Senate Standing Committee on Foreign Affairs, Defence and Trade

QUESTIONS ON NOTICE - COMMITTEES

Senate Additional Estimates

Q142 - Collins Sustainment

Senator Johnston provided in writing:

In relation to benchmarking, in answers to May QON 64 Defence advised that "A redacted version that would not require clearance from the participating organisations would not offer any significant value. Defence has sought through ASC, clearance of a full version from participating organisation. DMO formally request ASC to seek clearance in early April 2011, as the lead contractor for the review. Advise in yet to be received that the two overseas contributing organisations have agreed to release the report. ASC are awaiting a formal response. a)What is the status of the clearance for release? b)When will this report be tabled? c)Why hasn't it been tabled to date?

Response:

a) The report has been cleared for release.

b) The report is attached.

c) Tabling of the report was delayed while formal written clearance was sought from the originators, and then processed for release within the Department.

IMPORTANT NOTE

The following Maintenance Benchmarking Review was undertaken by ASC, Electric Boat and Kockums as an initial fact-finding comparison. The Review was intended to be the basis for further analysis and a more detailed study. The information from Electric Boat and Kockums was provided on the basis that the recipients would have a significant level of submarine design, build and maintenance experience.

Maintenance Benchmarking Review

7 May 2010

Overview of Presentation

- Background
- The Review Team and its task
- Constraints and method
- Analysis and findings
- Recommendations

The Review Team

- Eric Jones, EB
- Mike Peterson, EB
- Kai Stenborg, Kockums
- Peter Thuvesson, Kockums
- Trevor Harrison, ASC retired
- Jane Cleasby , ASC Worksmart
- Hans Wicklander, ASC

- 233 years of submarine experience

The Task

Scope

c) ASC will undertake a Maintenance Benchmarking Review to determine improvements in efficiency and effectiveness of COLLINS Class maintenance by comparing the current maintenance practices, philosophy and methods against US and Swedish practices. ASC will be supported by EB and Kockums. EB and Kockums will be tasked to prepare information of submarine maintenance enabling comparison. An integrated Benchmarking Review team will conduct the review during two weeks in Adelaide. The team will comprise two staff from each of ASC, EB and Kockums. ASC will lead the team. One representative for CoA will be invited to participate.

d) The activity will take into account the differences between the US, Swedish and Australian submarine communities, normalising the effects of, for example, operational environment, equipment fit, and organisations.

e) The Review will:

   i) Identify all tasks/activities undertaken by each community w.r.t maintenance.

   ii) Identify which specific organizations (contractor, government , etc.) within each community who undertakes those tasks.

   iii) Identify if the Australian community is performing tasks which the other communities are not, and the necessity of those tasks.

   iv) On similar tasks, identify performance (qualitative and quantitative) of ASC compared to the other communities.

   v) Make recommendations for improvements, and cost savings w.r.t Collins maintenance, and determine areas where further study is required.

C

f) Where appropriate, the review shall consider in its comparisons:

i) Maintenance philosophies

ii) Maintenance activities undertaken, outputs and services provided identifying which organisation within the submarine community undertakes the activities.

iii) Where Australian maintenance activities differ between US and Swedish communities, identify if the activity is required

iv) Maintenance processes, work practices, and Objective Quality Evidence practices

v) Technical regulatory systems

vi) Maintenance documentation

vii) Logistics Engineering practices

viii) Customer/maintainer commercial arrangements

ix) Performance metrics

Deliverables

g) A final presentation shall be produced to include:

i) Comparisons of maintenance philosophies and activities, overall maintenance costs, fleet availability, system/equipment reliability.

ii) Overview of differences between maintenance in the US and Swedish submarine fleets, as determined in c).

iii) Recommendations that will lead to measurable improvements in operational availability and an increase in value for money for COLLINS Class maintenance through life.

iv) Areas for more detailed future study (if required).

Constraints

- One week homework (4 man weeks effort)
- Two weeks IPT in Adelaide (14 man weeks effort)
  - 26 April - 7 May 2010

- Information presented by the review team is based on face value of information provided to the team
- Limited time available to go back to source documents

- Total effort about 800h
- Cost about $250k

Our Method

- Homework conducted by EB and KAB
- Information gathering at ASC
- Analysis
  - Brainstorm
  - Discussions
  - Calculations
  - Studies of ASC documents
  - Small case study
- Review
- Presentation

Maintenance Philosophy

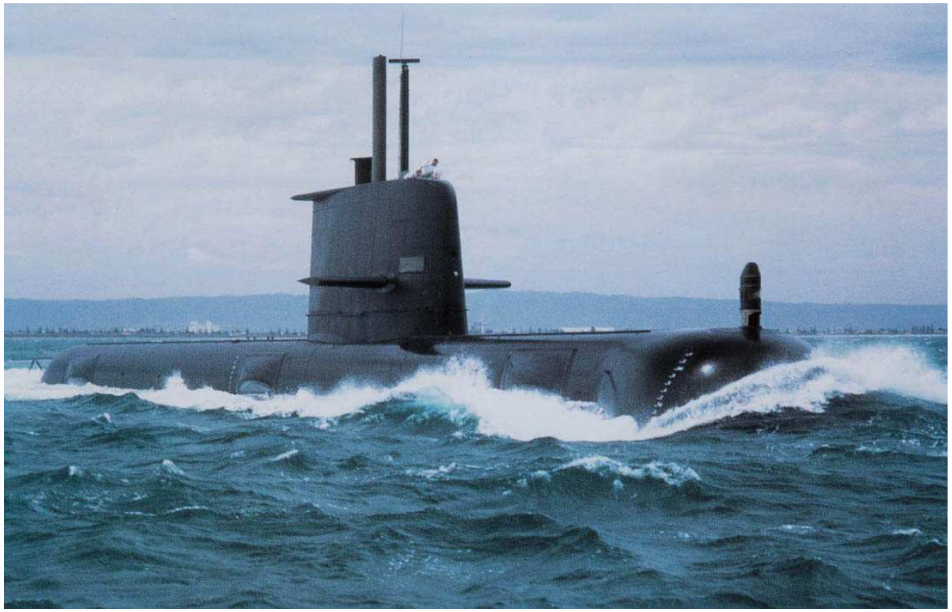
- AUS
  - ASC does maintenance according to the UUC
  - All maintenance done according to SIMS ensuring compliance
  - Crew does little maintenance other than at sea
  - Crew leaves boat at ASC for Depot level activities
  - ASC procures parts for Depot level (FCD) activities - CoA provide for all other activities. (After 2012 ASC will be solely responsible for the platform component of the Collins supply chain)
  - Limited rotatable pool
- SWE
  - KAB conduct maintenance in accordance with a Plan (UUC)
  - Crew does all maintenance between availabilities
  - Crew has Matcon except for Depot level availabilities
  - Crew is always there, except for Depot level, where only small but competent core remains
  - Condition Based Maintenance
  - LOGBAT (Navy) defines scope and provides all replacement parts
  - Adequate rotatable pool which ensures part availability when required
- US
  - US conduct maintenance in accordance with a Operational Lifecycle Plan (UUC)
  - Submarine base (I) and naval/private shipyards (D) conducts maintenance
  - Crew has Matcon except for Depot level, where specific systems are handed to maintainer
  - Crew is always there and does planned maintenance
  - Condition Based Maintenance via crew and shipyard pretesting
  - O level maintenance accomplished to Planned Maintenance System
  - I and D level maintenance accomplished to Class Maintenance Plan
  - Executing activity procures all replacement parts
  - Significant rotatable pool

Operational Environment

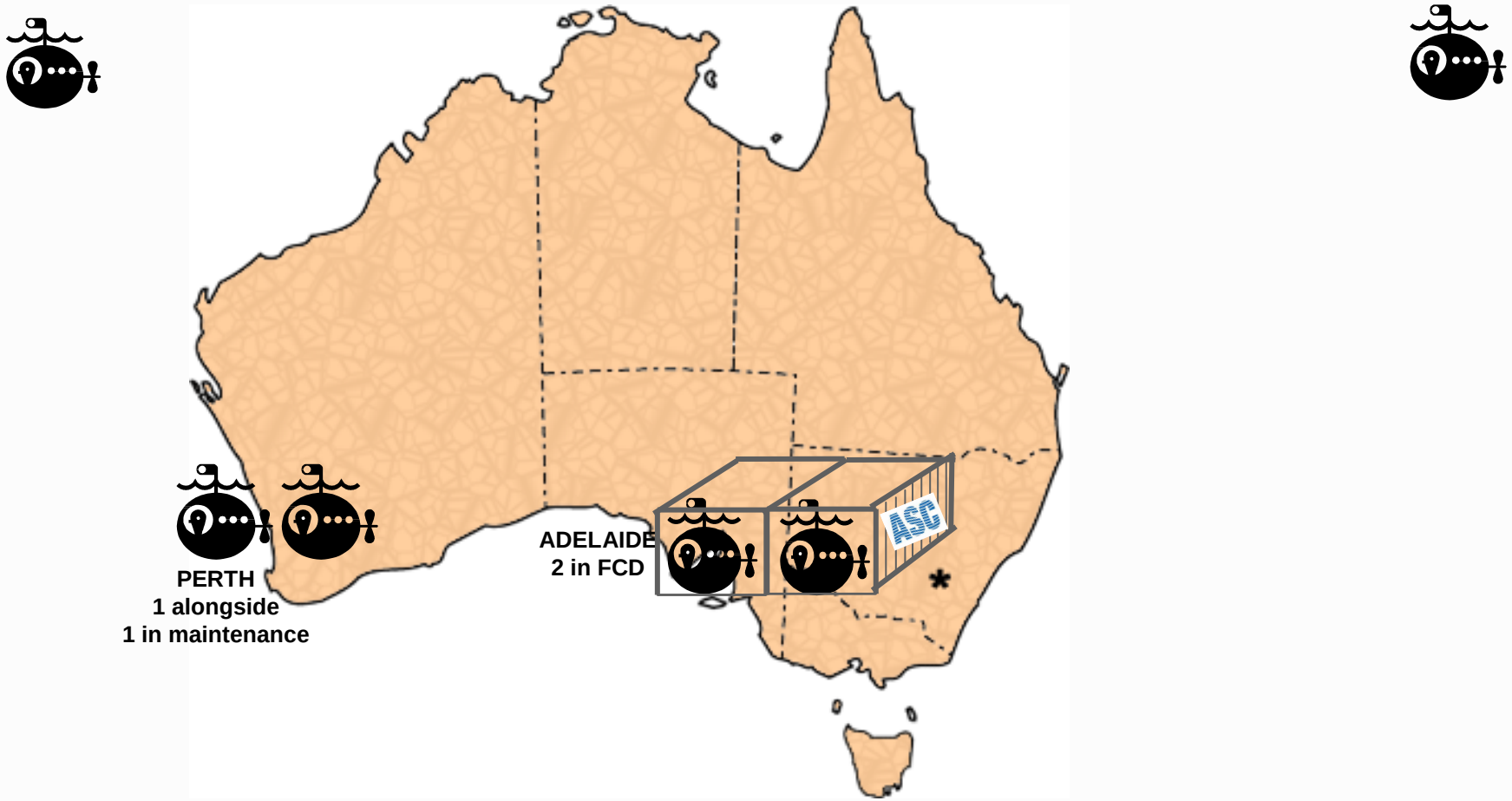
- US
  - Average ocean salinity 3.3-3.8 %
  - Temperature range -2 to 30 C
  - Long operations, small percentage is transit
- SWE
  - Baltic average salinity 0.75 %
  - Temperature range 0 to 25 C
  - Short operations, small percentage is transit
- AUS
  - Average ocean salinity 3.3-3.8 %
  - Temperature range 10 to 35 C
  - Long operations, high percentage is transit

AUS Submarines

- 6 Collins – average age is 10 years
- Crew of 43, with enough submariners to man three boats
- Collins class is reference
  - 3000 tonnes
  - Diesel electric



AUS Submarine Maintenance Enterprise



AUS Support to Submarine Maintenance

- DMO - Design Acceptance Representative
- DMO - ASC customer
- Submarine force - has the crews

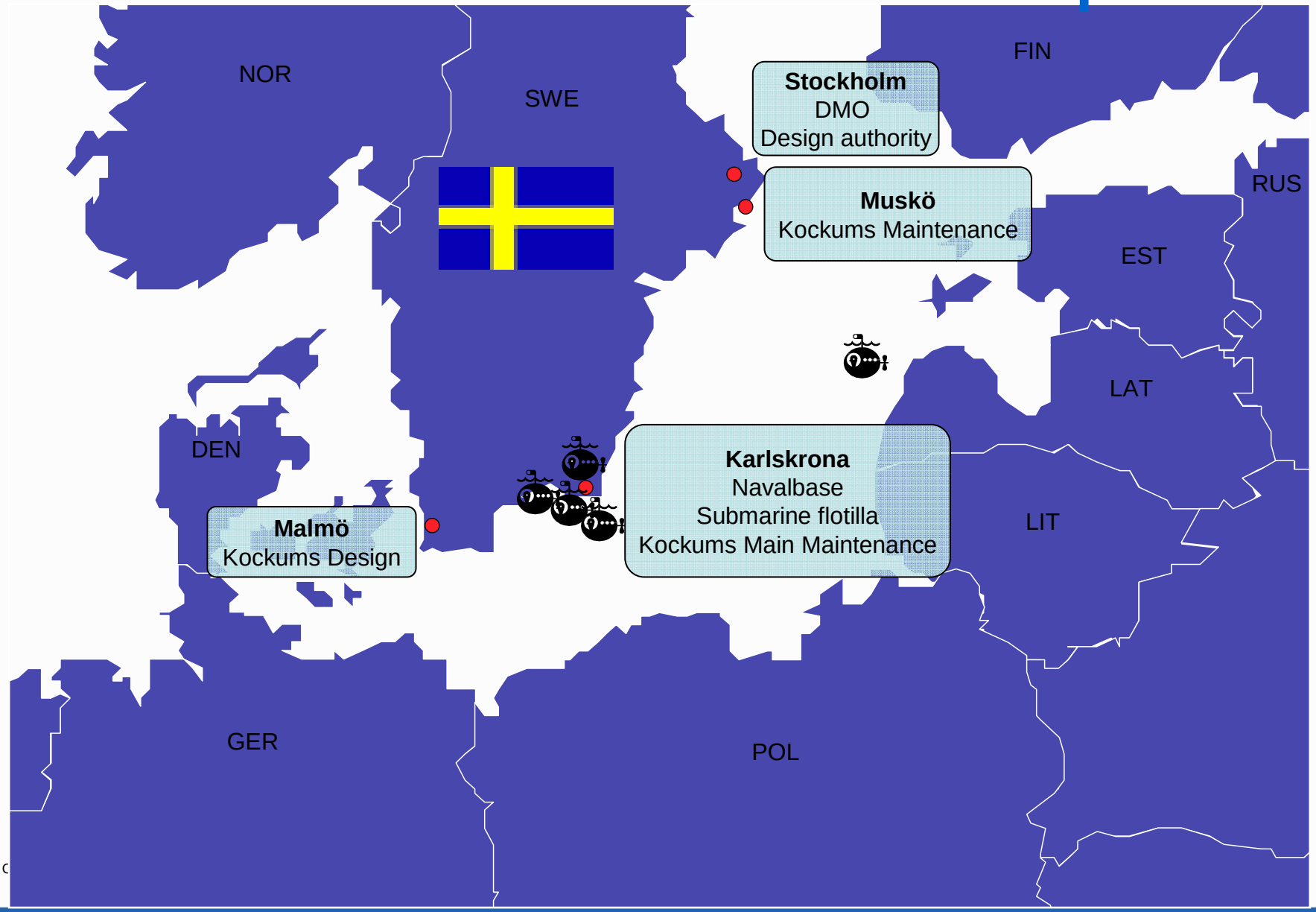
- ASC - Plans the work and does the work
- ASC in service Design Authority

- LSA-N - Defence supply chain for in service
- ASC - Supply chain for FCD
- OEMs
- DSTO - limited role for regular maintenance

SWE Submarines

- 3 Gotland – average age is 11 years
- 2 Västergotland, – average age is 22 years , midlife upgrade 2003-2004
- Crew of 28
- Gotland class chosen as reference
  - 1600 tonnes
  - Diesel electric, all have AIP

SWE Submarine Maintenance Enterprise



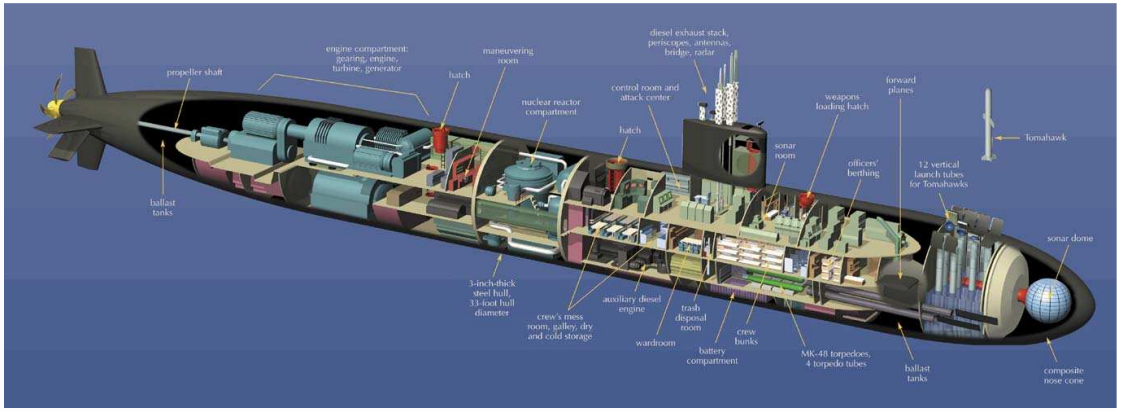
SWE Support to Submarine Maintenance

- FMV, Design Authority - very limited role for regular maintenance
- LOGBAT – Kockums customer, plans the work and gets the spares
- Submarine force – has the crews

- Kockums shipyards – does the work
- Kockums Submarine Design – very limited role for regular maintenance

- FMLOG (defence supply chain)
- Navy workshops for weapons
- Saab - combat system
- OEMs
- Defence Research Establishment (FOI) - very limited role for regular maintenance

US Submarines



- 52 SSN – average age is 16 years
- 14 SSBN – average age is 19 years
- 4 SSGN – average age is 27 years

- There are 17,570 submariners allocated to the above boats with 3,366 on training at any one time.

- SSN 688, Los Angeles class, chosen as reference
  - 6900 tonnes
  - Nuclear, diesel for emergency power/air replenishment only
  - Crew of 143

Overview of the U.S. Submarine Enterprise

Maine
- Portsmouth Naval Shipyard
Kittery, ME
-Submarine Maintenance Engineering Planning and Procurement Activity
- Kittery, ME

Indiana
- Naval Surface Warfare Center Crane Division
Crane, IN

Rhode Island
- Naval Undersea Warfare Center – Newport
Newport, RI
- Electric Boat
Quonset Point, RI

Connecticut
- **COMSUBGRU-2**
- **SUPSHIP Groton**
- **General Dynamics Electric Boat**
Groton, CT

Washington
- Naval Undersea Warfare Center – Keyport
Keyport, WA
-COMSUBGRU-9
Bangor, WA
- **Puget Sound Naval Shipyard**
Bremerton, WA

Pennsylvania
- **Naval Surface Warfare Center – Philadelphia**
Philadelphia, PA

California
- SUBRON-11
San Diego, CA

Maryland
- Naval Surface Warfare Center Carderock Division
Carderock, MD

Virginia
- COMSUBFOR
- **Norfolk Naval Shipyard**
Portsmouth, VA
SUPSHIP Newport News
- Huntington Ingalls Industries
Newport News, VA

Washington, D.C.
- **Naval Reactors**
Washington, D.C.
-Team Submarine
Washington, D.C.

Georgia
- COMSUBGRU-10
Newport News, VA

Guam
- **Naval Base Guam**
Apra Harbor, Guam

Japan
- **COMSUBGRU-7**
Yokosuka, Japan

Hawaii
- COMSUBPAC
Pearl Harbor Naval Shipyard
Pearl Harbor, Hawaii

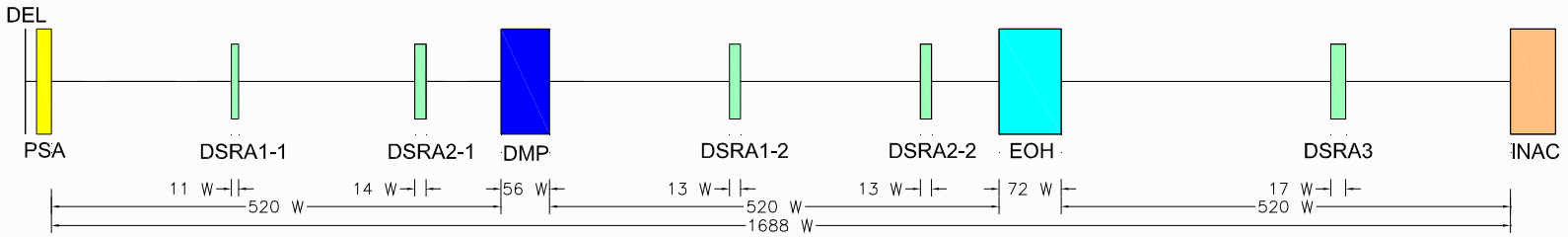
Italy
- COMSUBGRU-8
Naples Italy

US Maintenance Framework – Submarine Maintenance Lifecycle Evolution - Summary

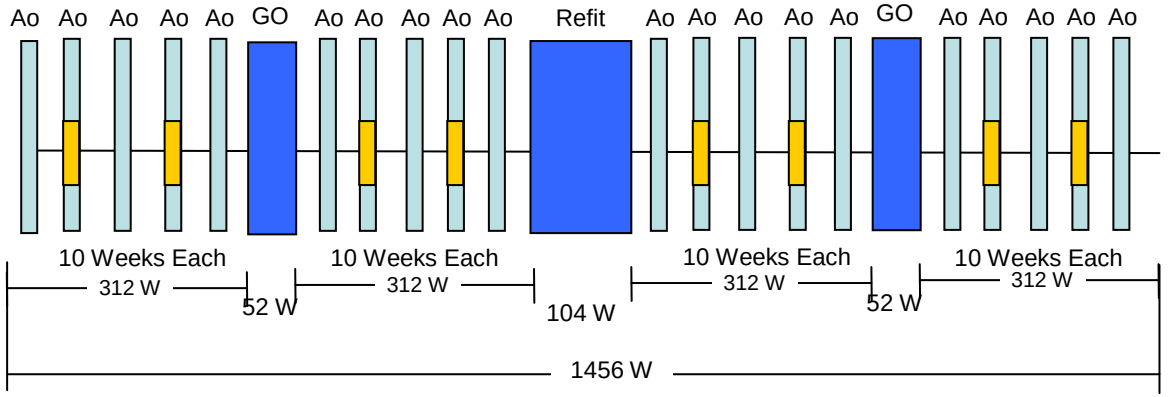
- SSN 688 Class submarines lifecycle maintenance costs have been reduced from over 1,000,000 man-days (MDs) in 1974 to approx. 526,000 MDs by 2011, a 40% reduction.
- Service life extension
  - SSN 688 - From 30 yr. to 33 yr. (10% increase)
  - SSBN 726 - From 30 yr. to 42 yr. (40% increase)
- The optimisation of the SSN 688 Class Life Cycle Maintenance Plan and Extension of the Design Service Lives of the SSN 688 and SSBN 726 Classes was the result of thorough technical reviews of material condition feedback and maintenance data collected on these and previous classes of submarines.

Usage and Upkeep Cycles

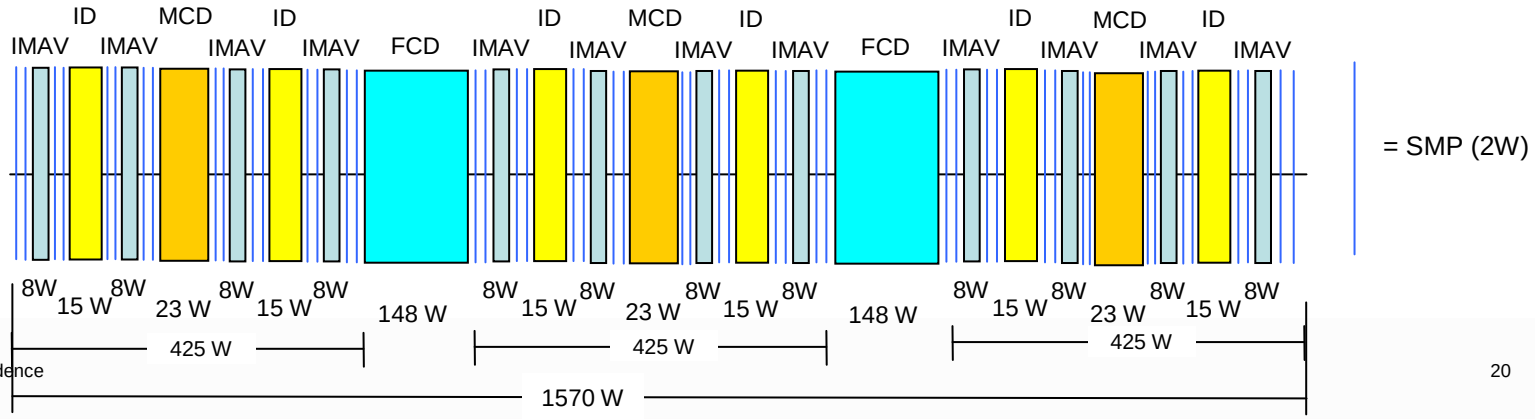
US
71%
Availability



SWE
72%
availability



AUS
65%
availability



Usage and Upkeep Cycle

- **Assumptions 1(2)**
  - The comparison UUC chart includes all Intermediate & Depot level maintenance
  - Organisational (Crew) level maintenance is not included
  - AUS data includes only maintenance hours - does not include
    - ASC Corporate overhead labour hours
    - Enhancement (Generation) hours (design and implementation)
    - Safety/Certification
    - Configuration Management
  - SWE data includes maintenance hours performed by KAB plus all subcontractors who work on site
  - US and AUS data includes maintenance hours performed by them, but does not include subcontractor hours whether the work is conducted on site or off site: e.g. OEM overhaul

Usage and Upkeep Cycle

- **Assumptions 2(2)**
  - Data does not consider impact of man hour charge out rate: i.e. cost to execute
  - Based only on planned and corrective maintenance identified to be worked within the planned maintenance periods
  - Hour/schedule impact of URDEFs/CASREPs/UHB and associated voyage repairs not taken into account

Comparison Usage and Upkeep Cycles

	Activity type	Maint manhours per activity type (,000s)	Number of times activity performed over life of submarine	Total maint manhours, per activity type, used over life of submarine (,000s)	Total maint manhrs used over life of submarine (,000s)	Maint manhours (hours) cost per tonne-year	Life of submarine (years)	% of life ready for sea	% of life at sea	% of life in maint activities	Maint cost of Ownership (,000s of maint hours) per 3000 tonnes		
											Per year of life	Per available sea year	Per actual sea year
US							33	71	43	12			
Los Angeles Class	DRSA	252	2	504									
6900 tonnes	DRSA	252	2	504									
	DRSA	320	1	320									
	DMP	1,160	1	1160									
	EOH	1,725	1	1725	4,213	18.5					55.7	92.8	214.9
SWE	AO	10	20	200			28	72	20	28			
Gotland Class	GO	80	2	160									
1600 tonnes	GO/MCV	200	1	200	560	12.5					38	52	260
AUS	SMP	1	48	48			30	65	35	35			
Collins Class	IMAV	35	12	420									
3000 tonnes	ID	77	6	462									
	MCD	178	3	534									
	FCD	1,169	2	2338	3,802	42.2					127	195	557

Average Manning per Availability (8h Days)

US

- EOH 439 persons
- DMP 428 persons
- DSRA 326 persons (10 hour days)

SWE

- GO/MCV 48 persons
- GO 38 persons
- AO 25 persons

AUS

- FCD 197 persons (over 2 shifts)
- MCD 193 persons (over 2 shifts)
- ID 128 persons (over 2 shifts)
- IMAV 109 persons (over 2 shifts)
- SMP 13 persons

Condition Based Monitoring (CBM)

- **US CBM**
  - US started CBM around 1974 on the 616 class of boats which were at least **a third of their way through their life cycle** i.e. after 10 years.
  - In order to do this they recruited approx 40 engineers and evaluated the maintenance for the 41 SSBNs over a period of 4 years. These were a new part within NAVSEA. Their task was to figure out system/component limitations and evaluate the D level work packages.
  - Site teams were formed to collect data which was analysed by these NAVSEA engineers to determine when maintenance should be accomplished.
  - This resulted in maintenance being reprogrammed to ensure it was both applicable and effective, and resulted in an overall reduction in maintenance over the submarine lifecycle.

- **SWE CBM**
  - For SWE boats KAB started early in 1960 (including empirical information from earlier classes) and developed initial CBM based on early ILS information. This was subsequently enhanced by the crews during service.

- **AUS CBM**
  - ASC has set up a CBM programme, including a Pre Availability Condition Assessment (PACA) conducted prior to major maintenance activities. However the responsibility for carrying out the PACA rests with the crew and is often not completed.

Comparisons

- US and SWE have many short maintenance activities
- US and SWE have more condition based maintenance
- AUS have more equipment ripped out
- AUS have more detailed maintenance instructions than US and SWE
- US crew does more planned and corrective maintenance than SWE crews
- SWE crew does more planned and corrective maintenance than AUS crews

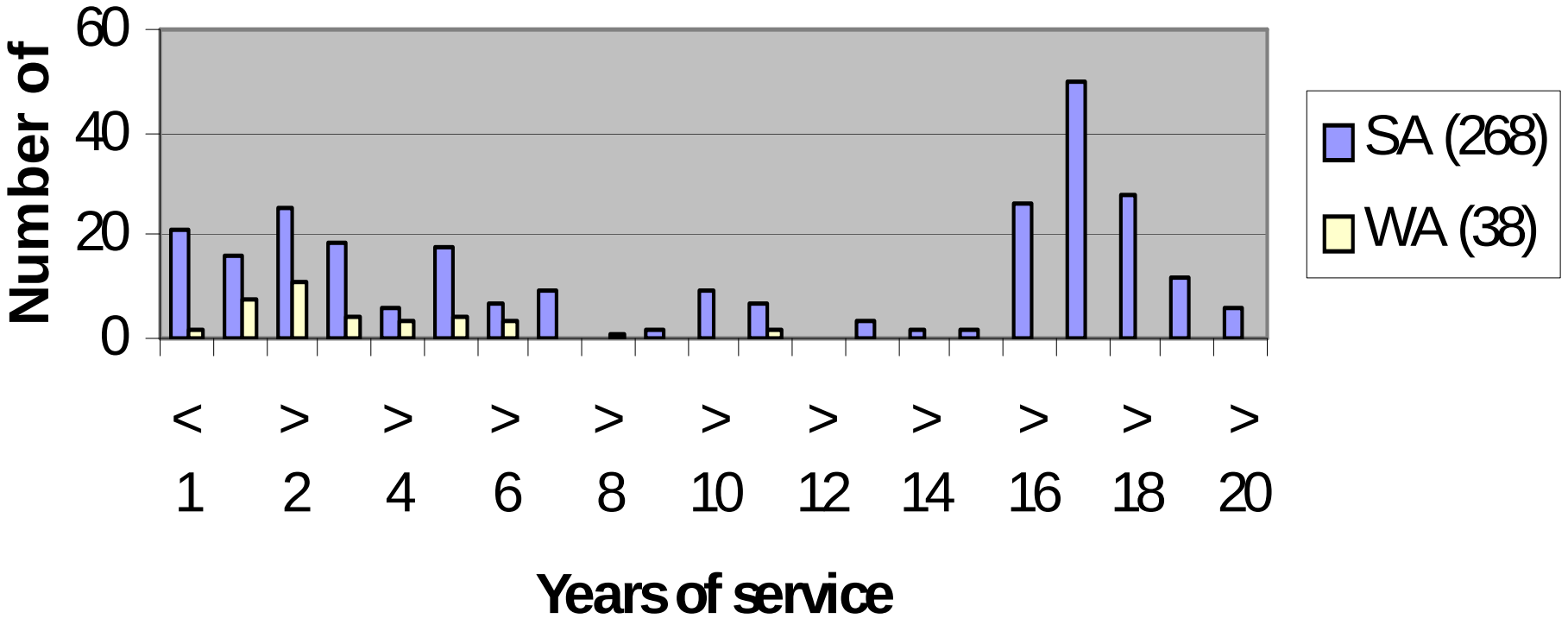
Body of Knowledge

- The US enterprise was reviewed and due to its size and distributed functional responsibilities, it is not practical to use in any comparison. However, a detailed assessment against the SWE enterprise has been carried out.

- Comparison AUS/SWE
  - Office staff versus Production personnel
    - AUS – 296 Office Staff to 394 Production (excluding DGSM) **– ratio 1:1.3**
    - SWE – 111 Office Staff to 347 Production (including 150 navy) **– ratio 1:3.1**
  - Years of service/time on the job
    - AUS – Average years of service, SA 11 and WA 3.6
    - SWE – Average years of service 22 years, average age 42
  - AUS – Single project workforce – shifting from construction to maintenance
  - SWE – Multiple project workforce – gaining experience in new installation for later use in maintenance

ASC Production Workers

(Core employees only)



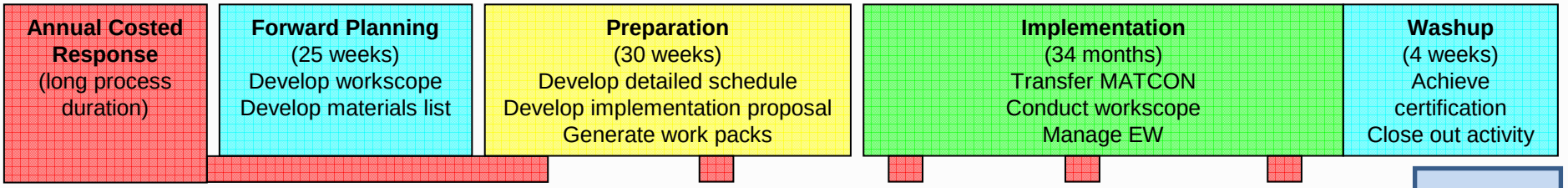
Body of Knowledge – Maintenance Enterprise

- SWE
  - The body of knowledge, supporting the maintenance of 5 boats is about 397:
    - 222 KAB
    - 25 LOGBAT
    - 150 crew

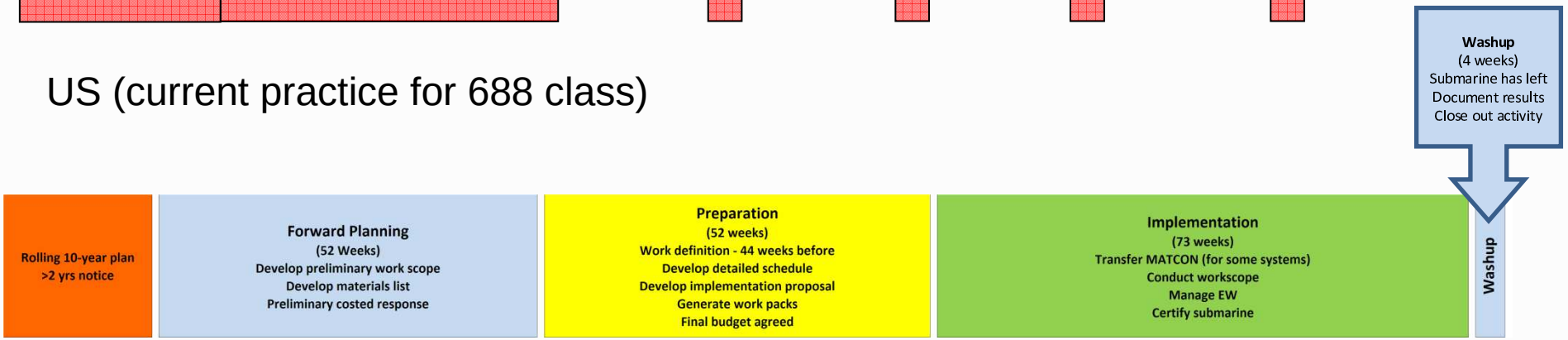
- AUS
  - The body of knowledge, supporting the maintenance of 6 boats is approx 926:
    - 690 ASC personnel
    - 148 DGSM (reduced 40% for Generation)
    - 88 crew

Depot Level Planning Cycle

AUS (current plan)

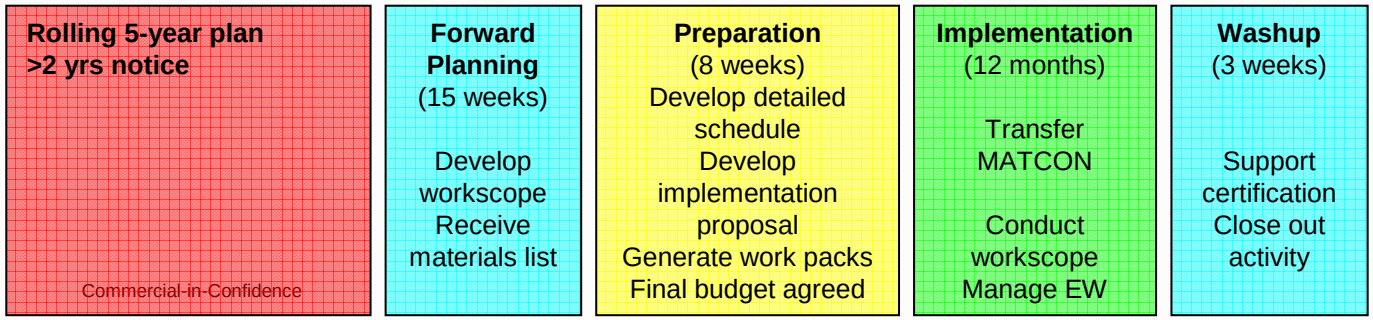


US (current practice for 688 class)



these blocks have been scaled to their duration

SWE (current practice)



Process

- Same objectives US-SWE-AUS
  - Safety
  - OQE

- Different in AUS
  - Level of documentation
  - Work process
  - Regulatory framework

Commercial Environment

- US and SWE spend little time and effort on commercial matters
- Competition is rare in US and SWE
- US and SWE Shipyards know the program of work five years in advance
- US and SWE win contracts for whole activities
- US and SWE - IP is not an issue in submarines maintenance

- Contractual Arrangements
  - US
    - Public shipyards – cost
    - Private shipyards – cost plus and fixed price with incentives have been used
  - SWE - Cost plus, underpinned by a funding agreement
  - AUS
    - TLS – Cost plus
    - In Service Support Contract (ISSC) – Fixed price, shared pain / gain

Performance Metrics

- US
  - Schedule is the main driver
  - Earned Value Management System (EVMS) used, comparing budgeted schedules and progress to return costs
  - CNO availabilities assessed weekly with stop light indicators for both cost and schedule
  - I Level availabilities managed by tracking work list schedules for work load, delinquencies and readiness
- SWE
  - Schedule is the main driver
  - A process similar to EVMS, comparing budgeted schedules to progress
  - All availabilities assessed weekly with the customer
- AUS
  - Schedule has been prioritised as the main driver and a common IMS has been established
  - EVMS used, comparing budgeted schedules and progress to return costs
  - FCD availabilities managed by tracking work list schedules for work load, delinquencies and readiness
  - Weekly stop light reporting of schedules and priority issues to Customer

Fundamental Drivers of Maintenance

- Design
- Usage
- Passage of time
- Environment

- Key factors that impact maintenance
  - Supportable design
  - Balanced operation and maintenance procedures
  - Sufficient knowledge based on feedback and experience
  - Competent workforce
  - Plans balancing operations and maintenance

Recommendations

- Implement comprehensive CBM across the enterprise
  - US and SWE have proven it is beneficial to start during mid life of a class
    - Collins life cycle maintenance could be economised
    - This could be flowed through to future designs
- Incorporate In Service Tolerances
  - When and what to repair or replace
  - Extent of maintenance
- MRR
  - Reduce complexity of non critical MRRs when revising or generating new
  - Address burden carried by MRRs
- Expand FCD Maintenance Instructions

Recommendations

- Invest in rotatable pool components
  - Should shorten repair cycle
  - Will minimise need to cannibalise
  - Improves readiness

- Obsolescence
  - Ensure funding is available to address ‘Whole of Life’ funding model
    - Clear backlog of DMDRs relating to obsolescence
    - Adopt a proactive approach to obsolescence

Recommendations

- Schedule
  - Drive for shorter duration of availabilities
    - Address observations relating to FCD duration
  - Review extent of IMS
    - Enhancements
    - Ageing assets

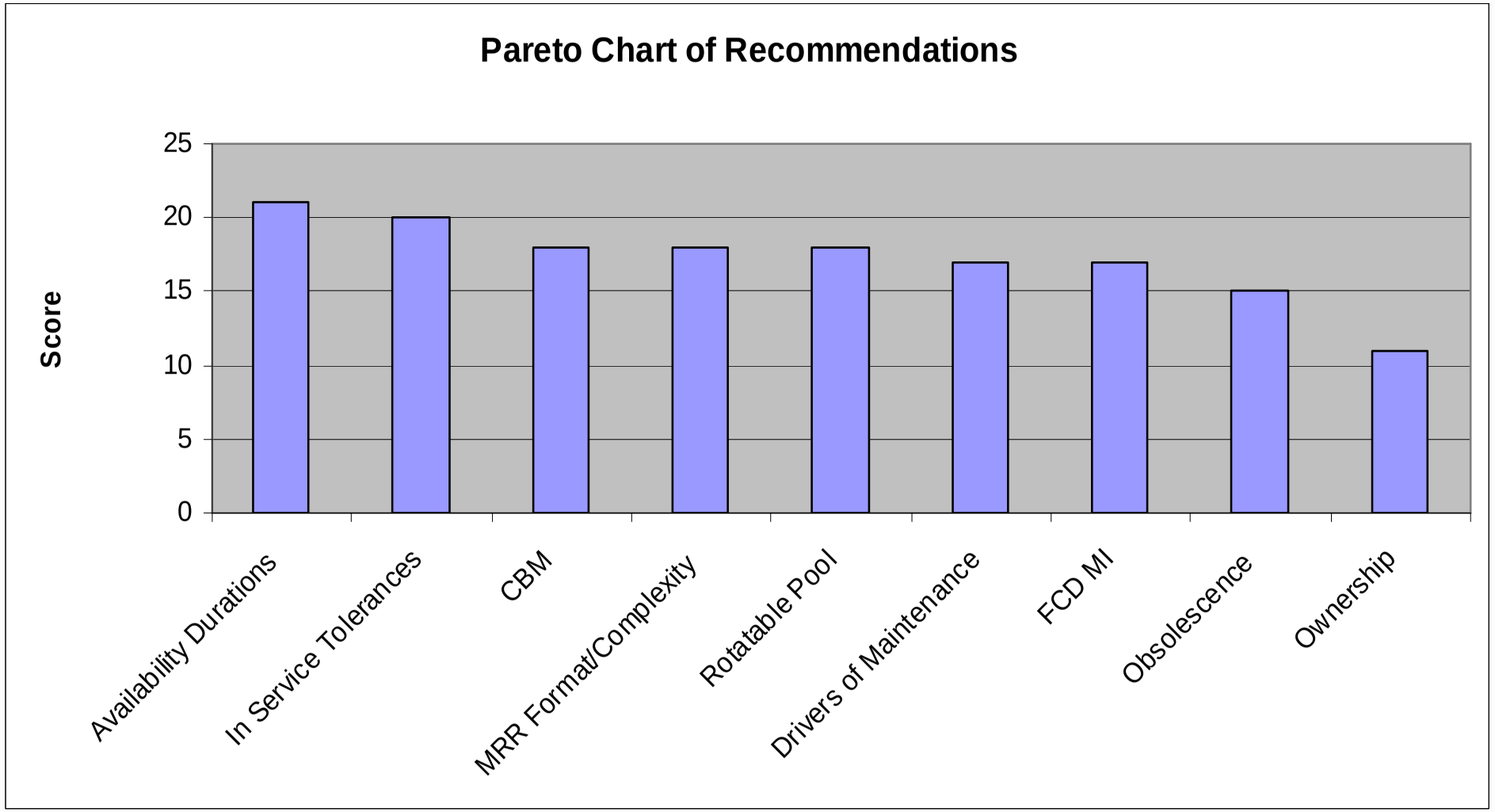
- “Ownership”
  - Have crew retain responsibility through the life cycle
    - Consider using upcoming MCD with skeleton crew as a model for future FCD
      - Allows crew to participate in critical equipment maintenance
      - Enhances maintenance experience of the crew

Recommendations

- Assess Fundamental Drivers of Maintenance
  - Conduct maintenance reduction processes similar to US (Customer Driven)
    - Maintenance Effective Reviews (MER)
      - Involving Production, Fleet/Crew, ILS, LE, D&E
    - Reliability Centred Maintenance Reviews
      - Involving ILS, LE, D&E

Pareto Analysis

Recommendation	Benefit to Maintenance	Cost to implement	Cost Saving	Time Saving	Time to Implement	Total Score
Low to High	1 to 5	5 to 1	1 to 5	1 to 5	5 to 1	5 to 25
CBM	5	2	5	5	1	18
In Service Toleranc	5	3	5	4	3	20
MRR Format/Comp	3	5	3	4	3	18
FCD MI	5	2	4	5	1	17
Rotatable Pool	5	1	3	5	4	18
Obsolescence	4	1	3	4	3	15
Availability Duration	5	2	5	5	4	21
Ownership	3	2	2	2	2	11
Drivers of Maintena	5	1	5	5	1	17


Pareto Chart of Recommendations
Score
25
20
15
10
5
0
Availability Durations
In Service Tolerances
CBM
MRR Format/Complexity
Rotatable Pool
Drivers of Maintenance
FCD MI
Obsolescence
Ownership