

# PM/FM Matrix & CBM Gap Analysis in Reliability Centered Maintenance



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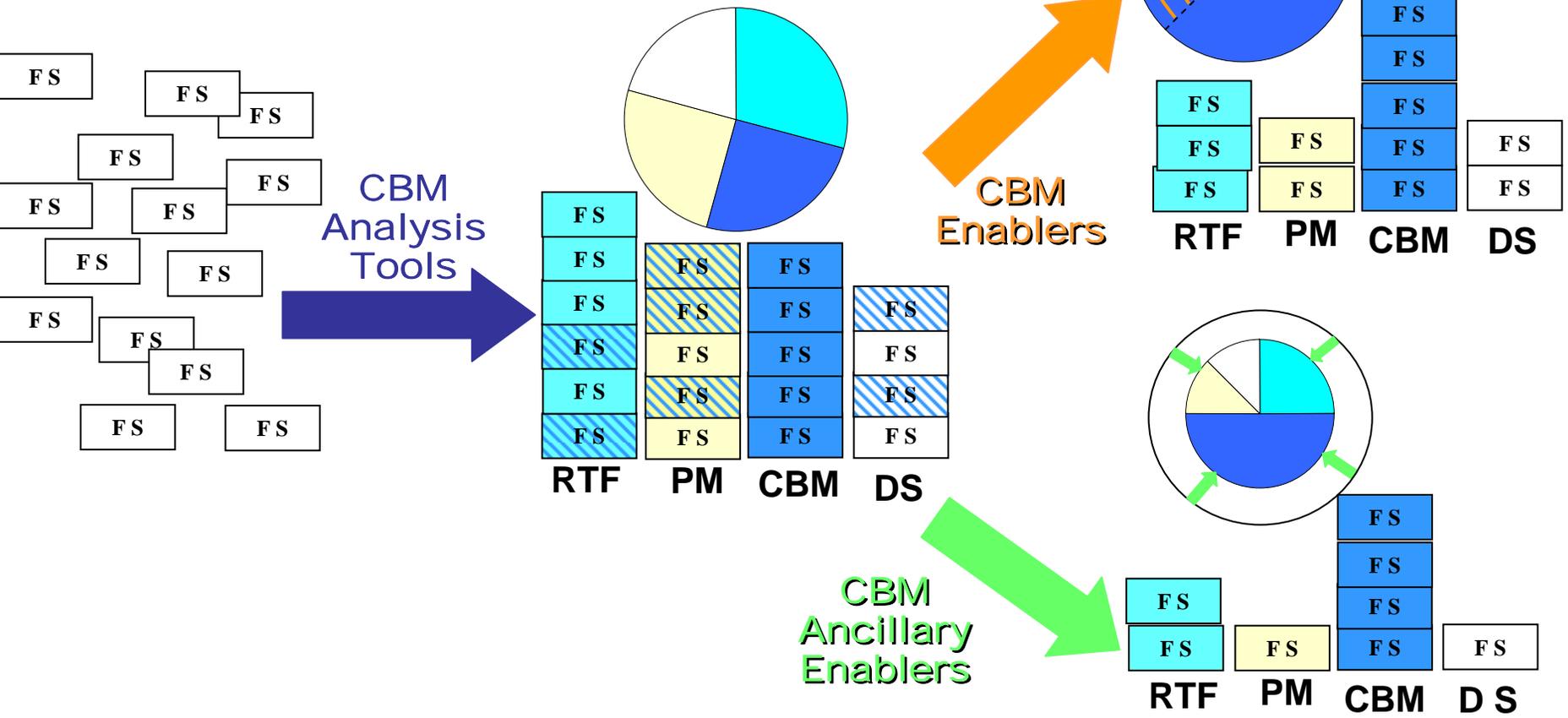
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# CBM+ Initiatives

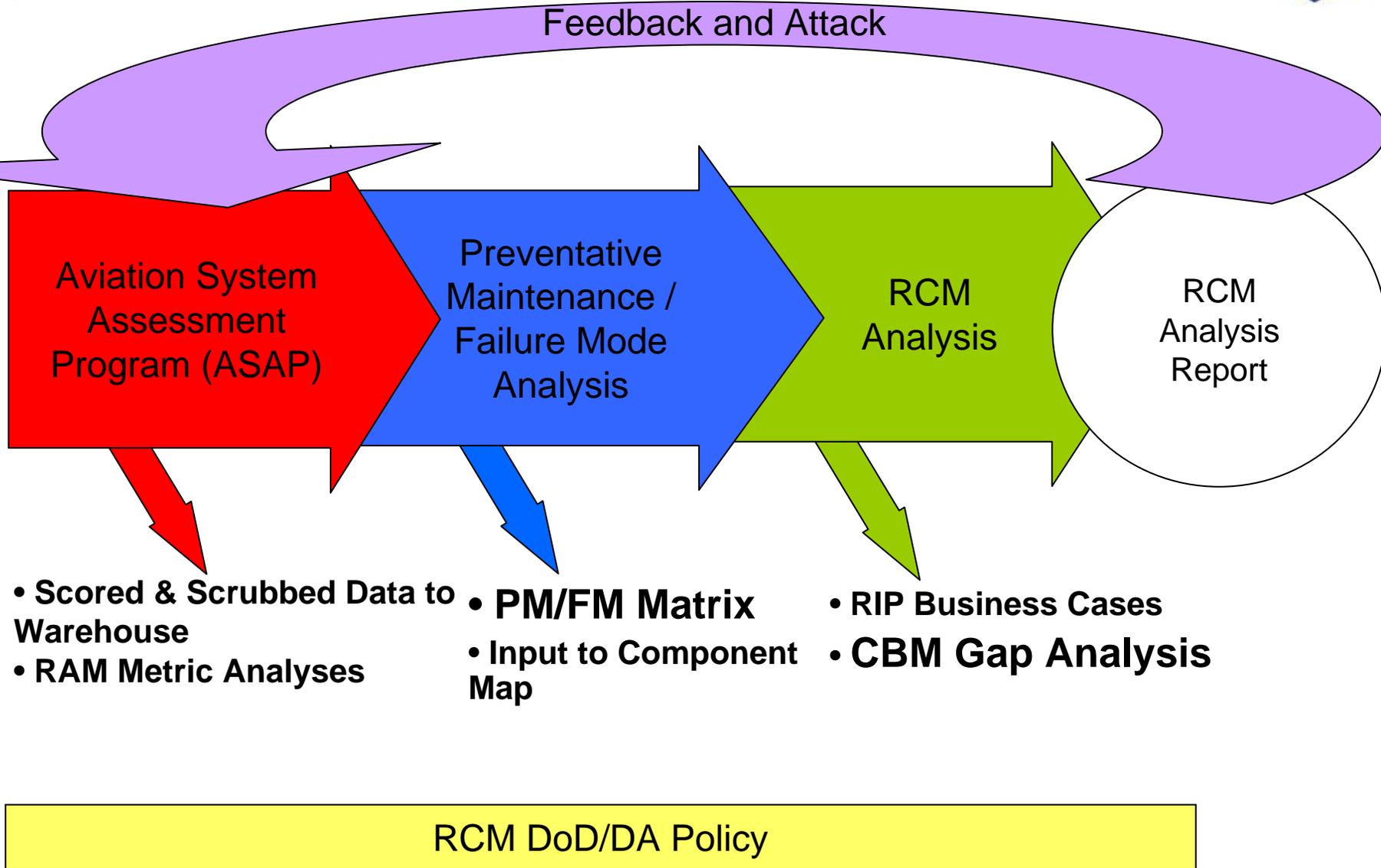
- **CBM Analysis Tools – Tools to Define Where and How to Apply CBM but do not by themselves make the System Failure Strategies go to CBM**
  - ◆ RCM
  - ◆ FMECA
  - ◆ Business Case Analysis
  - ◆ Seeded Fault Testing
  - ◆ Data Collection, Scoring & Warehousing
- **CBM Enablers – Technologies Applied to System that Drive Failure Strategies to CBM**
  - ◆ Built-In Test
  - ◆ HUMS
  - ◆ IETMS
  - ◆ Diagnostics/Prognostics
  - ◆ Data Warehouse Algorithms/Analysis
- **CBM Ancillary Enablers – Technologies/Tools Applied to System that do not Drive Failure Strategies to CBM but Reduce Overall Failure Occurrence and/or Maintenance Resource Burden**
  - ◆ Reliability Improvement
  - ◆ Diagnostic Improvements
  - ◆ Maintenance Training
  - ◆ Maintenance Improvement
  - ◆ Supply Chain Maintenance
  - ◆ Asset Visibility

# CBM+ Initiatives

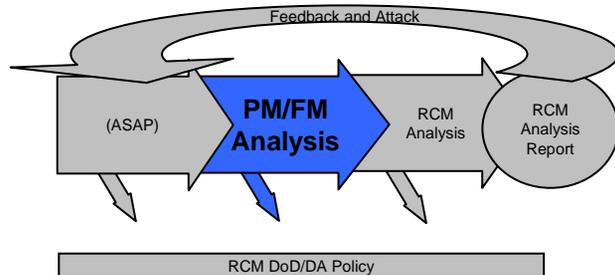
FS Failure Strategy Associated with a Failure Mode  
FS Failure Strategy with Potential to go to CBM  
 (With CBM Enablers Applied)



# RAM CBM/RCM Analysis Process



# RAM CBM/RCM Analysis Process (PM/FM Analysis)



## CBM PM/FM Analysis

- Identifies Opportunities to Reduce Inspection Requirements.
- Quantifies Potential Value of New Prognostic Technologies.
- Identifies Future Prognostic Needs.

## CBM Inspection Analysis Work

- We have completed linking the 2410 removals and Navy IRCMS failure modes to schedule maintenance for all UH-60 Rotor components.
- This information is driving the UH-60 component mapping effort.
- The UH-60 Drive System and Sub Systems components are currently being generated.
- FY07 Begin Analysis of AH-64

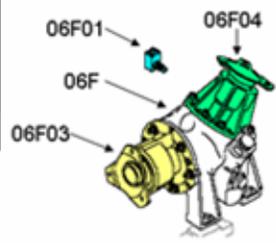
## PM/FM Matrix

**Rotating Swashplate**  
 NSN: 1615-01-357-5089  
 Part #: 70104-00001-045  
 WUC: 05A03A02  
**Total Inspections: 3**

Component Failure Modes	#	%	BIT Detection Capabilities	Inspection Failure Modes		
				PMS (10 hr)	350 hr 12 mo	PMI 2 (700 hr)
<b>IRCMS Failure Modes</b>						
Einding	0	0.00%			✓	✓
Chating	0	0.00%				
Corrosion	1	33.33%		✓		
Crack	1	33.33%		✓		✓
Damage	1	33.33%				
Delamination	0	0.00%		✓		✓
Distortion	0	0.00%		✓		
Looseness	0	0.00%		✓		✓
Wear	0	0.00%				✓
<b>Total IRCMS Failures</b>	<b>3</b>	<b>100.00%</b>				
<b>2410 Removals</b>						
Beating or Bushing Failure	24	4.77%		✓	✓	✓
Beyond Specified Tolerance	16	3.18%				
Einding, Friction Exc...	5	0.99%			✓	✓
Broken	4	0.80%		✓		✓
Brush Failure/Worn Exc...	1	0.20%				
Etuned	1	0.20%		✓		✓
Crated	1	0.20%				
Scored	1	0.20%				
Seal/Gasket Blown	3	0.60%				✓
Seized	1	0.20%				
Storm Damage	2	0.40%				
Stripped	2	0.40%				
Sudden Stoppage, Blad..	1	0.20%				
Troubleshooting	1	0.20%				
Worn Excessively	36	7.16%		✓		✓
Wrong Part	1	0.00%				
<b>Totals</b>	<b>503</b>					

# Preventive Maintenance Failure Mode Matrix

**Intermediate Gear Box**  
 NSN: 1615-01-074-5152  
 WUC 06F  
 Total Inspections: 6

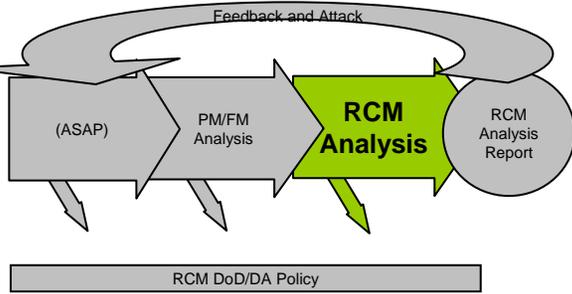


## AH-64 IGB

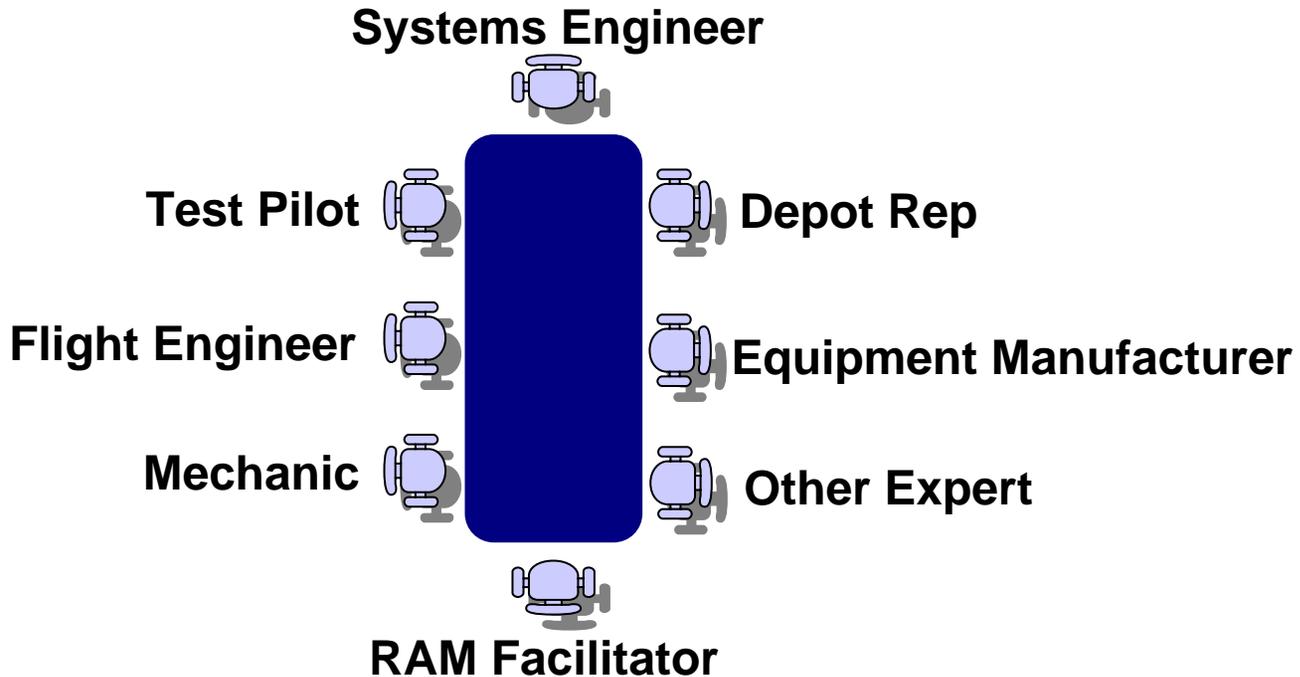
Component Failure Modes	# Occurred	%	Existing BIT Detection Capabilities	Inspection Failure Modes & WUC Inspected					
				Daily	PMS (40 hr)	120 hr	PMI 1 (700 hr)	PMI 2 (700 hr)	90 Day
				06F 06F01	06F 06F01 06F03 06F04	06F 06F01	06F 06F01	06F 06F01 06F03 06F04	06F
Corroded	100	37.59%		✓			✓	✓	
Impending/Incipient Failure	26	9.77%	✓				✓		
Sudden Stoppage, Blad	15	5.64%							
Metal on Magnetic Plu	14	5.26%	✓	✓	✓	✓	✓		
Internal Failure	12	4.51%	✓		✓	✓	✓		
Leaking (Liquid)	12	4.51%		✓			✓		
Bearing or Bushing Failed	11	4.14%	✓				✓		
Contamination	9	3.38%		✓	✓				
Pitted	8	3.01%							
Worn Excessively	7	2.63%	✓				✓		
Chipped	6	2.26%	✓		✓		✓		
Others	5	1.88%							
Cracked	4	1.50%		✓			✓		
Grooved	0	0.00%	✓						
Oil Gasket Blown	0	0.00%					✓		
Slippage	0	0.00%	✓						
Tooth Broken on Gear	0	0.00%	✓						
Vibration Excessine	0	0.00%	✓				✓		
<b>Totals</b>	<b>266</b>	<b>100%</b>		<b>6%</b>	<b>53%</b>	<b>13%</b>	<b>10%</b>	<b>79%</b>	<b>38%</b>

# RAM CBM/RCM Analysis Process

## (RCM Analysis)



- **Facilitated Group Approach**
- **Pilots/Maintainers on Staff**
- **Established ALNG Contacts for RCM Support**

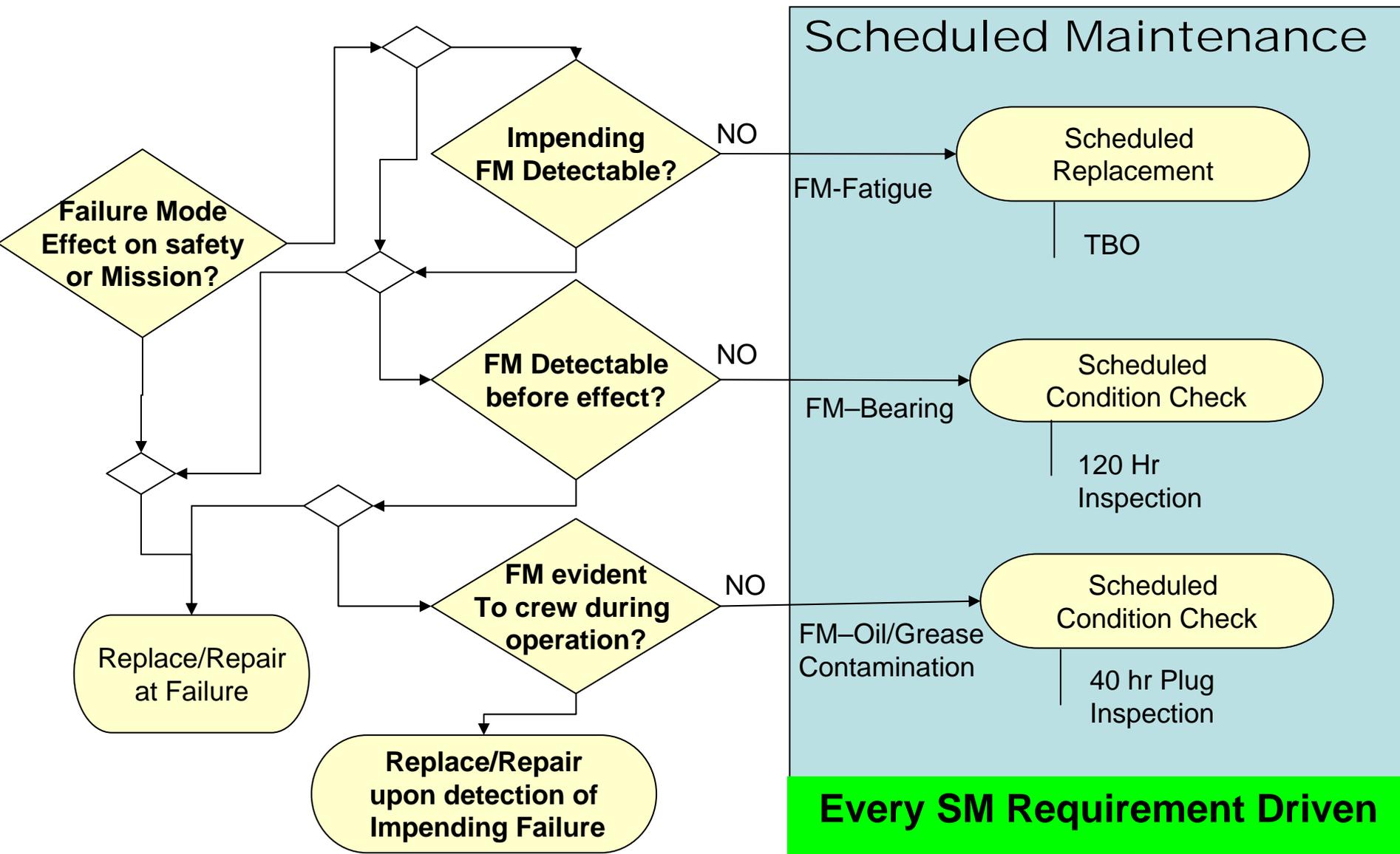




# CBM Gap Analysis

- Classical RCM
  - Captures Existing Design and Maintenance Structure
  - Decision Tree Tool Optimizes Maintenance Practices to Component Needs
  - Results – Optimized Maintenance Strategy Mix (CBM, Inspection, Replace at Failure, etc.)**
- CBM Gap Analysis (Add on tool)
  - Force Decision Tree to CBM
  - ID Points Where Existing Design Branches Off CBM
  - Address Gaps in Design
  - Results – CBM Requirements**

# Traditional RCM Analysis



**Scheduled Maintenance**

Scheduled Replacement  
TBO

Scheduled Condition Check  
120 Hr Inspection

Scheduled Condition Check  
40 hr Plug Inspection

**Every SM Requirement Driven by Technology/Design Gap**

# CBM Gap Analysis

## Drive Design to CBM

