

A large U.S. Navy ship, possibly a fleet ocean tug, is seen on the horizon under a dramatic sunset sky. In the foreground, a submarine is partially visible, moving through the water and leaving a white wake. The overall scene is a maritime setting with a focus on naval vessels.

RCM/CBM: Realizing Inherent Reliability at Lowest Total Life-Cycle Cost

U.S. Navy Ship Approach

Ken Jacobs

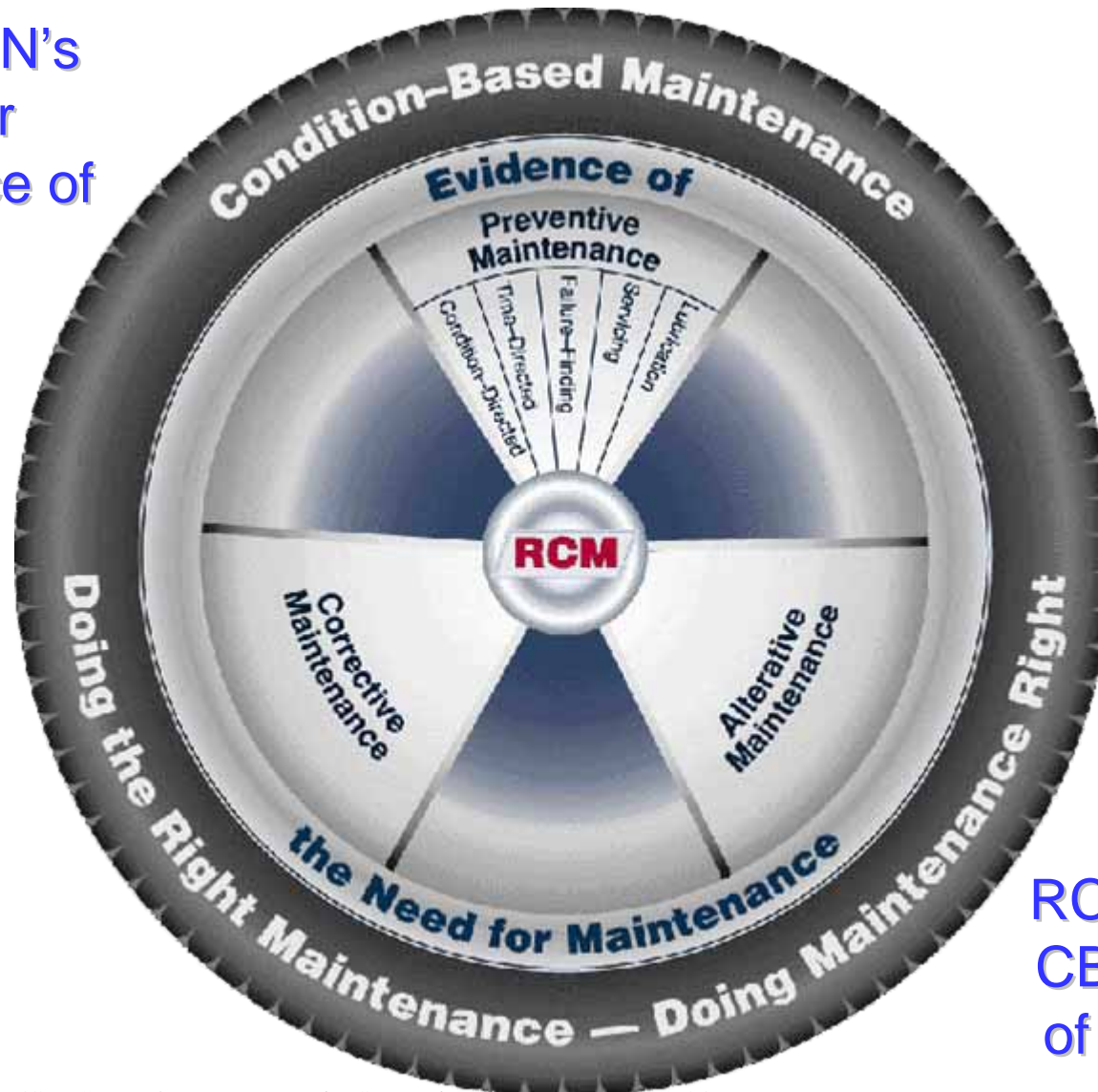
Director, Maintenance

Engineering Division (SEA04RM)

RCM Is the Hub of CBM



CBM is USN's policy for maintenance of ships.



RCM provides CBM's "Rules of Evidence."

US Navy Maintenance

Definitions



DoD Directive 4151.18 – dated 31 March 2004

“Maintenance programs shall consist of (RCM) applicable and effective tasks for addressing the failure modes and effects using Reliability-Centered analysis...”

OPNAVINST 4700.7K – dated 11 July 2003

“Maintenance procedures... are to be developed and performed in accordance with CBM.... This will be determined in accordance with RCM.”

Class Maintenance Plans “will be based on CBM methodology using RCM principles.”

OPNAVINST 4790.16 – dated 6 May 1998

“CBM – A strategy that stipulates the performance of maintenance only when there is objective evidence of need.”

“RCM – A method which identifies applicable and effective maintenance tasks needed to maintain the inherent reliability of systems or equipment at minimum cost. RCM provides rules for determining appropriate objective evidence of need.”

Two RCM Processes



Initial PMS Development (Classic Approach)

Interfaces

Risk Assessment

Risk Management

Age Exploration

Partitioning

FMEA

RCM
Logic

Continuous
Improvement

Requirement

Benefit

Task Value

Age Degradation

Applicability

Effectiveness

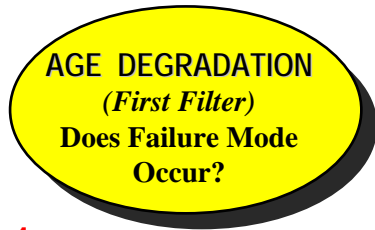
“Does Failure Mode
Occur ?”

“Does Task Restore Reliability?”

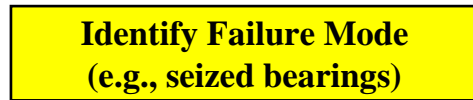
“Does Task Pay for Itself?”

Maintenance Effectiveness Review (MER) (“Backfit” Approach)

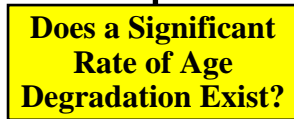
Roadmap for applying CBM to Maintenance Tasks



Step 1:



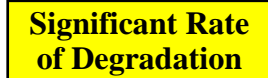
Step 2:



No Yes



• No task



Step 3:

Determine/Classify Type Task

TIME- DIR. (TD)	CONDITION- DIR. (CD)	FAILURE- FINDING (FF)	SERVICING (S)	LUBE (L)
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Step 4:

Is the Existing Maintenance Task Applicable?

Apply Rules for Applicability

TD: Life Renewal Replace/Restore
CD: Health Monitoring
FF: Hidden Failure (Find/Repair)
S/L: Servicing and Lubrication

No

Yes

Task Does Not Satisfy Applicability Rules

- Redesign
- Improve task
- "Fix when failed"

Task Does Satisfy Applicability Rules

Step 5:

Identify Failure Consequence

Step 6:

Is the Maintenance Task Effective?

Apply Rule for Effectiveness

Safety or the Environment (Law)
Operational performance (Mission)
All other failures

No

Yes

Task Does Not Satisfy Effectiveness Rule

- Extend periodicity
- Sample Vs 100% inspection
- Make situational
- Redesign task
- See other options

Task Does Satisfy Effectiveness Rule

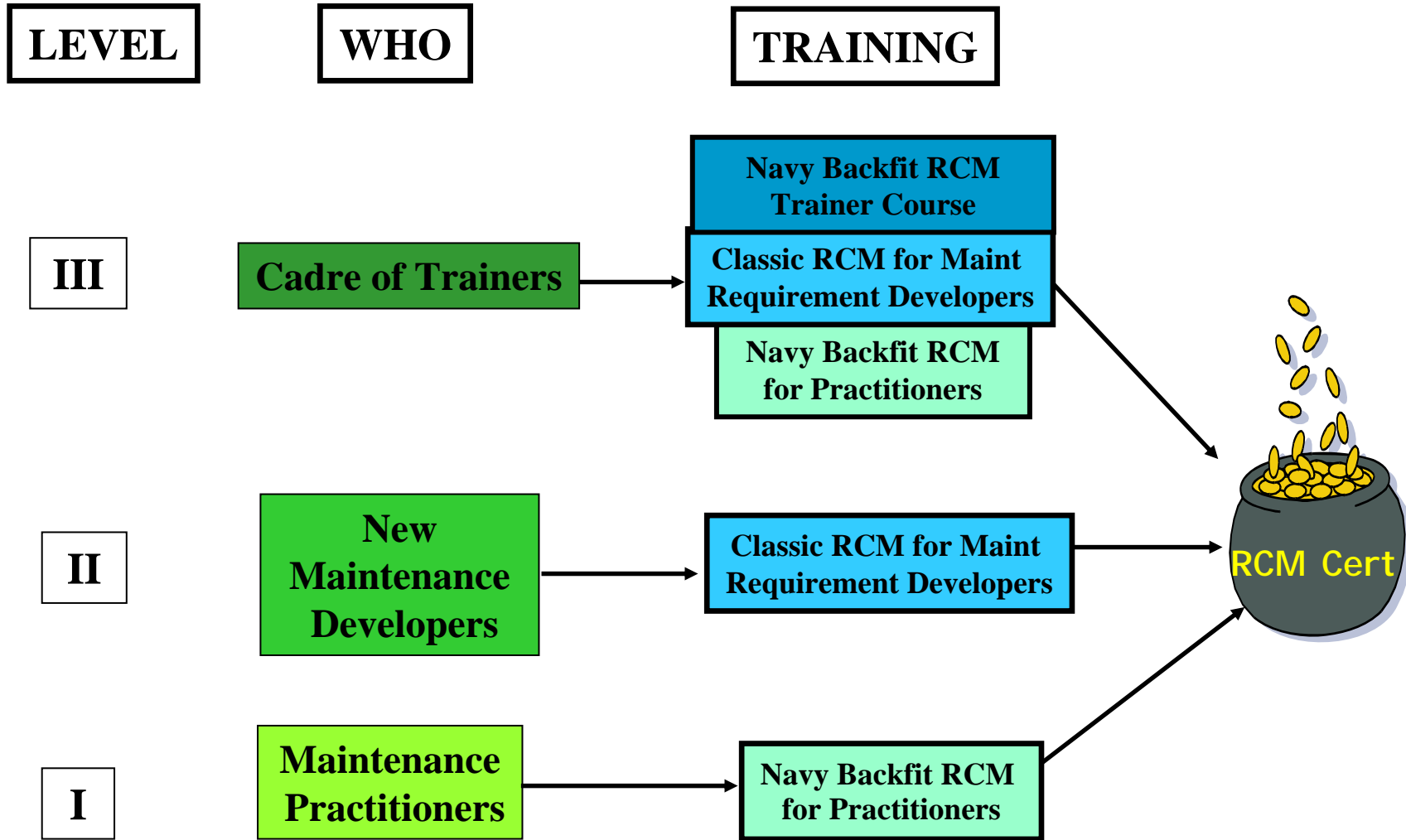
Step 7:

Can Task Be Improved?

Schedule Task



NAVSEA RCM Certification Program



RCM for CBM-Enabling Technology Selection



Step 1:

Identify the Functional Failure

Step 2:

Is it reasonable to expect this failure mode will occur during the lifetime of the equipment?

No Yes

No or Acceptably Slow Rate of Degradation

• No need

What are the measurable failure mode parameters?

Step 4:

Can the technology accurately and consistently detect failure mode onset?

Apply Rules for Applicability

TD: Life Renewal (Replace/Restore)

CD: Health Monitoring

FF: Hidden Failure (Find/Repair)

S/L: Servicing and Lubrication

No

Yes

Technology Does Not Satisfy Applicability Rules

- Redesign
- Improve technology
- "Fix when failed"

Technology Does Satisfy Applicability Rules

Step 3:

Determine/Classify Type Parameters

TIME- DIR. (TD)	CONDITION- DIR. (CD)	FAILURE- FINDING (FF)	SERVICING (S)	LUBE (L)

Step 5:

What is the ROI of the technology WRT failure consequence?

Identify Failure Consequence

Apply Rule for Effectiveness

Safety or the Environment (Law)
Operational performance (Mission)
All other failures

No

Yes

Technology Does Not Satisfy Effectiveness Rule

Reject technology

Technology Does Satisfy Effectiveness Rule

Accept technology

Step 6:

• Develop Recommendations for Change

Continuous Improvement: Periodic re-evaluation and adjustment of application



Summary



- RCM and CBM are DoD requirements
- CBM is Maintenance based on ‘Evidence of Need’
 - RCM provides the ‘Rules of Evidence’
- NAVSEA’s Program
 - RCM Certification Required
 - Two differing processes, initial development and continuous improvement
 - CBM Enabling Technology insertion uses the same basic ‘Rules of Evidence’