

Do as little as possible

Why shutdown at all?

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Why do shutdowns?

Some work requires equipment off-line

Some equipment can't be taken off-line without taking a plant (or line) down

So why do we do any more work than that?

Impact

Production is down
Revenue is lost (opportunity cost)
Maintenance cost is high

- Usually there are many involved



Conscious Asset Management

Keep it short

To minimize business impact we keep shutdowns as short as possible

- Extensive planning (more than usual)
- Critical path is watched closely
- Scope is locked down early
- Additional scope is added only with highest levels of approval

But...

- From the outset there is a tendency to add a lot of scope out of “convenience”
 - › It is easier to do most work when shut down, but it isn't always necessary

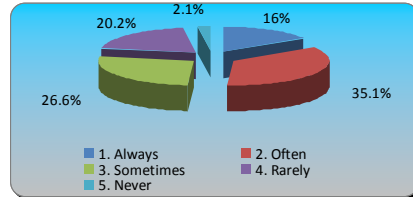


Conscious Asset Management

Does your plant or facility schedule work that does not really need to be done in a shutdown, just because it's convenient?

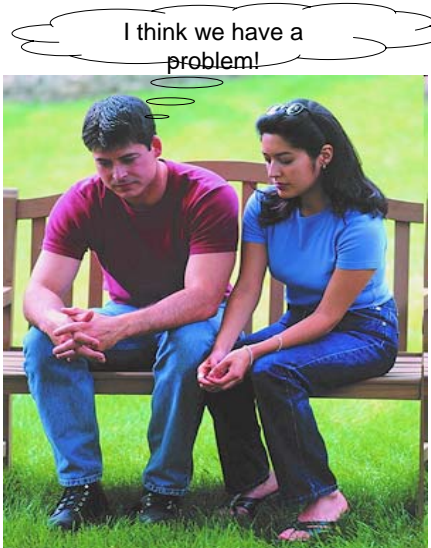
Always
Often
Sometimes
Rarely
Never

| | | |
|---------------|-----------|-------------|
| 1. Always | 15 | 15.96% |
| 2. Often | 33 | 35.11% |
| 3. Sometimes | 25 | 26.60% |
| 4. Rarely | 19 | 20.21% |
| 5. Never | 2 | 2.13% |
| Totals | 94 | 100% |



Work identification

- Predictive maintenance reveals need well in advance**
- Preventive maintenance**
 - Faults are discovered during this work
- Other faults that are evident before shutdown**
- And then some are found during work execution**
 - New faults detected



What about “found work?”

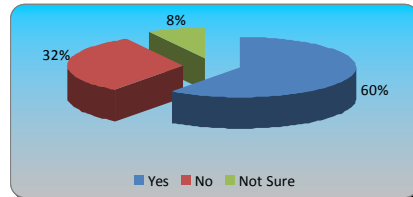
**Does it really need a shutdown to correct?
Is there any way to correct it on the run?
Will it extend the shutdown duration?**

**And later...
Why didn't you know it was there before the shutdown started?
What's wrong with your Predictive Maintenance program?**



Have you experienced forced outages within one week of a plant shutdown?

| | | | |
|----------|---------------|------------|-------------|
| Y | Yes | 60 | 60% |
| N | No | 32 | 32% |
| Not Sure | Not Sure | 8 | 8% |
| | Totals | 100 | 100% |



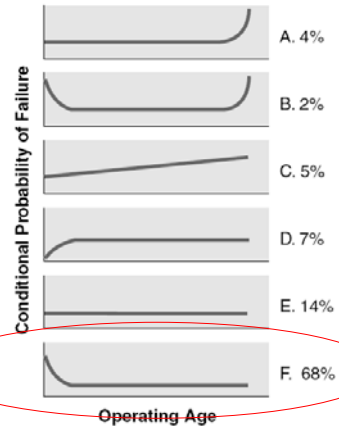
What's your risk?

Any intervention (PM, CM, etc.) runs a risk of creating more failures

- Parts problems
- Materials
- Workmanship

Work will be rushed

- Risks increase



Result

Forced outage / shutdown shortly after the turnaround (pattern F)

- We see this in power plants, refineries, chemical plants, rotating equipment, static equipment, civil infrastructure, vehicles, appliances...

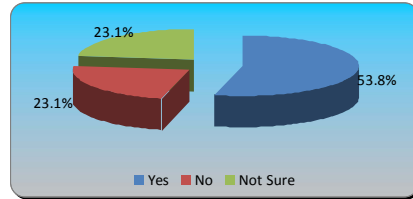
68% comes from Nowland & Heap (circa 1970's)

- Today the figure is likely lower due to increased use of CBM
- But it is still high!



Was the cause of the forced outage directly related to work that was done?

| | | | |
|----------|---------------|-----------|-------------|
| Y | Yes | 49 | 53.85% |
| N | No | 21 | 23.08% |
| Not Sure | Not Sure | 21 | 23.08% |
| | Totals | 91 | 100% |



World Energy Council - 2004

Generating Unit Availability Following Planned Outages

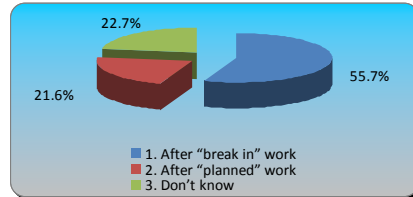
- 47% chance a unit will have its first forced outage the day it returns to service
- If it doesn't there is a 5% chance of it on day 2
- The probability of at least one forced outage in the week following a planned outage is 63%
- The ratio of forced outage hours to period hours decreases rapidly as each day progresses
 - › In Power Plants the major contributors are boiler tube leaks and turbine vibrations
 - › Next are boiler control systems and turbine overspeed test failures
 - › Turbines are the most likely cause on day 1
- About 60% of forced outages in the first week last less than 1 day

From: Corio, M.R., President, Applied Economic Research Company, Inc., Mills, J.B., Senior Reliability Engineer, Southern Company Services, Inc., Costantini, L.P., Director, North American Electric Reliability Council, *Generating Unit Availability Following Planned Outages*.



In your opinion, are you more likely to experience forced outages after doing “break in” work or work that was already planned into the Shutdown?

| | | | |
|-----------------------|--------------------------|-----------|-------------|
| After “break in” work | 1. After “break in” work | 54 | 55.67% |
| After “planned” work | 2. After “planned” work | 21 | 21.65% |
| Don’t know | 3. Don’t know | 22 | 22.68% |
| | Totals | 97 | 100% |



Why such a high risk?

Planning is usually not complete

- This reveals problems with day to day maintenance management as well...
- Why don't you have a standard job plan that you can use?

Sense of urgency - rushed

Parts & materials may need to be rushed to site

Workforce is already heavily loaded

- Especially if budgets were tightened up

Risk of errors is higher



Example

3 phase switches

Manufacturer recommends regular overhaul

Failures in service

- Many
- After overhaul (most)
- After sitting for long

Solution

- Stopped overhauls
- Operated switches regularly

Savings 50% of budgeted maintenance costs

Failures since

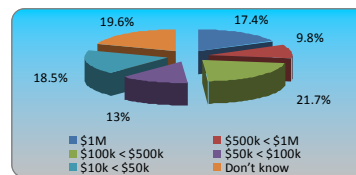
- Only a few



What does downtime cost your company per hour?

- > \$1M
- > \$500k < \$1M
- > \$100k < \$500k
- > \$50k < \$100k
- > \$10k < \$50k
- Don't know

| | | |
|-----------------|-----------|-------------|
| \$1M | 16 | 17.39% |
| \$500k < \$1M | 9 | 9.78% |
| \$100k < \$500k | 20 | 21.74% |
| \$50k < \$100k | 12 | 13.04% |
| \$10k < \$50k | 17 | 18.48% |
| Don't know | 18 | 19.57% |
| Totals | 92 | 100% |



Solution

Keep scope small to begin with

- Only do it if you absolutely NEED a shutdown

Don't add more work!

- Exception: you find yourself stuck
 - › Sorry – it is too late for this shutdown
 - › Good news – what about the next?

Avoid the situation

- Better predictive maintenance / diagnostics
- Better follow up on other “signs” of trouble



Better work identification

Reliability Centered Maintenance

- For critical systems, especially those that can take a plant down or require it down for work
- Defines the scope of work and its frequency
- If you have not used RCM you are missing a big opportunity
 - › You might think that you know your equipment and its requirements already
 - › Most RCM analyses reveal quite the opposite
 - You don't know what you don't know

Maintenance Task Analysis / PM Optimization

- For less critical systems
- If you could use MTA / PMO on a system, then don't consider that system / equipment for inclusion in a shutdown



Better CBM / Diagnostics

Let's say you've done RCM / MTA and you still had problems with "found" work

- Perhaps the analysis was flawed
 - › It is often rushed to save time
 - › Data or trades-persons' experience was not complete
 - › Analysts / facilitators not properly trained and competent
- Perhaps the description or execution of the tasks identified is flawed
 - › Brief descriptions leave room for error in interpretation
- Perhaps the skills of those doing your CBM / Diagnostics are not as good as they could be
 - › Training for your trades / technicians



You probably can't eliminate all "found work"

But you can sure minimize it

Thank you

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