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Optimizing Preventive Maintenance

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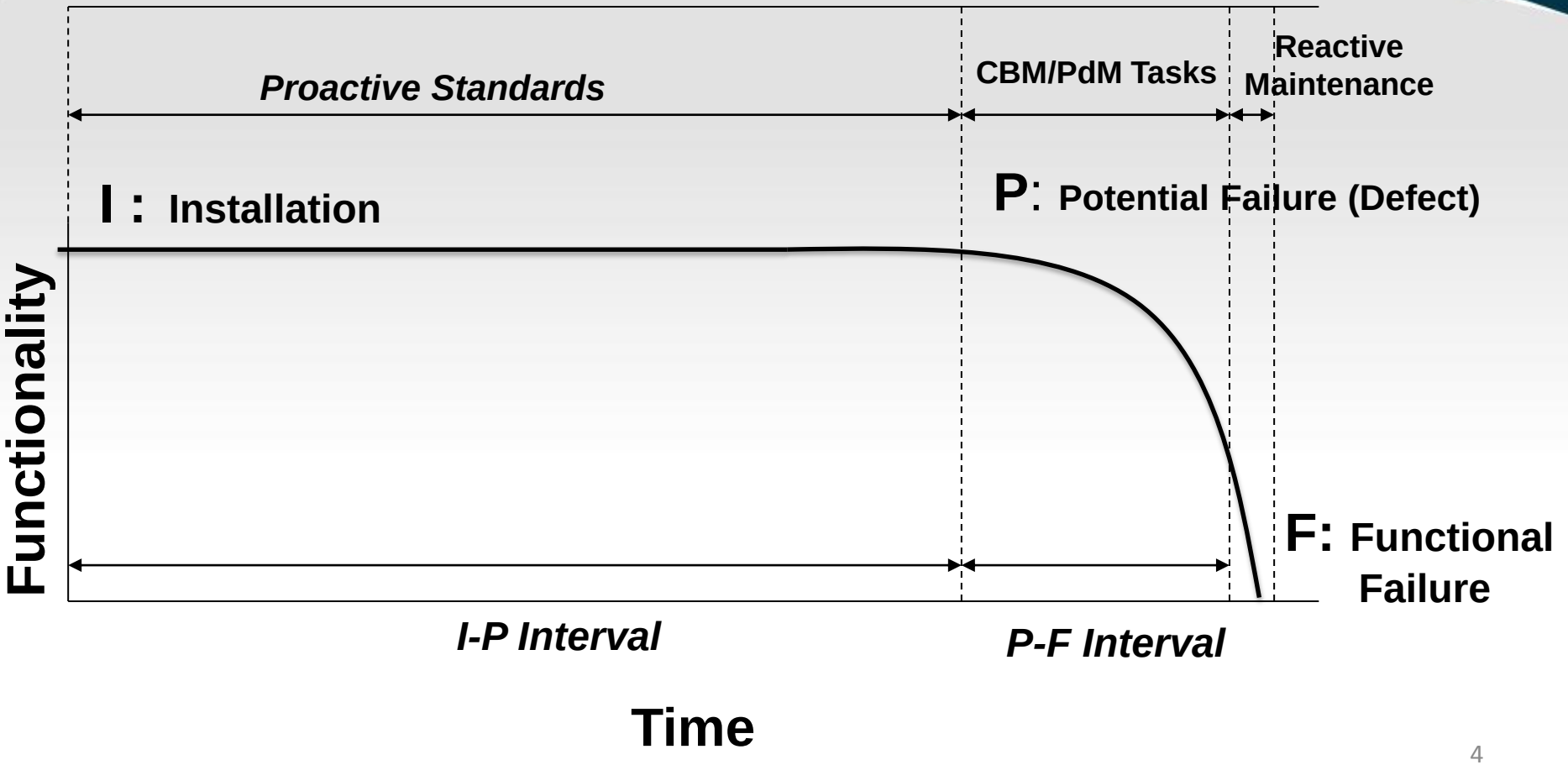
My Deliverable

- Preventive Maintenance (PM) programs are often the base of every organization's reliability plans. However, too often they become the repository of desperate measures to placate the organization and half formed root cause analyses. A proactive PM program must be under systemic evaluation to continue to give the results organizations demand.
- I will show you how to evaluate your current PMs to ensure that they are producing proactive, valuable results. In addition, I will show you a systemic evaluation method that you can begin using today to keep your program fresh and in tune with your organization's changing needs and expectations.

Definitions

- Preventive/Routine Maintenance
  - Time Based Replacement
  - Condition Based
  - Sensory
- Criticality
  - Equipment relative importance
  - Used for allocating assets

The I-P-F Curve



Equipment Health Strategies

- Run to failure
- Time based replacement
- Instrument inspection
  - Non-Destructive Testing (NDT)
  - PdM/CBM tools and gauges
- Conditional Trending
- Constant Monitoring (Alarms)

Routine Maintenance (PM)

Misconceptions About PM

1. PM systems are all the same. You can just copy the system from the manual or from your old job and it will work.
   - PM systems must be designed for the actual equipment as set up, age of the equipment, product, type of service, hours of operation, skill of operators, and many other factors.
2. PM is extra work on top of existing workloads and it costs more money.
   - PM increases uptime, reduces energy usage, reduces unplanned events, reduces airfreight bills, etc. There are hundreds of ways PM saves the organization resources.
   - The only time it is in addition to the existing workload is at the startup when you put a PM system into place. You will have to spend extra to fund monies not invested into the equipment in the past (pay for past sins).
3. With good forms and descriptions, unskilled people can do PM tasks.
   - Unskilled (in maintenance) people can do some of the PM tasks successfully with good training and clear forms. For greatest return on investment, skilled people must be in the loop. TLC activities (such as lubrication, cleaning, or tightening bolts) can certainly be done by trained but not maintenance employees. Generally, inspection benefits greatly from experienced eyes and hands.
4. PM will eliminate breakdown.
   - The equipment must be able to do the job. PM cannot make a 5 hp motor do the work of a 10 hp motor. Even with the most advanced PM, there will still be breakdowns from abuse, misapplication, or accident.
   - Some failure modes do not currently lend themselves to PM approaches (such as some electronics failures).

Process Elements

- PM Policy
- Assets
- Equipment Maintenance Plans (EMP)
- Preventive Maintenance Optimization

PM Policy

Purpose:

- To prevent unscheduled breakdowns while maintaining lowest cost
  - To identify and correct defects before
    - They effect performance
    - They cause subsequent degradation
  - To cost effectively maintain the facility
    - Safety / Environmental (Regulatory)
    - Competitive in market place

Advocate:

- Individual assigned to ensure effectiveness of PM program
- Has authority and budget to execute PM program

Process Elements

- PM Policy
- Assets
- Equipment Maintenance Plans (EMP)
- Preventive Maintenance Optimization

Assets

- Do you know what you have?
- Are they all still there?
- Has criticality been defined?
- Is there a seasonal criticality?

Equipment Criticality

- Not all equipment is equal
  - Standardize Criticality
  - Write it down
  - Re-assess when business changes
- Determine necessary results
- Maintain to those results

Process Elements

- PM Policy
- Assets
- Equipment Maintenance Plans
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Equipment Maintenance Plans

- Failure modes
  - FMEA/RCM
  - Root Cause Analysis: must go to Systemic and Latent roots
  - Anecdotal information
  - OEM/Industry recommendation
- Criteria for Action/Task
  - Random or life cycle failure
  - Accessibility to equipment or component
  - Equipment Health Strategy
  - Effect of failure
- Frequency
  - <1/2 Failure (P-F) timeline

Current PMs (Example)

Dept	Asset	Criticality	PM/Tasks	Frequency	# People	Duration	Hours /Year	Yearly Materials
100	B123	950	Sample Oil	M	1	0.25	3	$ x.xx
100	B123	950	Change Filter	SA	2	1	4	$ xx.xx
100	B123	950	Check Vibration	M	1	0.25	3	
100	**B126**	**980**	**Change Oil**	**Q**	**1**	**1**	**4**	**$ xx.xx**
100	**B126**	**980**	**Sample Oil**	**M**	**1**	**0.25**	**3**	**$ x.xx**
100	**B126**	**980**	**Check Oil**	**Y**	**1**	**0.5**	**0.5**	**$ x.xx**
100	**B126**	**980**	**Check Vibration**	**M**	**1**	**0.25**	**3**	
100	B127	700	Inspect Filter	W	1	0.25	13	
100	B127	700	Change Oil	Q	1	1	4	$ xx.xx

- Create 52 Week Load Report
- Balance work load

Equipment Maintenance Data

- 52 Week PM plan
- Failure data (MTBF)
  - By individual equipment
  - By equipment class
- Resource utilization by equipment
  - Labor
  - Materials
  - Utilities

Inspection frequency: Outage

- PMs designed to identify shut down overhaul work should be performed at least 1.5 times before the normal lead time of parts to be ordered.
- For instance, if it takes 3 months to get new parts, and outage is at a specific date, equipment inspection PMs should be performed at least 4.5 months before the outage is scheduled.
- This means these 'inspection' PMs need to be in the system.

Process Elements

- PM Policy
- Assets
- Equipment Maintenance Plans
- Preventive Maintenance Optimization

PM Optimization: Task Evaluation

- Does it prevent a failure?
- Does the failure need to be prevented?
- Is there a better way to do it?

PM Evaluation – Existing System

PM Task Action Recommendation	# of Tasks	% of Tasks	Man-Hours Represented	% Man-Hours
Non-Value Added (Delete)	1,640	8%	6,661	8%
Replace with CBM/PdM	6,437	32%	28,222	32%
Reengineer	5,200	26%	26,221	30%
No Modifications Required	6,723	34%	26,192	30%
Totals	20,000	100%	87,296	100%

Source: Allied Reliability Group Assessment at a Steel Mill

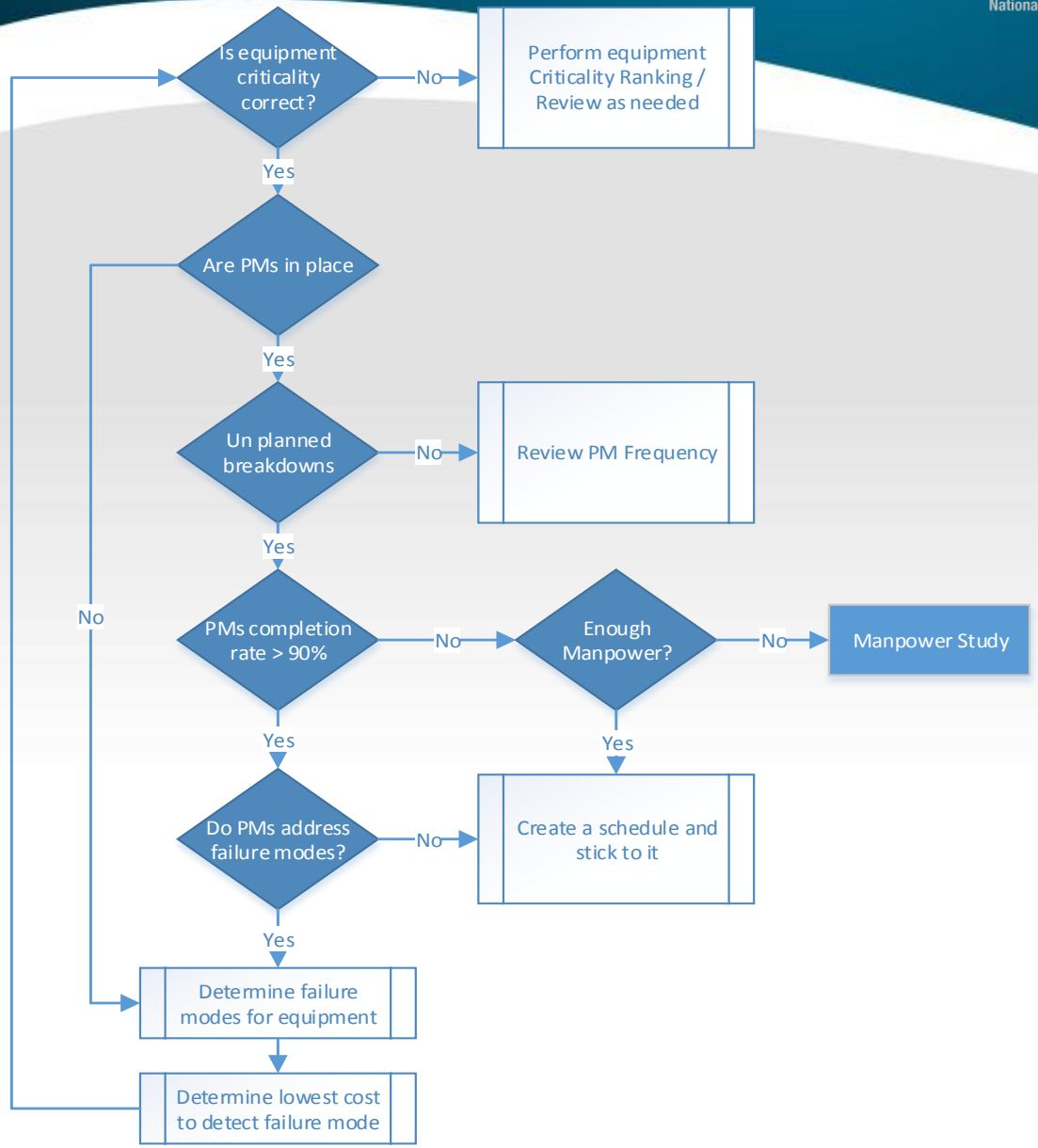
PM Review / Refresh

- Intervals for Preventive Maintenance tasks are reviewed frequently and adjusted to optimize costs and equipment needs.
- Review 20% of equipment each year:
  - Review at least 10% of top critical equipment
  - Review 10% of less critical equipment
- This would result in 2% of PMs reviewed each month with 2 months grace for shutdowns and vacations.

Review PMs Yearly

- If alterations are necessary, do content first then frequency of PM
- PM Content
- PM Frequency / Efficiency

PM Effectiveness



Time Investment

- Criticality: 30-100 assets/hour
- Current 52 week plan: 2 hours
- Current resource utilization: 4 hours
- Breakdown / MTBF: 8 hours
- PM Optimization review: Method Dependent
  - Individual PM: Time to perform it

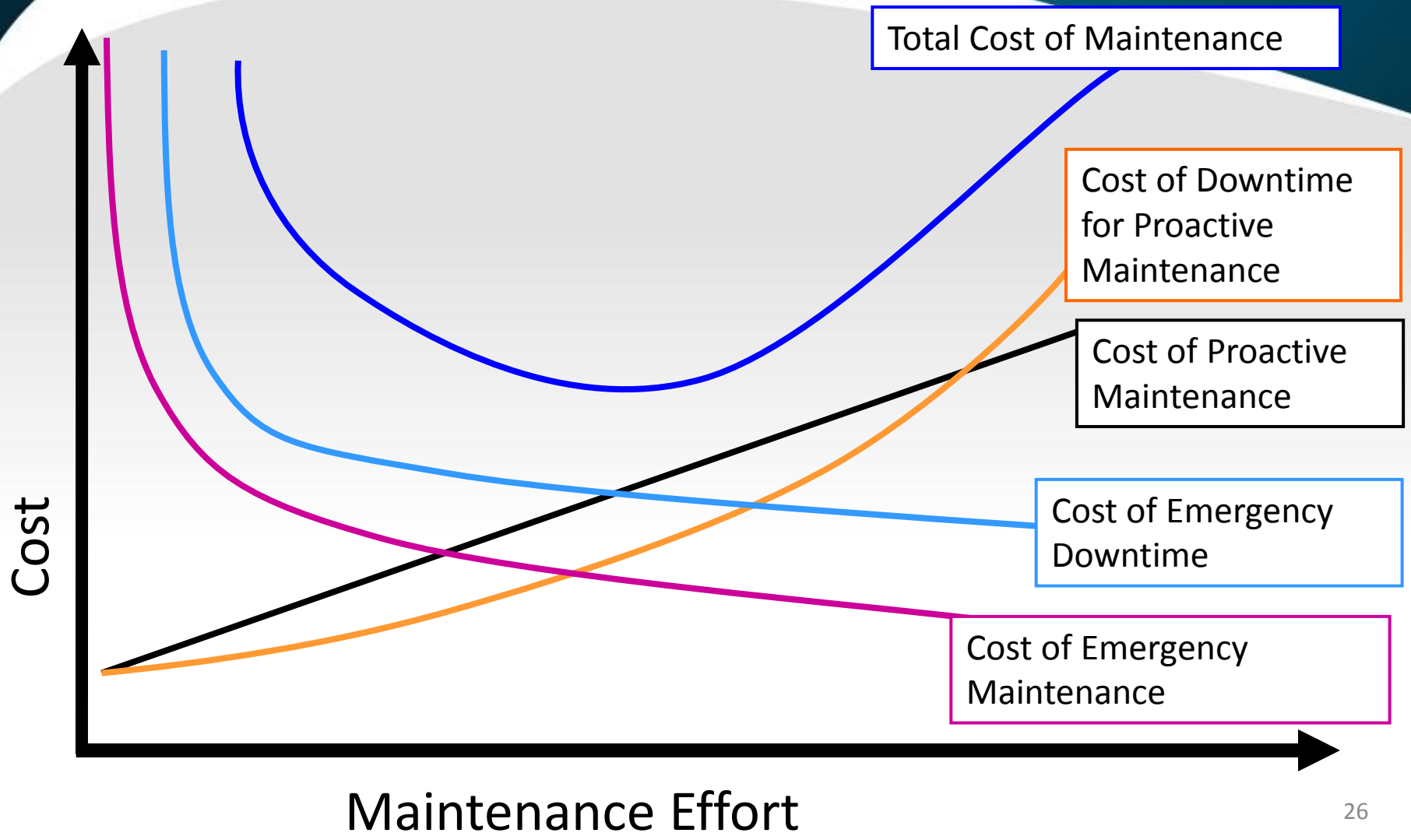
Asset Investment

- Condition Monitoring
  - Real Time
  - Tools (MCA, Ultrasound, Infrared, Vibration, …)
- Accessibility Improvements

Payback Opportunities

- Reduced material costs
- Improved equipment life (delay capital)
- Reduced labor
  - Contract Labor
  - Overtime
- Reduced energy cost
- Reduced MRO inventory

Total Cost of Maintenance



Optimizing Preventive Maintenance

Questions / Comments?

Poor Root Cause Analyses

Defect: Flight attendant cold at altitude.
Action: Ground checks OK.

Defect: 3 roaches in cabin.
Action: 1 roach killed, 1 wounded, 1 got away.

Defect: Weather radar went ape!
Action: Opened radar, let out ape, cleaned up mess!

Defect: Left inside main tire almost needs replacement.
Action: Almost replaced left inside main tire.

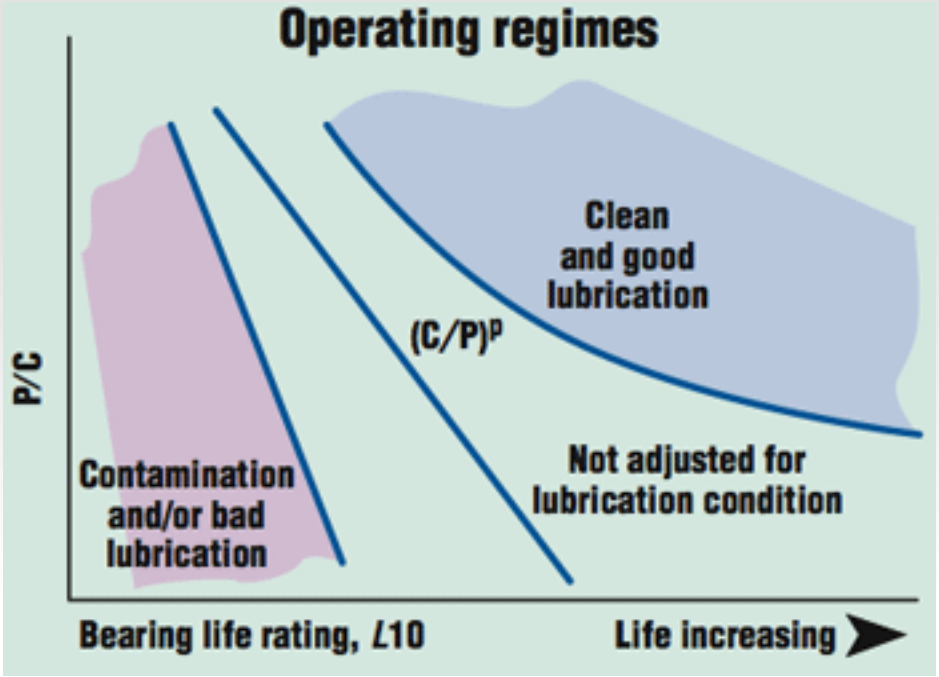
Defect: Something loose in cockpit.
Action: Something tightened in cockpit.

Defect: Evidence of leak on right main landing gear.
Action: Evidence removed.

Defect: DME volume unbelievably loud.
Action: DME volume set to more believable level.

Defect: Test flight OK, except auto-land very rough.
Action: Auto-land not installed on this aircraft.

Bearing L10 Life



Relative effects of contamination and lubrication condition on bearing life with different load levels

Source: http://machinedesign.com/bearings/meaning-bearing-life