

Upstream Risk Management AS

gloryRCM

—

Industry standard tool suite for condition based maintenance of rotating equipment

The art of tough decision making

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Introduction

Study on subsea field maintenance (2010):

- “86% of maintenance is either too late (reactive) or too frequent (unnecessary preventive)”
- “63% of maintenance work orders resulted in no value-added work”

- **Q:**
 - **How can we help reduce cost and uncertainty related to critical asset rotating equipment failures?**

- **A:**
 - **Adopt the gloryRCM process as means to enable consistent validation of your asset maintenance plans**



gloryRCM – Process

- 1. Significant item identification and screening
 - “System failure analysis”. Global impacts related to system state and configuration.
- 2. FMECA
 - “Component failure analysis”. Local- and system impacts of failures.
- 3. Critical maintenance task selection
 - “Predictive maintenance task selection based on operating conditions”
 - “Preventive maintenance task selection”
 - “Run to failure” (corrective maintenance only)
- 4. Predictive maintenance interval optimisation (condition based)
- 5. Preventive maintenance interval optimisation (age based)
- 6. Spare parts optimisation
 - “Fast moving spares”
 - “Slow moving spares”
 - “Rotables spares”



gloryRCM – Steps 1&2

- 1. Significant item identification
 - “System failure analysis”

Significant Item Identification					Failure of item compromises:				Redundancy status			Consequence class, Priority: 1-7	Item significant or insignificant	
id	Item	Operational mode	Function	Function requirements	HSE	Production Volume	Product Quality	Maintenance cost	No redundancy exists	Partial redundancy exists	Full redundancy exists			
1		Running			1				1			1	Significant	
2		Start-up											7	Insignificant
3		Testing					1		1				3	Significant
4		Idle			1	1	1	1			1		6	Significant
5		Standby						1	1				4	Significant
6						1			1				2	Significant
7					1	1	1	1		1			5	Significant

- 2. FMECA
 - “Component failure analysis”.

Failure Modes, Effects and						Criticality Decision Matrix										Criticality Analysis		
id	Item	Function	Failure mode	Failure Effect	Failure rate	Failure Effect Classification				Severity	Frequency					Severity	Frequency	Criticality decision
						HSE	Production Volume	Product Quality	Maintenance Cost		1/1000 year	1/100 year	1/10 year	1/year	≥1/month			
										Very Unlikely	Remote	Occasional	Probable	Frequent				
										1	2	3	4	5				
1						Massive Impact	Massive Impact	Massive Impact	Massive Impact	5					H	5	3	
6						Major Impact	Major Impact	Major Impact	Major Impact	4						4	1	
3																3	4	
5						Moderate Impact	Moderate Impact	Moderate Impact	Moderate Impact	3						2	5	
7												M			1	2		
4						Minor Impact	Minor Impact	Minor Impact	Minor Impact	2		L				0	3	
						Slight Impact	Slight Impact	Slight Impact	Slight Impact	1								
						No Impact	No Impact	No Impact	No Impact	0								



gloryRCM – Steps 3&4

- 3. Critical maintenance task selection
 - “Predictive maintenance task selection” / “Preventive maintenance task selection” / “Run to failure”
- 4. Predictive maintenance optimisation (condition/inspection based)

gloryRCM Lite. DEMO - NOT FOR COMMERCIAL USE! - Upstream Risk Management AS (c) 2018

Item description (<150 kW)		ID No.	Solid ingress	CF	z1	z2	z3	Lube precision (bearings)			
Bearing		123	Light non-abrasive	1	0	0	0	Baseline	Actual		
Condition	Hum (/100)	Vib (m/s ²)	pH	Temp1 (C)	Temp2 (C)	POD	x1	x2	x3	Ultra (dB)	Indication
	0,45	0,98	7	30	30	0	0	0	0	0	Lubrication OK!
Costs	Cpm (\$)	Ci (\$)	Cu (\$)	Reliability data		MTTF (h)	Aging	Alpha	Beta	Time (h)	RUL (mth)
	200	100	6000			87600	Medium aging	3		0	
Interval optimization											
Decision	Operate										
Next inspection (If operate)	Interval (mth)										
Total cost of maintenance in next interval											
Residual Lifetime (mth)	p90	p50	p10								
Probability of failure before next inspection											
										Calculate interval	Exit



gloryRCM – Steps 5&6

- 5. Preventive maintenance optimisation (age based)
- 6. Spare parts optimisation

Spares Calculator - Upstream Risk Management AS (c) 2018

Spare unavailability driven model

Mean number of demands (/yr)

Mean lead time (yrs)

Cost of shortage (/unit-yr)

Cost of storage (/unit-yr)

Solution	# of units	Cost	Prob. of shortage
Optimum	<input type="text" value="1"/>	<input type="text" value="1.3"/>	<input type="text" value="0.003"/>
Optimum +1	<input type="text" value="2"/>	<input type="text" value="2.0"/>	<input type="text" value="0.000"/>
Optimum -1	<input type="text" value="0"/>	<input type="text" value="8.3"/>	<input type="text" value="0.083"/>

Storage/Order cost driven model

	Mean	Err factor	p95	p5
Number of demands (/yr)	<input type="text" value="1"/>	<input type="text" value="3"/>	<input type="text" value="0.3"/>	<input type="text" value="3.0"/>
Lead time per order (yrs)	<input type="text" value="0.5"/>	<input type="text" value="1.5"/>	<input type="text" value="0.3"/>	<input type="text" value="0.8"/>
Planning period (yrs)	<input type="text" value="5"/>			
Fixed order cost (/order)	<input type="text" value="10"/>			
Cost of ordering (/unit)	<input type="text" value="1"/>			
Cost of storage (/unit-yr)	<input type="text" value="2"/>			
Cost of shortage (/unit-yr)	<input type="text" value="1000"/>			
Ordering amount (units)	<input type="text" value="5"/>			
Ordering point (units in stock)	<input type="text" value="1"/>			
Mean cost in planning period	<input type="text" value="23.0"/>			
Probability of shortage	<input type="text" value="0.001"/>			

Number of simulations

Expiry date

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gloryRCM – Benefits

- Ability to determine probability of system failure during the next x months
 - RUL(s) provided
- Ability to skip some scheduled inspections. What are risks involved?
 - Criticality informed task selection provided
- Ability to decide about postponing a maintenance task to next maintenance window. What are risks involved?
 - Criticality informed task selection provided
 - Grouping results provided
- Ability to decide what components should be prioritised if several require maintenance
 - Significant item identification and screening

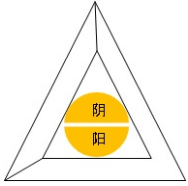


Summary

How to reduce cost and uncertainty related to maintenance management of rotating equipment?

- Upstream Risk Management suggest you adopt the gloryRCM tool to consistently validate your asset maintenance plans
 - Your field-specific expertise, experience data and conditions coupled to;
 - State-of-art probabilistic component degradation and maintenance models
- Benefits:

Consistent solution for identifying the most cost-effective condition based maintenance plan!



Upstream Risk Management AS

- Are you willing to spend billions of dollars on something without making sure it performs?
- We offer you the ability to quantify complex asset risks
 - Safety and Maintenance cost
 - Operating expenses and Production losses
- Our vision is to provide all key metrics for tough decision making in asset management
 - Products and services based on solutions developed with clients in the field

The art of tough decision making

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