Defining Equipment Reliability

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Reliability measures the capacity of equipment or processes to operate without failure for a time interval when put into service and operated correctly.

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Reliability Is?

- **Reliability is concerned with avoiding failures of equipment and processes by proper design and careful operation of the equipment by trained personnel in a specified environment for a given time interval.**
- **The ultimate aim of reliability is a failure free environment.**

MIL-HDBK-338: Reliability- 1) The duration or probability of failure-free performance under stated conditions. 2) The probability that an item can perform its intended function for a specified interval under stated conditions.

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Which Is More Important?

- **Avoiding failures OR fixing failures?**
  - – You cannot repair yourself to happiness!
- **Equipment OR processes?**
  - – Equipment = pawns, Processes = king
- **Trained operators OR maintainers?**
  - – Untrained operators can break equipment faster than trained maintainers can repair

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Maintenance Is?

- **Maintenance is concerned with retaining function or quickly correcting failures, by use of <u>trained employees</u> using <u>correct procedures</u>.**
- **The ultimate aim of maintenance is minimizing maintenance costs and downtime to keep equipment operating as designed.**

MIL-HDBK-338: Maintenance-All actions necessary for retaining an item in or restoring it to a specified condition.

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Business Is?

- Business is all about making money. This is a balance between avoiding failures, repairing failures, and keeping the process operating to make money.
- In the end, reliability and maintenance are all about money.
- The ultimate aim of business is satisfying customers with on-time deliveries of quality products while producing a satisfactory long-term return for stockholders.

Which Is More Important?

- In business:
  - The process is the king → big $'s!
  - The pawns are the equipment → little $'s.
- For the business you must think:
  - Top down
  - Prioritize by use of $ Pareto distributions
  - Unemotionally rather than love affairs
  - Protect the money stream

Engineers Are---?

- **Reliability Engineers-Strategic Assets**
  - **Dedicated to mainly preventing failures**
- **Maintenance Engineers-Tactical Assets**
  - **Dedicated to mainly correcting failures**
- **You need ~10 Maintenance Engineers to every 1 Reliability Engineer**
  - **No increase in plant head count**

Need job descriptions?:
http://www.barringer1.com/jobdescriptions.htm

Get Organized

- Most mangers talk about reliability but emphasize maintenance they cross communicate!!
  - **Get your organization right**
  - **Get your emphasis right—say the right things**
  - **Get your motivation right—what's the reward?**
  - **Be consistent—no wishy-washy positions!**
  - **Work for long terms improvements**
  - **Work your Pareto list based on $'s**

Attack Problems Top Down

- You've got to know **where** to attack & **what** to do
- Do you accept the risk of failure?
  - $Risk = (probability of failure)*$Consequence of failure
  - This is the do-nothing case. Can you afford it? What are your alternative**s**? Price out the details—say it in $'s.
- Do you reject the risk of failure?
  - Measure your alternatives against the do nothing case
  - Don't take too much risk. You can't afford the exposure.
  - Don't take too little risk. Timidity waste money.

What's your personal risk allowance?: See your SAP signature authority.

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Where To Improve

- Go for the money—not your love affair!
- Does the system need improvement?
- Does a device need improvement?
- Does a component need improvement?
- What are your alternative**s**?—say it with money
- Can you avoid the big $ problems by an alternative called redundancy—think of the Gordian knot solution

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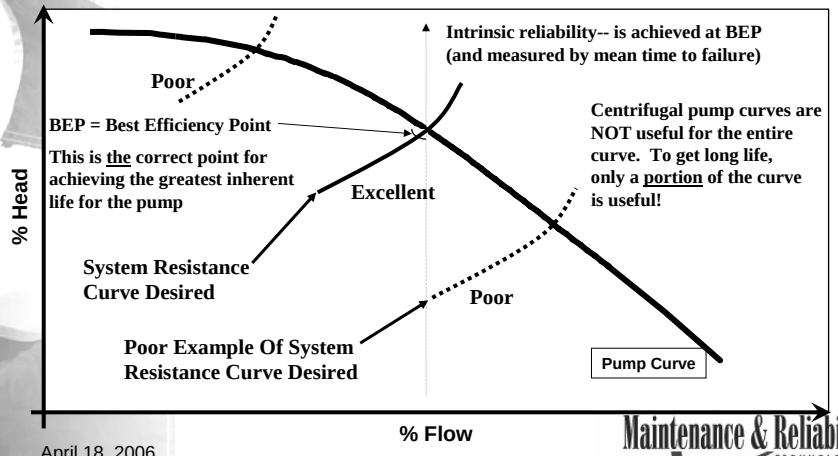
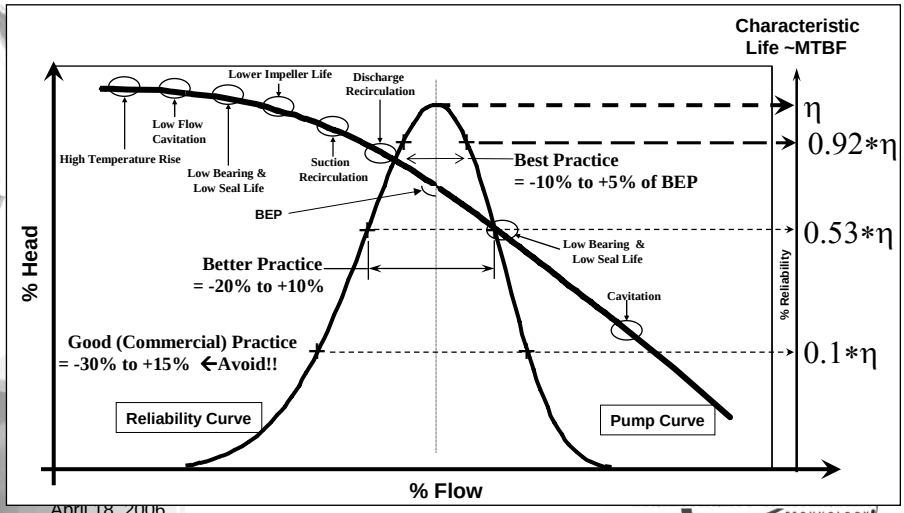
Best Place For Gains?

- Improve **people performance**—~38% of problems
  - Make it easy for people to do right & hard to do wrong
- Improve **procedures and practices**—~34%
  - Write it down correctly and train, train, train
- Improve **hardware**—~28% of problems
  - Hardware problems may disappear if above corrected
- Engineers, by nature, think reliability issues are resolved with hardware and components and thus they often work on the wrong issues!

The Pump Curve Issue



Pump Curve Practices



Pump Practices vs Life

Do		Pump Curve % Off BEP	L/D Suction Straight Runs	Rotational Shaft Alignment	Piping Alignment	Rotational Balance	Foundation Design	Grouting
Best Practices	Resulting eta Multiplier	+ 5% to -10% of BEP	L/D = 10 to 12	±0.001 inches/inch error	±0.003 inch error	Smooth at 0.0198 ips	5 Times Equipment Mass	Monolithic And Adhesive Epoxy
Impeller	0.9726	98%	100%	100%	100%	100%	100%	100%
Housing	0.8547	86%	100%	100%	100%	100%	100%	100%
Pump Bearings	0.8719	98%	100%	100%	100%	99%	100%	100%
Mech. Seal	0.9533	98%	99%	100%	100%	100%	100%	100%
Bearing Seal	0.8719	98%						
Shaft	0.9801	98%						
Coupling	1.0000	99%						
Motor Bearings	1.0000	100%						
Replacement Mtr.	1.0000	99%						
Motor Starter	1.0000	100%						

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Maybe		Pump Curve % Off BEP	L/D Suction Straight Runs	Rotational Shaft Alignment	Piping Alignment	Rotational Balance	Foundation Design	Grouting
Better Practices	Resulting eta Multiplier	+ 10% to -20% of BEP	L/D = 6 to 8	±0.003 inches/inch error	±0.010 inch error	Good at 0.0448 ips	3.5 Times Equipment Mass	Slightly Pourous But Adhesive
Impeller	0.6583	88%	95%	95%	94%	95%	95%	98%
Housing	0.5163	73%	95%	95%	92%	95%	95%	95%
Pump Bearings	0.3950	79%	90%	88%	88%	90%	90%	90%
Mech. Seal	0.4314	88%						
Bearing Seal	0.3950	88%						
Shaft	0.5705	79%						
Coupling	0.6036	92%						
Motor Bearings	0.9776	94%						
Replacement Mtr.	0.6036	100%						
Motor Starter	1.0000	100%						

Avoid!		Pump Curve % Off BEP	L/D Suction Straight Runs	Rotational Shaft Alignment	Piping Alignment	Rotational Balance	Foundation Design	Grouting
Good Practices	Resulting eta Multiplier	+15% to -30% of BEP	L/D = 1 to 3	±0.009 inches/inch error	±0.125 inches error	Rough at 0.248 ips	0.5 Times Equipment Mass or Stilt-Mounted	Cementitous & Low Adhesion
Impeller	0.1949	68%	75%	90%	69%	81%	88%	88%
Housing	0.1438	70%	80%	83%	64%	79%	78%	80%
Pump Bearings	0.0151	65%	60%	58%	40%	61%	50%	55%
Mech. Seal	0.0095	65%	60%	58%	40%	61%	50%	55%
Bearing Seal	0.0151	51%	60%	40%	40%	64%	55%	55%
Shaft	0.1149	65%	60%	58%	40%	61%	50%	55%
Coupling	0.0737	76%	80%	65%	71%	78%	70%	75%
Motor Bearings	0.8625	78%	80%	55%	80%	75%	60%	60%
Replacement Mtr.	0.0737	100%	100%	100%	100%	100%	100%	100%
Motor Starter	1.0000	100%	100%	100%	100%	100%	100%	100%

Reliability practices must be connected with costs to find the lowest long term cost of ownership calculated by net present value.

Summary

- Get your reliability program right
- Think about reliability issues strategically
- Look for gains first via people, second by processes and procedures, and last by way of components—many component issues disappear when people/processes/procedure issues are solved to achieve inherent component reliability!
- Make money decisions—watch your love affairs!