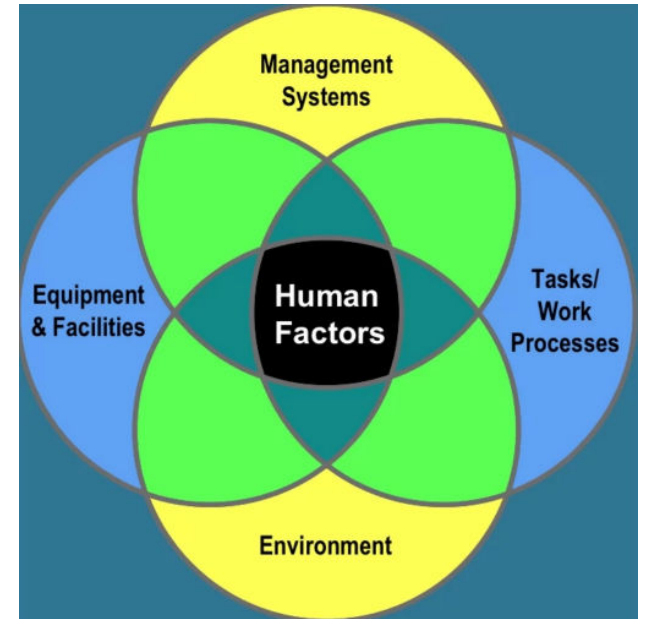


# People (Asset) Excellence

- Leadership and empowerment
- Invest in people development
- Engineer the Human Factor
- Double down on supervisor excellence
- Certification and coaching
- Reward & motivate



- ✓ MLTI
- ✓ MLTII
- ✓ MLAI
- ✓ MLAII
- ✓ MLAIII
- ✓ MLE



# Summary/Steps to consider next

- Build Case for Action
- Gain Management Support/Establish Champions
- Go After a Few Low Hanging Fruit/Reward Success/Build On Success
- Prepare for Root Cause Push Back
- Leverage the Right Tools (CMMS, RCA, FMEA, Vendors, etc.)
- Make Systemic Changes for Sustainment
- **Take measured risks, do not be afraid of mistakes, INNOVATE**
- **HAVE FUN!**