

Learning from Root Cause Analysis Collins Class Submarines

Rodney Brown
ASC Chief Engineer



My Submarine Background



Platform Trials COLLINS
Build

Marine Engineer Officer
HMAS FARNCOMB
HMAS RANKIN

PNR WA

Exchange Officer - Canada
SSO SUBS (Victoria Class)

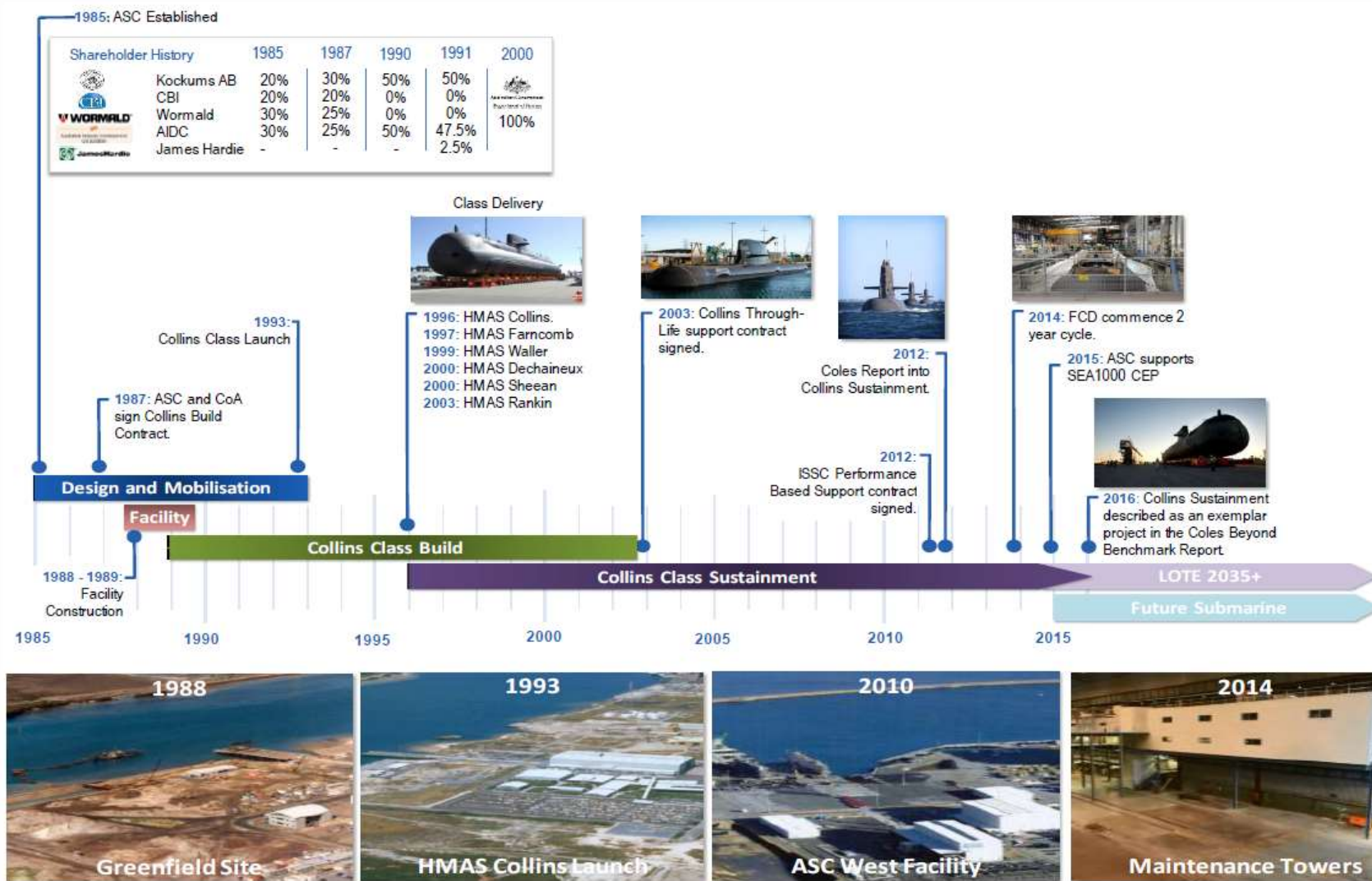


ASC Engineering Manager WA
ASC Chief Engineer CCSM

Marine Engineer
Officer
HMAS ORION
HMAS OTAMA
(Oberon Class)



History of Supporting Australia's Submarine Capabilities



CCSM Total Days Available



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A Key Failure – kicked started our RCA Program

- Original build cane arrangement in French built generators allows good airflow and cooling of the canes
- In country build agent for the generators have bundled canes which reduces airflow and cooling – heat builds up in centre of bundle
- In country build agent for generators VPI process did not work
- Lead indicator s
 - 2002 Generator Failure – Its okay we replaced in FCD
 - 2008 Thermal damage to generator canes – insitu repair
 - 2009 RCA completed and class remediation commenced



French built generators

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In country agent - built generators

Stator canes

Failure Modes

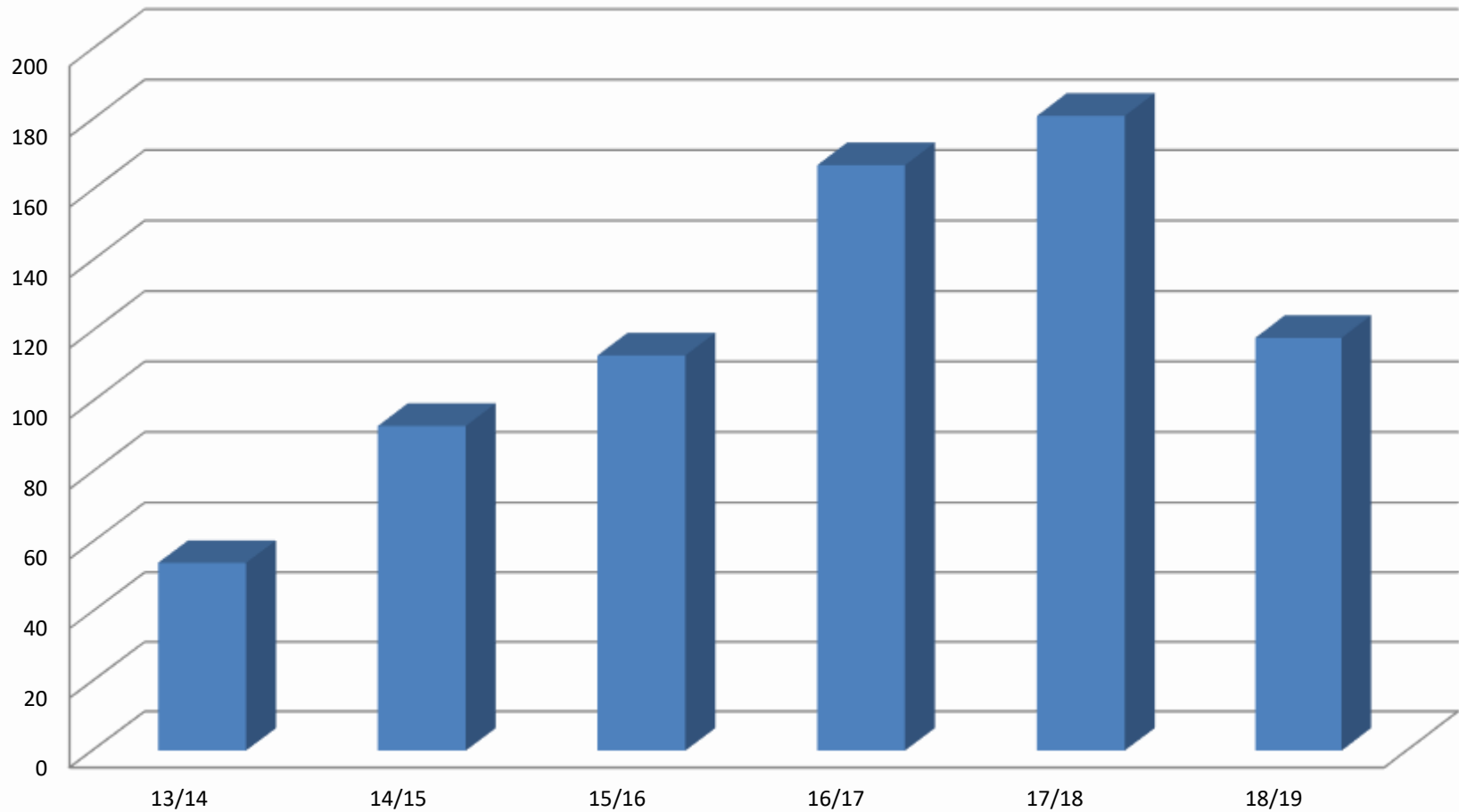


1. Inadequate VPI causing a turn to turn failure within the slots



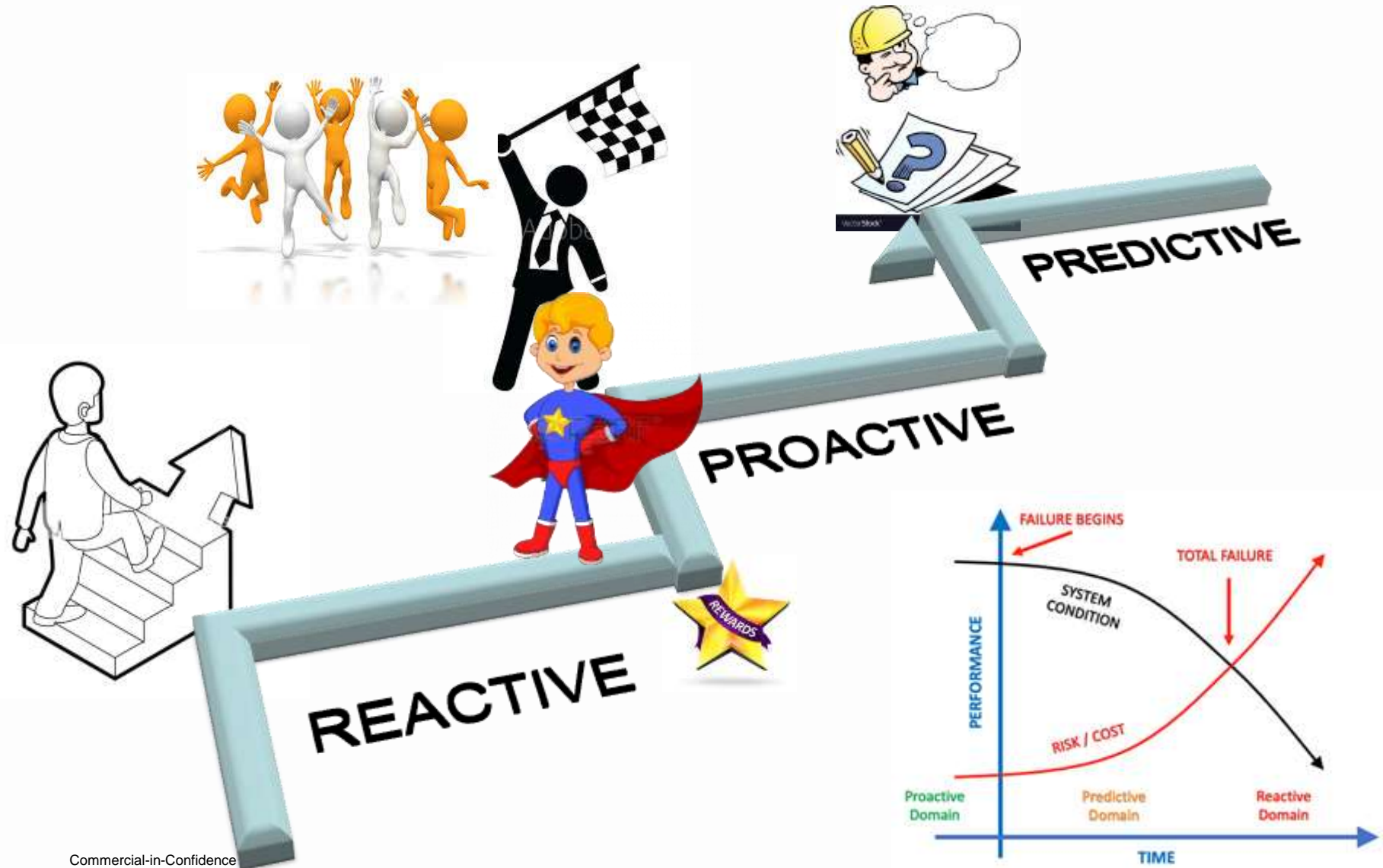
2. Inadequate cane separation causing a thermal run away failure

Total Root Cause Analysis Investigations



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CULTURE - CELEBRATING THE FIX



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Root Cause Analysis

- RCA
 - Reactive approach to implementing a proactive plan
 - Conducted on critical failures
 - Consider criticality of failure including consideration:
 - Quality of work / materials / maintenance decisions
 - Cost of prevention Vs failure
 - Schedule impact to operational objectives
 - How could early failure be detected through PACA

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ROOT CAUSE ANALYSIS

PRE AVAILABILITY CONDITION ASSESSMENT

PLANNED MAINTENANCE
DEFERRED WORK (MCP)
CONCESSED WORK (PDR)

SET TO WORK

HARBOUR ACCEPTANCE TRIALS
(NAVY)

SEA ACCEPTANCE TRIALS (NAVY)

FAILURE

RCA – Who Cares?

- GM CCSM
 - Contract Performance is output based. Profit impacted by:
 - Days submarine is available – agreed cost /day when submarine not available
 - Days submarine is at a defined level of capability
- Supply
 - \$ wasted on non compliant / performing material
- Project Managers
 - \$ lost of fixing the same defect
- GM Operations
 - Trade frustration of fixing the same thing / rework

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UUC Change

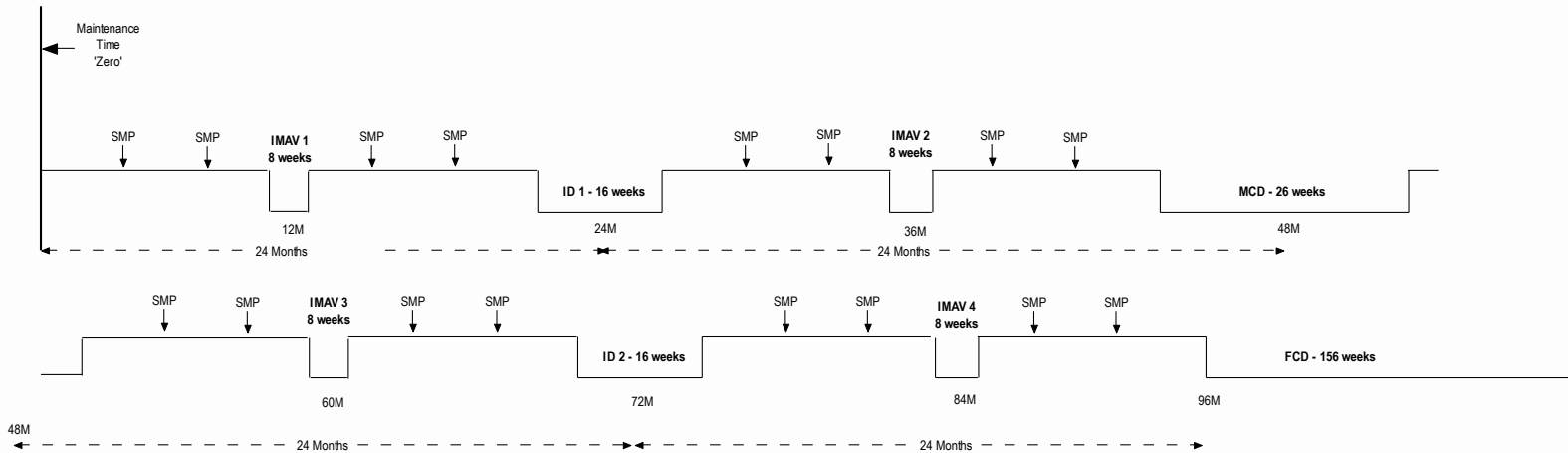
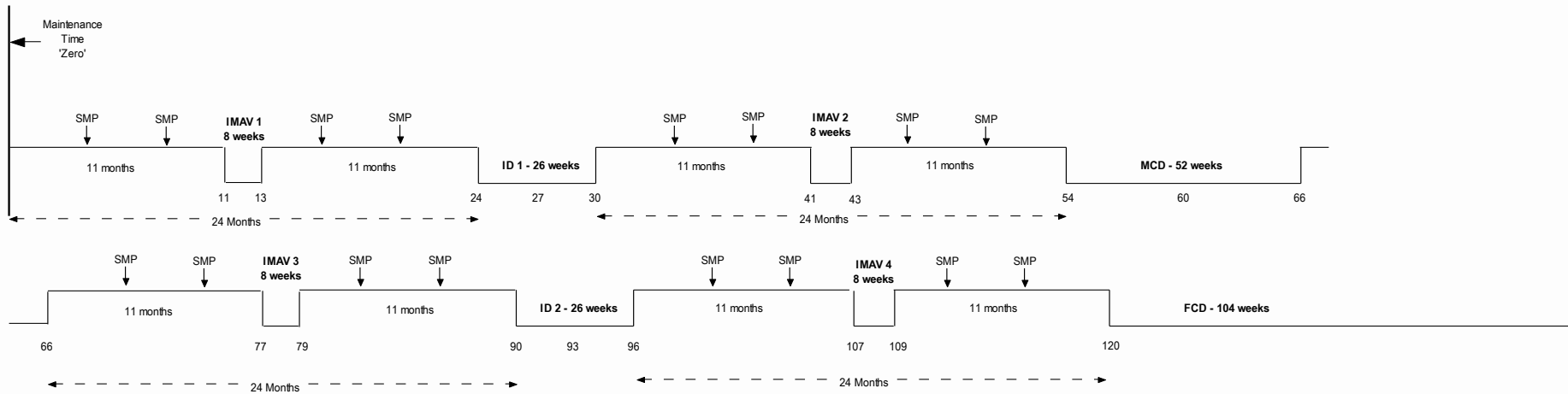


Figure 1 – Current 8 + 3 UUP



Work Scope in FCD

Single Coat Paint Scheme



Cumferential Hull Cut



Maintenance Support
Towers (MST)



Lessons Learnt from RCA Program

- The root causes can be varied, so data alone will not solve root causes
- Vital that customer is engaged in the plan – Joint Procedure
- Whole of business approach
- Context of the Submarine lifecycle is critical to keep RCA output current
- Be able to identify the point you can solve the issue with an action to reduce wasted effort
- Be careful not to get tunnel vision / complacency
- Think, Plan before Act!

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Lessons Learnt from RCA Program

- Mid Life Issues arising – Identify Risk equipment and how to monitor for lead indicators
- Fit / Form / Function
 - Is it Seaworthy for the application
- Material Supply
 - Change of suppliers and variance of quality
- Change Management
 - Maintenance Baseline (UUC)
 - Design / Experience of OEM/OED
 - Operation of the platform
- Procedures / knowledge

FREON UNIT FAILURE – Urgent Repair!

- Issue: No root cause of fault tree analysis conducted
 - Unit #2 Freon Unit Starter Failure
 - Removed control rack from Unit#2 and replace with unit#1
 - Unit #1 not operational due to compressor
 - The failure remains
 - unit #1 is not operation due to compressor and control rack
 - Remove control rack from unit#3 and put into unit#2
 - The failure remains
 - The control rack from #3 is now unserviceable
 - *There are NO serviceable Freon Units and No idea of the root cause to fix*

BLEED SCREW – Results in Water in Hydraulics

*Cost:
Docking a
submarine to
rectify*



Quick Win:

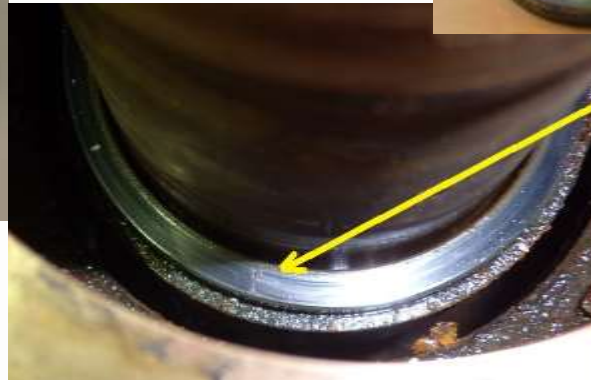
- We revised the calculated torque settings
- Replace during FCD

Bilge Pumps Failures – Vital Information not readily available

- Material Delivery Reports when OEM refurbish had indicators
- Failures appeared random – no RCA previously conducted
 - EW only addressed rectification
 - Maintenance reviews just reported failures were too random to implement a planned maintenance strategy
- Operating procedures were inducing failure
- Training was teaching this incorrect procedure
- Design not providing sufficient flow in all scenarios
- CBM not complete to identify this pump failure

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Bilge Pumps



Change in Fuel Line supplier

Torque value in fitment changed

- Not captured in the maintenance baseline



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Halon Seals

Root Cause

- Change in material hardness
- Batch impact
- Importance of hardness in design for seal
- Opening reports – the importance can be underestimated



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Duty Cycle impact



- The 3 FREON units were cycling excessively due to previous control system logic
- Identified through ISCMMS Data
- Other failures were masking this root cause

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Weight Compensating Pump Failures

- Appeared to be on the rise
- MTBF has not changed
 - Importance of cycles Vs time in the UUC
- Now implementing design improvements to support UUC

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Summary

- Moving from a Reactive Rewarding Environment to a proactive and ultimately predictive approach is a CULTURAL challenge
- Needs all of business buy in
 - Success is when projects are asking for RCA
- Need to be able to fund actions
- Need to advertise success
- Output needs to be in context to the current environment

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QUESTIONS



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