The DCU Reliability Investment Rely on Marsulex

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Coking.com®

2010 Galveston Safety Seminar

AGENDA

1. The Marsulex Approach
2. The Study of Key Customer Site
3. Model Development from Study
4. Unique Findings and Reliability Recommendations

THE MARSULEX APPROACH

The Marsulex Approach to enhance Customer Value is:

- Uncompromising Safety
  - TRIR = 0.29 (2006 to present)
- Superior Operating Skills
- Maintenance Reliability
  - Effective planning
  - Diligent execution
  - State of the art systems

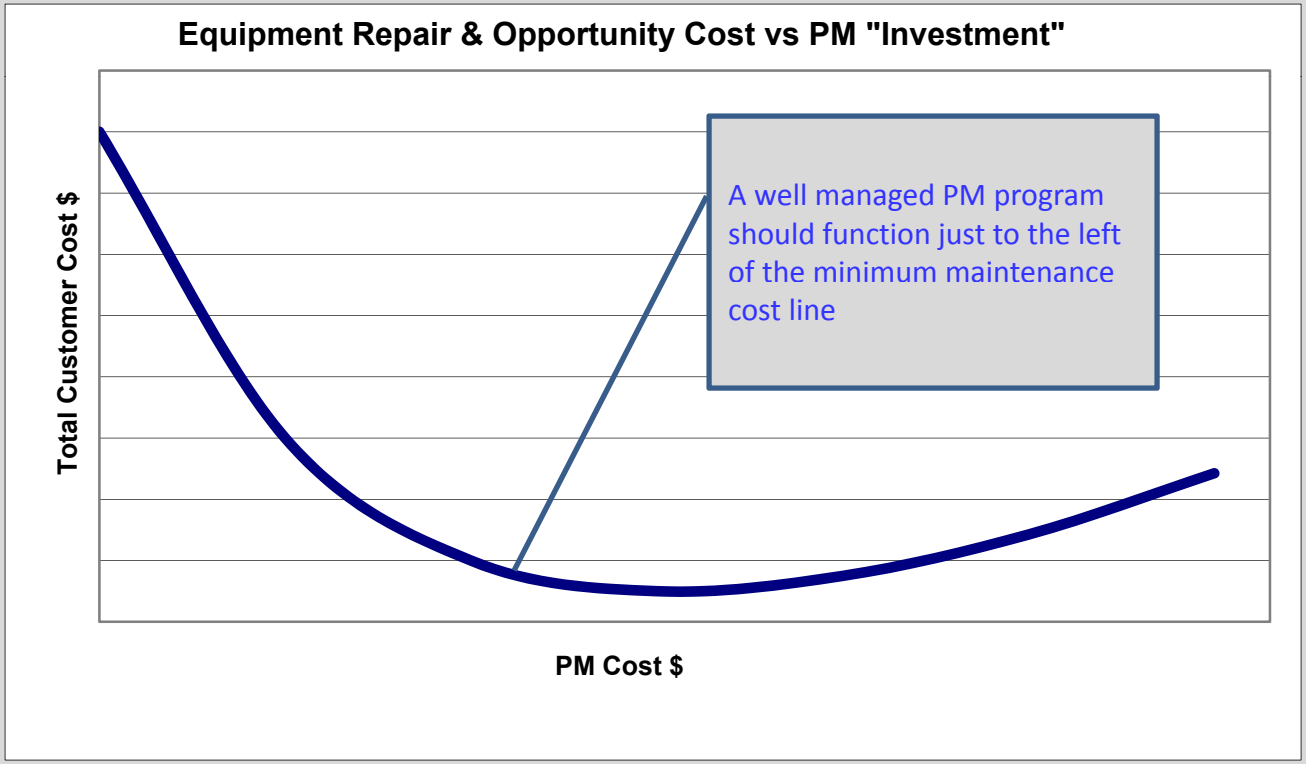
BALANCING VARIABILITY: COST, SAFETY, RELIABILITY

The major differentiator between coke cutting, handling & logistics providers is:

- The ability to meet & exceed demanding customer requirements
- **Superior operations skills, and know-how**
- Ability to execute in a safe manner without incurring large equipment failures & repair costs
- **Effective reliability program**

THE PREVENTATIVE MAINTENANCE PARABOLA

Costs related to maintenance/repair and lost production follow a parabolic relationship with PM resources



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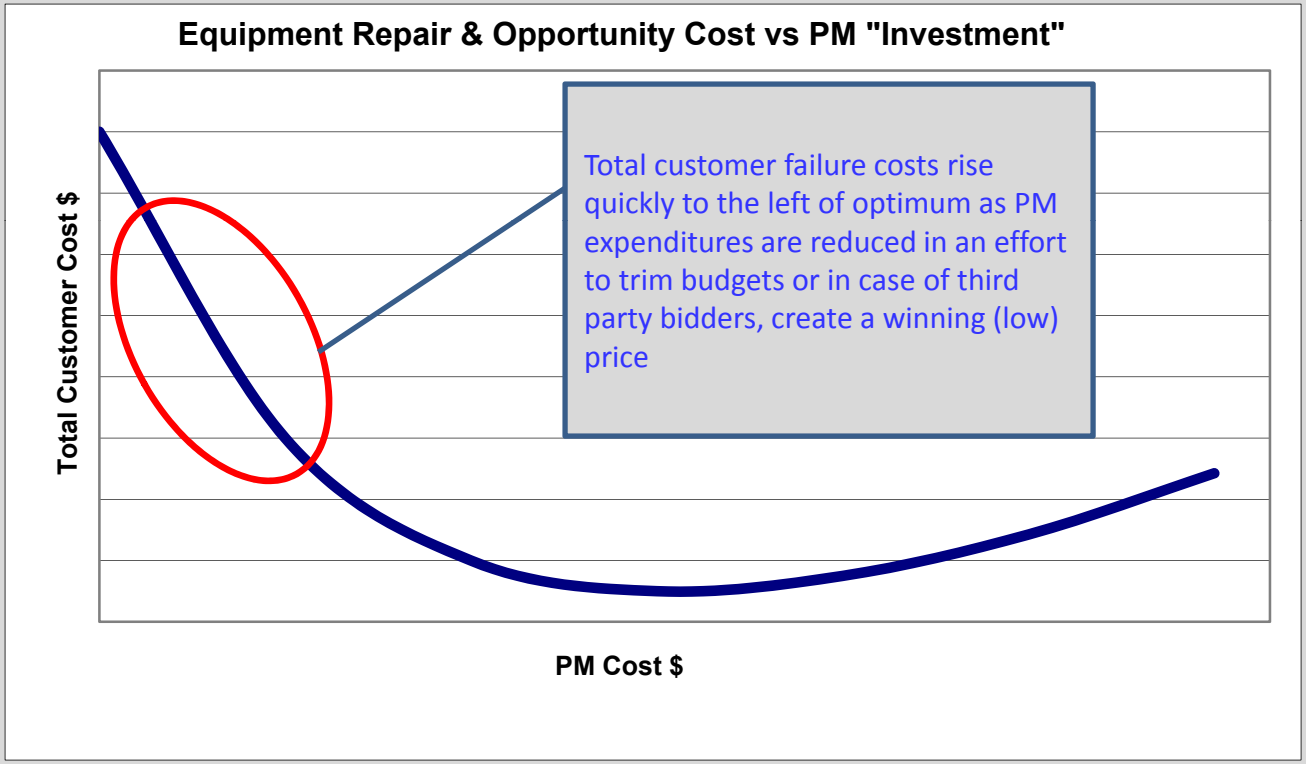
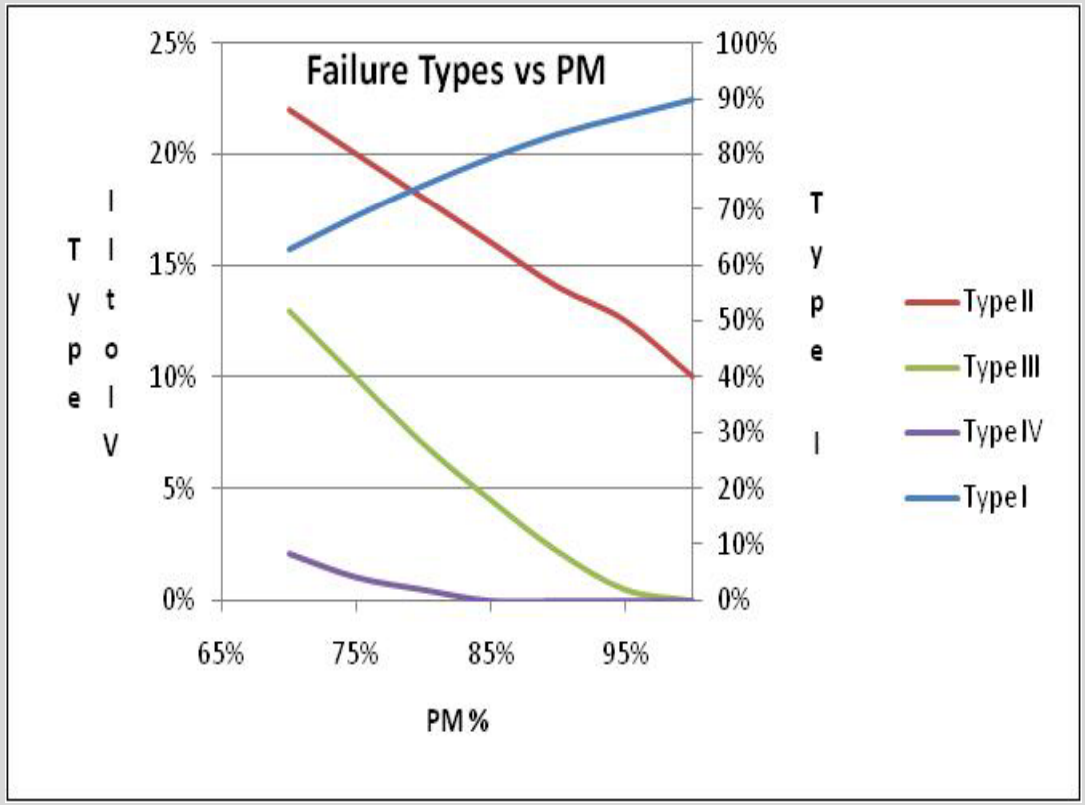


Refiners tend to source petcoke services on a time & material basis with limited focus on PM resource requirements and their significant leverage on total customer cost of ownership

RELIABILITY TRENDS



Repair Cost Categories

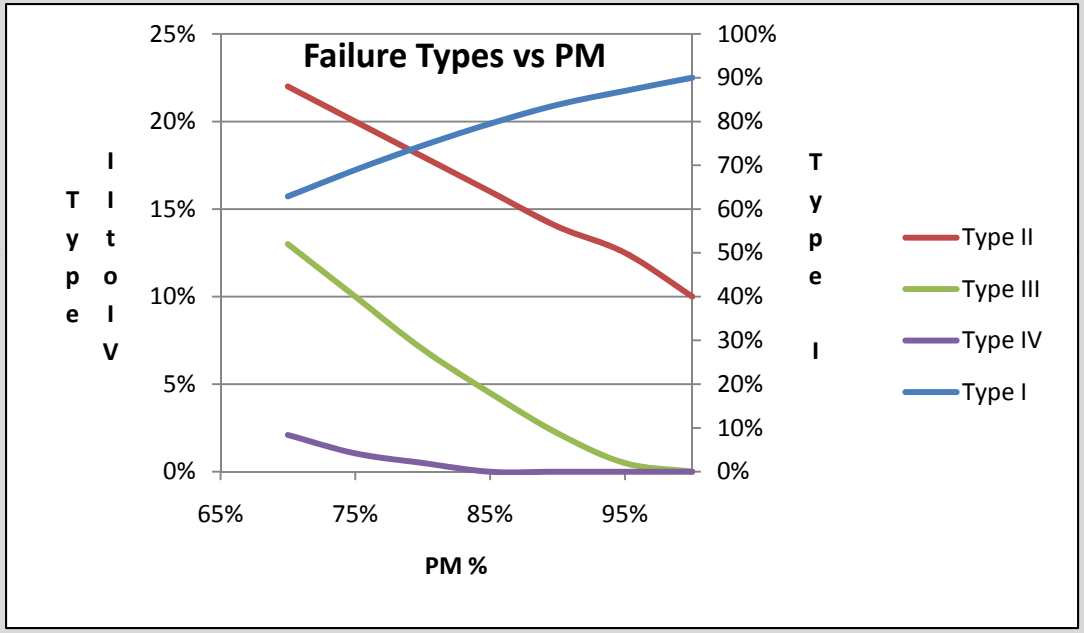
- Type I - Expected
- Type II - Unexpected
- Type III - Incident
- Type IV - Wreck

Note: Data from refinery studies

Repair Cost Categories

Repair	Outages	Cost Impact
Type I - Planned	**Expected and minor**	**1x$**
Type II - Unplanned	**Premature**	**3x$**
Type III - Incident	**Significant Premature** possible operations interruption	**6x$**
Type IV - Wreck	**Very Premature** significant operations interruption, often insurance involvement	**9x$** Lack of spare parts can double the loss

RELIABILITY TRENDS



Typical Failure Distribution vs PM level							
PM %	100%	95%	90%	85%	80%	75%	70%
Type I	90%	87%	84%	80%	75%	69%	63%
Type II	10%	13%	14.0%	16%	18%	20%	22%
Type III	0%	0.5%	2.2%	5%	7%	10%	13%
Type IV	0%	0%	0%	0.0%	0.5%	1%	2.1%
Total	100%	100%	100%	100%	100%	100%	100%

CASE STUDY

A Marsulex customer was used as a base case to examine the Marsulex equipment reliability program and the relationship to equipment failure

- Determined both PM and maintenance cost
- Compared the results with experience based expectations
- Developed specific reliability relationships
- Determined the effectiveness of the Marsulex reliability approach

STUDY ELEMENTS

Study Components

- Current PM program
- Ideal maintenance repair cost
- Actual maintenance cost

Study Methodology

- Relationship between PM and maintenance cost
  - Looked at repairs by types and how it compares with expectations
- Developed a Monte Carlo based reliability model
  - Compare the model with expected reliability trends

PM PROGRAM APPROACH

CRUSHER DAILY PM	Task	Time min	Freq	Period	Number	Total	FTE	Assigned
Check Oil Level in Sight Glass on Guard (85 – 140 Super Red)	Oil	10	2	D	1	20	0.042	Oper
Inspect Hopper for Uncrushables	Visual	10	2	D	1	20	0.042	Maint
Make Sure all Safety Guards are in place	Visual	15	2	D	1	30	0.063	Maint
Inspect all Mounting Bolts for tightness	Visual	2	1	D	10	20	0.042	Oper
Listen for any Unusual Noises like metal to metal, belts slapping	Visual	10	2	D	1	20	0.042	Oper
Inspect Crusher for any Leaks	Visual	5	2	D	1	10	0.021	Maint
Check for Excessive Vibration	Visual	5	2	D	1	10	0.021	Oper

- Reviewed a detailed PM list for all equipment
  - Example shown above
- Estimated times and full time equivalents, FTE, on all PMs
  - Also calculated cost per activity

IDEAL MAINTENANCE COST

Failure Expectation Table

Equipment		Material $/Failure	MTBF Years	No	Time Hrs	Cost $/y Eq
Bridge Crane	Hold Cable	$1,000.0	1.0	2.00	24.00	$2,000.0
	Close Cable	$500.0	2.0	4.00	24.00	$1,000.0
	Bearing	$2,100.0	4.0	2.00	4.00	$1,050.0
	Coupling	$12,500.0	5.0	2.00	4.00	$5,000.0
	Housing	$30,000.0	20.0	1.00	2.00	$1,500.0

- Major equipment categories
- Sub-categories in each group
- Expected MTBF for each piece of equipment
- Time and material cost for typical repair
- Total cost and equivalent cost per year

DETAILED REVIEW OF ACTUAL COST

Repairs Cost Sheet

Analysis Sheet	Repair Expense	No/Yr	Yearly Expense	Type Failure
Top Head	4.17	5.0	20.8	1
Bolts & Nuts	3.47	0.3	1.0	1
Bolts & Nuts	0.80	3.0	2.4	1
Gasket	1.33	0.5	0.7	1
Gasket Surface	1.10	0.5	0.6	1
N2 Skid				
N2 Pumps	1.00	0.2	0.2	1
N2 Skid Controls	75.00	1.0	75.0	2
N2 Bottles	75.00	1.0	75.0	2
North Console #5&6	7.00	1.0	7.0	2
South Console #3&4	0.50	3.0	1.5	1
Terminal Load Out				
Filters	2.50	4.0	10.0	1
Silo	2.00	1.0	2.0	1
Scale	3.00	0.5	1.5	1
Hydraulic Pressure Unit	4.00	1.0	4.0	1
Hydraulic Pressure Unit	8.33	1.0	8.3	2
HPU Pump	1.00	0.5	0.5	1

- Detailed review of repair cost over a multi-year period
- Analysis included:
  - Repair cost per failure
  - Average failures per year
  - Projected yearly expense
  - Failure type
    - Did the failure meet expectations?

PM STUDY RESULTS

PM Procedures Analysis

PM	No	Activity	%	% Cost	Exp
ChgFilters	1	1.00	0.6%	23.3%	$252.0
Clean	2	5.00	3.2%	14.1%	$152.4
Housekeep	3	1.00	0.6%	11.1%	$120.0
CheckVisual	4	78.00	50.0%	26.1%	$281.7
Lubricate	5	5.00	3.2%	2.6%	$28.1
Change Oil	6	27.00	17.3%	3.5%	$37.7
Refurbish	7	10.00	6.4%	2.7%	$29.3
Test	8	2.00	1.3%	0.4%	$4.3
Grease	9	18.00	11.5%	1.4%	$14.8
Calibrate	10	4.00	2.6%	1.4%	$15.4
Torque	11	1.00	0.6%	0.1%	$1.2
Inventory	12	1.00	0.6%	8.9%	$96.0
Hydroblast	13	1.00	0.6%	3.3%	$36.0
ChgBulbs	14	1.00	0.6%	1.1%	$12.0
Sample Oil	15	1.00	0.6%	0.0%	$0.1
		156.00	**100.0%**	**100.0%**	**$1,081.0**

Table Components

- Type of activity
- Number of checks
- Cost per check and total
- Percentage by activity and by cost

Full Time Equivalents

- Calculated the PM task on a Full Time Equivalents (FTE) basis
- Just under 40% of plant personnel tasks were PM related

REPAIR RESULTS

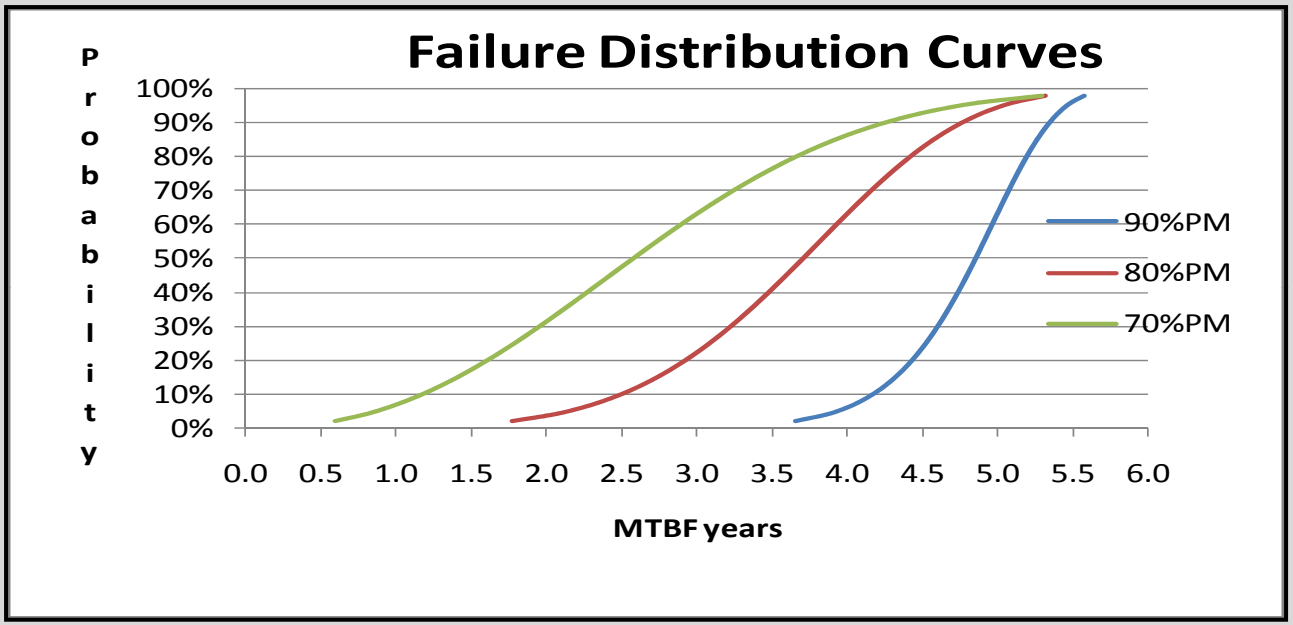
EQUIP	MAINT % IDEAL	MAINT % ACTUAL
Misc	0	42.10%
Crane	27.24%	25.64%
Feeder	2.31%	8.65%
Crusher	3.83%	0.55%
Heads	9.61%	28.02%
Cutting	30.73%	34.24%
Transport	2.49%	5.70%
Conveying	9.67%	5.34%
Rail	12.63%	15.50%
Loading	1.50%	2.10%
TOTAL	**100.0%**	**167.8%**

Actual maintenance repairs were 167% of ideal

Failure Type	% Task	Count
1	85.3%	81
2	12.6%	12
3	2.1%	2
4	0.0%	0
Total	100.0%	95

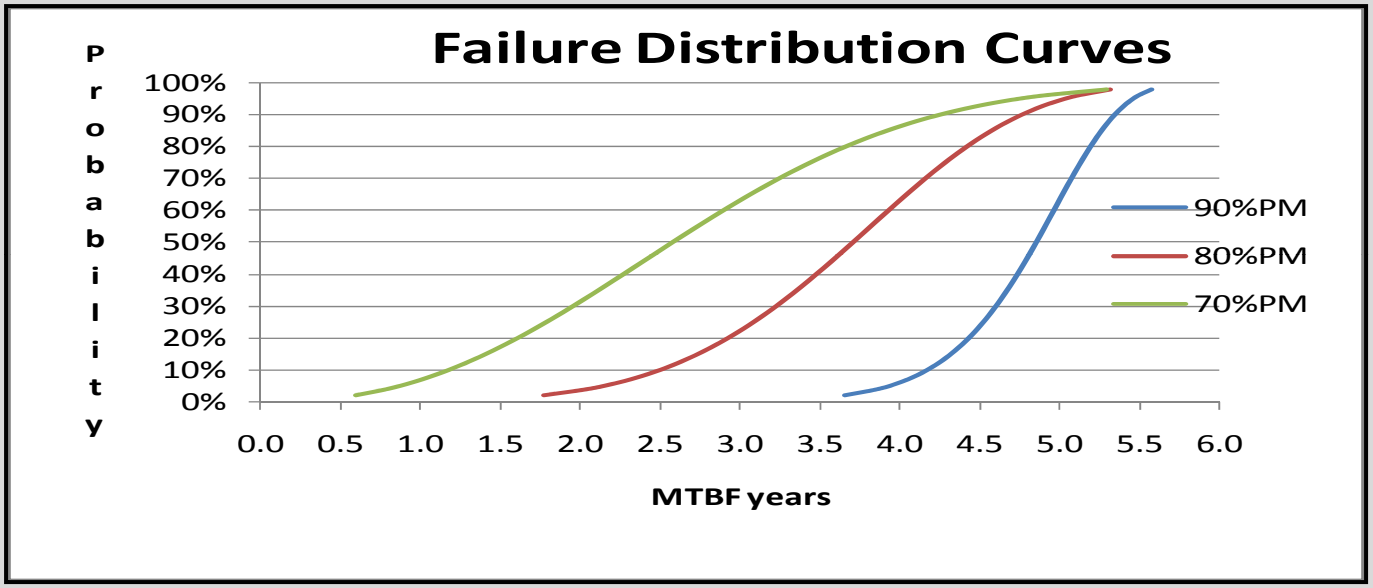
- Room for improvement but not all bad
  - Between 85% to 90% PM compliance
  - Type I, predictable maintenance, was 85.3% on a failure basis
- Largest variance was miscellaneous, which is always present

RELIABILITY MODEL APPROACH



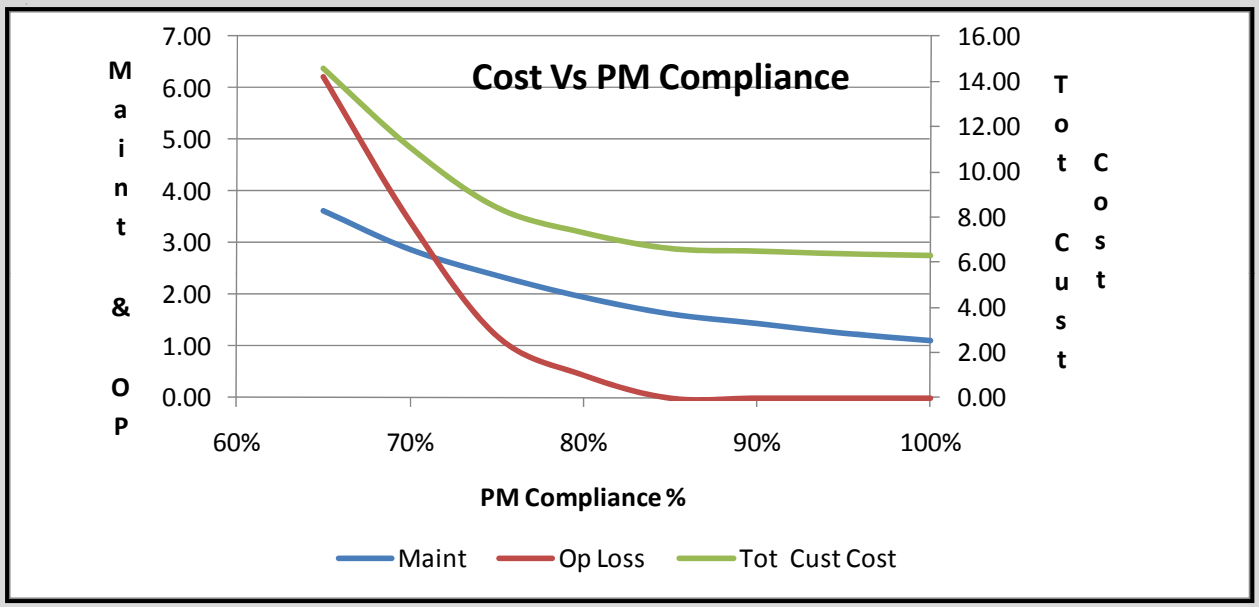
- Used Monte Carlo statistical methods
- The Model used the ideal maintenance table as a basis for repair cost determinations
- The curves are cumulative Weibull distributions that showed the relationship between PM compliance and equipment MTBF
- A model run produced random numbers for each piece of equipment to determine MTBF

RELIABILITY MODEL APPROACH



- As PM compliance was reduced the MTBF curve shifted to the left and widened
- Shifting the curve left, increased the probability of reduced MTBF and increased the average cost per year
- Model has to be tuned for each application

RELIABILITY MODEL



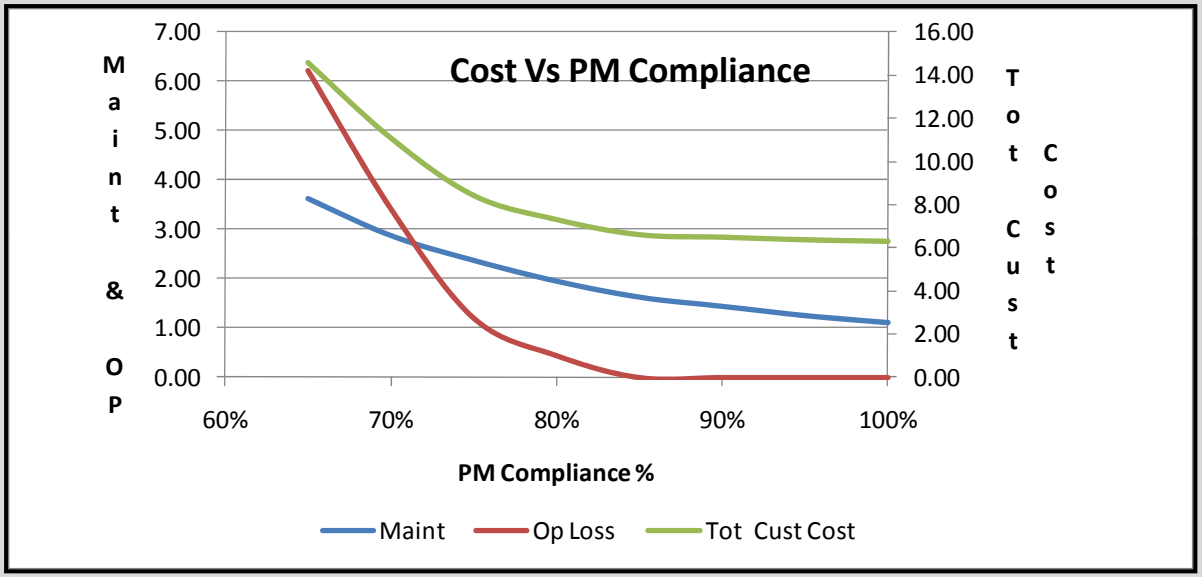
The Model Includes

1. MTBF changes with PM compliance
2. The time value of money
3. Severity of repairs
4. Operations/Logistics cost
5. Impact of spares on cost

Coking Business Cost vs. PM compliance

- Model curves shown are:
  - Repair cost, cost of operations losses or logistics, and total customer cost
- PM compliance could be replaced with program effectiveness
- All cost expressed as fractions of the ideal maintenance cost

RELIABILITY MODEL RESULTS



- Model gave good agreement with reliability trends
  - Cost increased rapidly below 85% Type I repairs

- The maintenance/PM relationships were consistent with model predictions for two consecutive and very different years

BENEFITS OF THE STUDY

- Highlighted areas for improvement in the PM program
- Helped to focus the reliability continuous improvement efforts
- Reinforced the relationship between PM compliance and cost of equipment repairs
- Demonstrated that a seemingly chaotic system could be modeled with statistical methods

THE MARSULEX SOLUTION

- Computerized Maintenance Management System
- Condition Based Equipment Inspection & Life Cycle Analysis
- OEM Support Network & Expanded PM's
- Full Time Equivalent Analysis & PM Support Staffing
- Maintenance Window Planning & Scheduling
- Root Cause Analysis of Findings
- Critical Spare Parts Identification & Risk Management

VALUE DELIVERED TO REFINER

- Outsourcing of non-core operations (petcoke cutting/handling)
- Safer and more reliable operation
- Lowest lifetime total cost of ownership
- Continuous improvement through sharing of best practices within Marsulex operating network
- Coke drum life preservation

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