

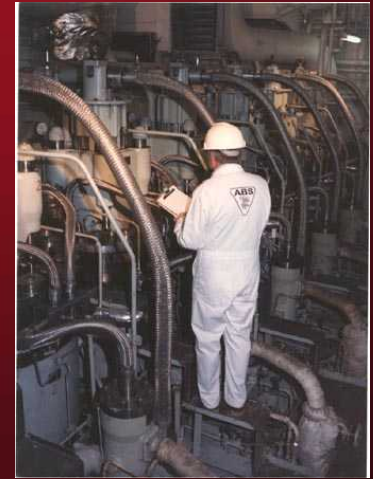
RELIABILITY CENTERED MAINTENANCE (RCM)

ABS Nautical Systems

Providing Client-Centered
Solutions to the Marine Industry
since 1983.

Why RCM?

- Applicable to *all* facets of machinery maintenance
- RCM is a structured asset maintenance philosophy designed to comprehensively address users' need for
 - Increased life of critical components
 - Enhancing reliability and availability
 - Eliminating unnecessary maintenance tasks
 - Improving safety, environmental impact & economic return
- Improved understanding of relationship between component failures and overall system performance



RCM Software

- Automates RCM analysis
- Data management software only
- Report writing features exports to MS Word
- Customizable for analysis views and reports
- User friendly
 - Tutorial
 - Step by step guide



System Hierarchy with Analysis Example

Safeship RCM Module - S:\058E\Life Cycle Support\Projects 2004\Projects 2004\197524-02 Risk-based RCM Guide\Example Real RCM Analyses\Templates\Piping SystemsW

File Edit View Tools Project Worksheet Window Help

RCM Analysis - Ship Details

- 01 - Mechanical Cargo Handling Systems
- 03 - Manoeuvring Systems
- 04 - Electrical Systems
- 05 - Mooring Systems
- 06 - Propulsion Systems
- 07 - Ship Piping systems
 - A - Cooling Water : M/E High Temp
 - B - Fuel Oil System: F.O. Transfer
 - C - Lube Oil System: Transfer and Purifying System
 - 1 - G/E LO Storage Tank
 - 2 - Main LO Storage Tank
 - 3 - Main LO Settling Tank
 - 4 - Diesel generator check valves
 - 5 - 3 - Way Valve
 - 6 - Main LO Sump Tank
 - 7 - LO Transfer Pump and
 - 1 - Inlet check valve from main storage/settling tanks (1)
 - 2 - Inlet check valve from G/E
 - 3 - Inlet check valve from Stern Tube LO Drain Tk
 - 4 - Inlet check valve from main storage/settling tanks (2)
 - 5 - Inlet check valve from main storage/settling tanks (2)
 - 6 - Main LO sump tank fill stop
 - 7 - Simplex Strainer
 - 8 - Inlet Pressure Indicator
 - 9 - LO Transfer Pump
 - 1 - External leak/rupture
 - 2 - Fails to start on demand
 - 3 - Fails to stop on demand
 - 4 - Fails off while running
 - 5 - Operates at degraded
 - 10 - Outlet Pressure Indicator
 - 11 - Outlet isolation check valve to stern tube LO drain tank
 - 12 - Outlet check valve to main
 - 8 - Main LO Purifier Pump &
 - 9 - Main LO Purifier Heater 1&2
 - 10 - Main LO Purifier 1&2
 - 11 - LO Purifier Sludge Tank
 - D - Cooling Water : Low Temp FW
 - E - Cooling Water : G/E LT and HT
 - F - Fuel Oil System: Incinerator Combustion F.O. Service
 - G - Exhaust Gas System
 - H - Bilge System in E/R
 - I - Compressed Air System: Starting Air/General Service/Control Air
 - J - Compressed Air System: Em'cy shut-off valve and fire damper
 - K - Cooling Water: Sanitary & F.W
 - L - Purifier Operating Water (Sanitary & F.W Serv. Sys)
 - M - Sanitary Discharge (Sanitary & F.W Serv. Sys)
- 08 - Fire Safety Systems

07.C.7.9.2 Fails to start on demand

Causes

No.	Link	Cause
Click here to add a Cause		
1		Pump motor failure
2		Pump bearings seized
3		Pump coupling failure
4		Pump control failure

Local Effects

No.	Link	Local Effect
Click here to add a Local Effect		
1		Inability to pump LO to tanks

Functional Failure

No.	Link	Functional Failure
Click here to add a Functional Failure		

End Effects

No.	Link	End Effect	Risk Tool
Click here to add an End Effect			
1		No effect of interest	

Indications/Safeguards

No.	Link	Indication/Safeguard
Click here to add an Indication/Safeguard		
1		If pump repair time is lengthy, can use main LO purifier pumps

Failure Management

No.	Type	Recommendation/One-time Change/Task	Frequency	Frequency Units	Comment	(Click Below For Task ...)
Click here to add a Failure Management Strategy						

start | Robert M Conac... | Microsoft Off... | Internet Expl... | Presentations | Microsoft Excel... | Microsoft Power... | Safeship RCM M... | 2:42 PM

RCM Template – FMEA Table

No.: 09.A.3.2		Supply Pump No. 1 (Duty)			Positive displacement screw pump with attached relief valve	
Item	Failure Mode	Causes	Local Effects	Functional Failure	End Effects	Indications and Safeguards
1	External leak/rupture	<ul style="list-style-type: none"> • Manufacturing flaw (not likely) • Mechanical seal rupture / failure • Pump housing erosion • Impact with a foreign object 	<ul style="list-style-type: none"> • Fuel oil leakage • Standby pump starts if leak is large 	<ul style="list-style-type: none"> • 1.5.1. Partial loss of containment of fuel • 1.5.2. Total loss of containment of fuel • 1.1.4. Provides fuel to the engine at a pressure less than Y bar 	Loss of Containment - Severity Level 1	<ul style="list-style-type: none"> • Automatic change over starts Standby pump when pressure drop occurs • General failure indicator will alert operator if pump changeover occurs • Daily visual inspection by officer on watch • Procedure for lifting objects over equipment
2	Fails to stop on demand	<ul style="list-style-type: none"> • Motor control failure 	<ul style="list-style-type: none"> • Pump continues to operate 	<ul style="list-style-type: none"> • 1.1.3. Provides more than X m³/hr of fuel to the engine 	No effect of interest	<ul style="list-style-type: none"> • If piping systems are overpressurized, relief valve on return pipe returns oil to F.O. Overflow Drain Tank • If piping systems are overpressurized, pump bypass valve in Supply Unit will open and F.O. will be recirculated

Sustaining the RCM Program

- RCM program must be dynamic
 - Initial program based on limited information
 - Should collect, analyze, respond to service data
 - Update based on changes (hardware/operations)
 - Continuously refine RCM program
- Effectiveness must be measured
 - Identify/monitor performance parameters (e.g. equipment availability; man-hours on scheduled vs. unscheduled tasks; repair costs; etc.)
- Reliability, Availability, Maintainability (RAM)
 - RAM provides trending for sustainment

Work Order Screen

Description		Admin Info		Materials	Labor	Status
Findings	Messages	Equipment/Spaces	File Attachments	Readings	CAR's	Failures
Failure Mode :	EXTERNAL LEAK/RUPTURE		Secondary Costs :	1,000.0000	USD	
Failure Cause :	CRACKED					
Equipment Offline		Equipment Back in Service				
Date :	09/21/2006	Time :	:	Date :	:	

→ Added:

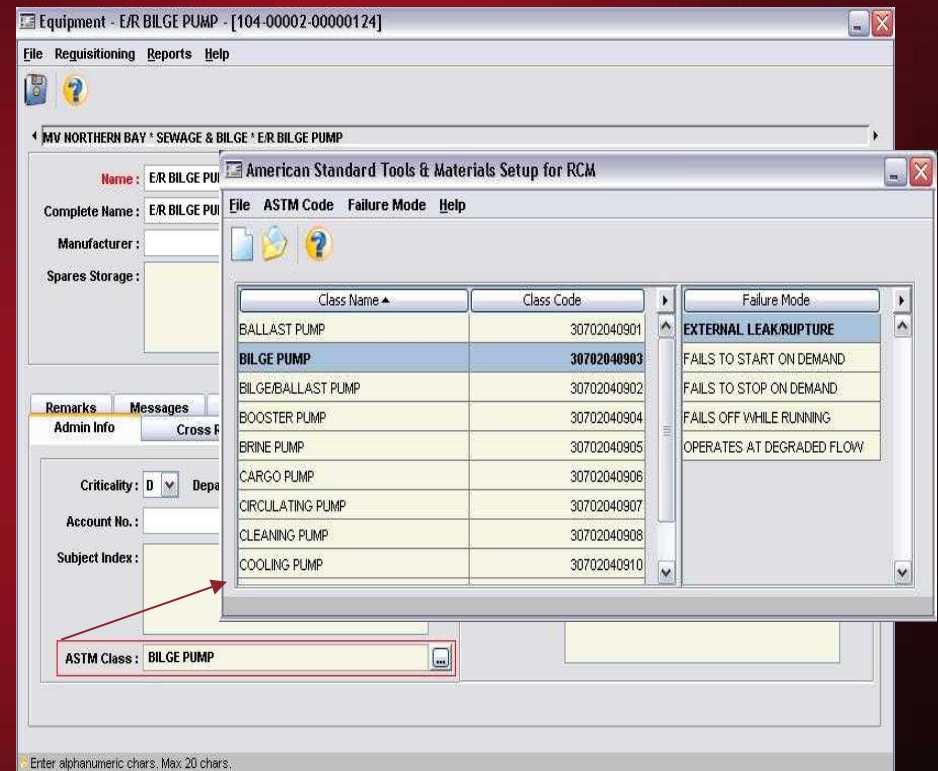
- Failure Mode – used in RCM analysis
- Failure Cause – used in RCM analysis
- Secondary Costs – e.g. lost revenue
- Added hours/minutes for offline/online – for detailed reporting

ASTM Codes and Failure Modes Mapping

→ Added

→ Equipment Class Code for data comparison - exchange per ASTM F2446-04

→ Applicable failure modes and equipment linked and customizable



Work Order Query

- Equipment Class Codes permit benchmarking of similar equipment
- Comparisons within fleet permissible
- Comparisons with other fleets possible now

The screenshot shows the 'Work Order Query' application window. The title bar reads '[0] Work Order Query'. The menu bar includes 'File', 'Tag', 'View', and 'Help'. Below the menu bar is a search bar with a search icon and a search field. The main area is titled 'Search Companion' and contains several sections:

- Search On Work Order :**
 - Job Types:** Service Requisitions, Work Orders, No-Action Jobs, SPO Items
 - Job Status:** Scheduled Jobs, Completed Jobs, Closed Jobs
 - Minimum Priority Level :** D
 - Date Range:** All, Select. From: [] To: []
- Indexes Failure Data:**
 - Failures Only, Non-Failures Only, All
 - Cause :** CRACKED
 - Mode :** EXTERNAL LEAK/RUPTURE
 - Total Repair Cost Over :** 10,000.00 USD
 - Equipment Offline:** All, Select. From: 08/01/2006 To: 08/31/2006

Buttons for 'Search' and 'Close' are at the bottom. A footer note says 'Enter date as MM/dd/yyyy:'.

Reports

Equipment Failure Report

Lists all failures as produced by WO Query.

Mean Time to Repair

All failures (as produced by WO Query) are used to calculate MTTR for each combination of Equipment and Failure Cause

Failure Count by Vessel

Number of failures per vessel, over a given time period.

Export failure data

Export failure data (as produced by WO Query) for analysis in e.g. Excel.

Concluding Remarks

- RCM provides sound basis – practical approach for developing maintenance program
 - An improvement in MTBF from 1,045 hours to 2,681 between failures of equipment
 - A reduction of \$150,000 in annual pump overhauls
 - A 62% reduction in low frequency maintenance tasks

Concluding Remarks

- RCM Module developed to ease RCM analyses
- NS5 and RCM Module enhanced to exchange data either way
- NS5 enhanced to collect RAM data for benchmarking and sustainment
- Properly implemented, RCM can be an alternative to classification periodical surveys of machinery

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