READINESS BASED SPARING – SUCCESSES IN THE US NAVY

A WHITE PAPER

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ABSTRACT

Major advances in US Navy logistics / readiness are being addressed through the use of Common Rates Computation System/Common Allowance Development System (CRCS/CADS) and Multi-echelon Readiness Based Sparing (MERBS). MERBS is a business process and decision support system that provides the capability to achieve specified weapon system Operational Availability (Ao) or Full Mission Capability (FMC) goals and minimize investment in spares inventories. It can also maximize readiness at a fixed cost. CRCS/CADS is a client-server system that provides the ability to update all aviation usage rates and turn-around-times (ITAT's) every quarter and to produce the needed allowances in a timely and flexible manner. CRCS/CADS with ME-RBS Workstation provides the ability to build allowances targeting single indenture and multi-indenture aviation readiness goals. The MERBS Workstation and CRCS/CADS provide the evaluation tools to improve future equipment/weapon systems, to optimize the readiness oriented logistics support infrastructure, and to reduce the total cost of ownership. This white paper addresses the features and benefits of this approach and introduces the possibility of its use with other services legacy and modernized maintenance systems. CACI has already achieved significant program savings through various analyses using RBS and ME and MI RBS implementation conservatively estimated in excess of $643 million.

BACKGROUND

CACI was founded in 1962 as a simulation and modeling company. These early beginnings were soon followed by relationships with the Federal government, especially the Department of Defense involving various business functions and processes. The natural evolution of these two brought simulation and modeling to bear on DoD problems such as military logistics, repair, maintenance, supply and readiness. This has led to numerous innovative approaches and technologies for logistics including key breakthroughs in readiness based sparing (RBS).

Historically, DoD has used demand based modeling to determine the appropriate level of spares required to maintain key equipments/weapon systems. Success was measured by fill rate. Under the evolution to RBS, the cost, readiness, reliability, maintainability, and requisition response time for parts not available are considered to determine consumer, or retail, sparing requirements. RBS is a business process (See Figure 1) and decision support system for achieving specified weapon system Operational Availability (Ao) or Full Mission Capability (FMC) goals and minimize investment in spares inventories. It can also maximize readiness at a fixed cost.

Figure 1 – The RBS Process

- **Structured progressive process throughout life cycle.**
- **System and configuration definition and validation.**
- **Engineering analysis – readiness assessment.**
- **Data and rates development, integration and validation**
- **Sparing analyses:**
  - **Single Echelon (SE)**
  - **Multi Echelon (ME)**
  - **Multi Indenture (MI)**
- **Supporting budget analyses**
- **Follow-on assessment**

DOD/US Navy has voiced a need[1] for Integrated Logistics and Supply (ILS) community to help in

- Aging fleet sustainment
- Under-investment recovery
- Multi-echelon tools
- Cost reduction tools
- Optimization of recapitalization/ reliability improvement

[1] Presentation entitled "AMCOM ILS Perspective" during the DA ILS Conference at Redstone Arsenal, AL, 1-3 Feb 2000.

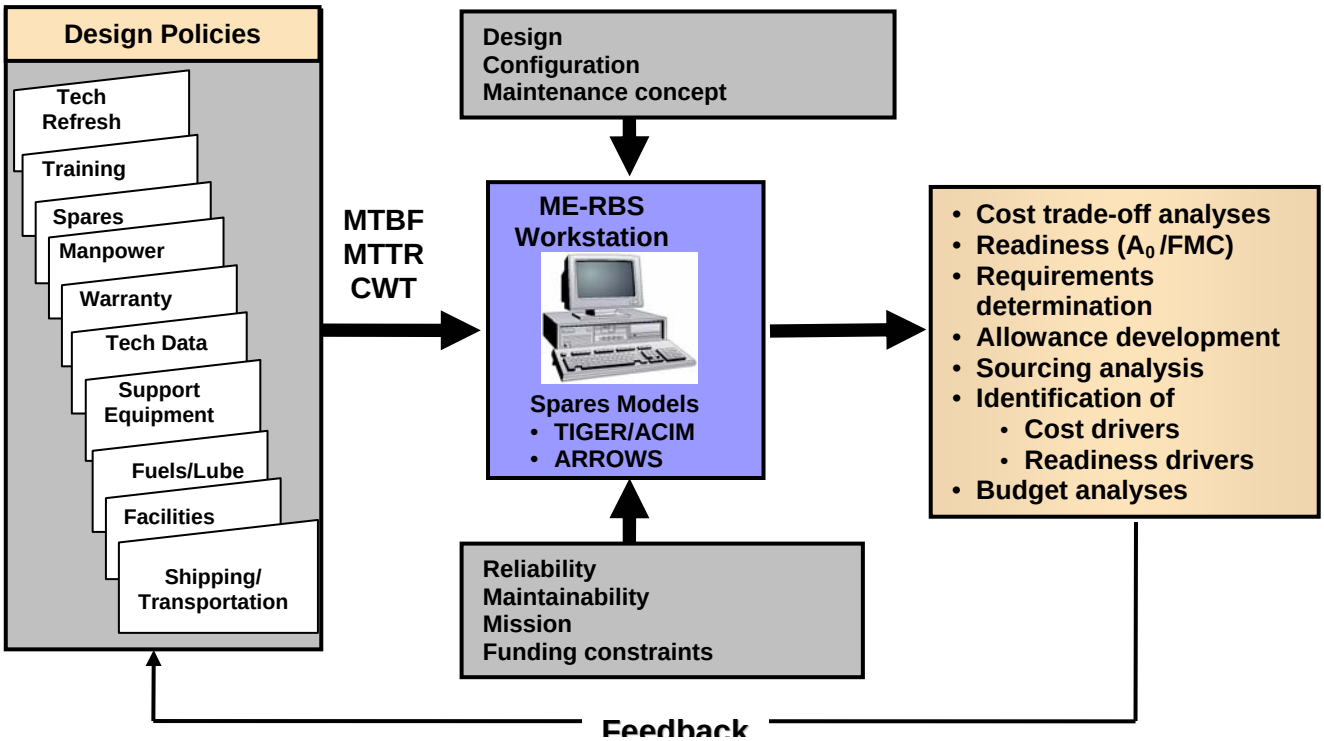
Two key tools in these areas are the CACI Multi-Echelon Readiness Based Workstation (MERBS) and Common Rates Computational/Common Allowance Development System (CRCS/CADS) addressed in this paper can eliminate or alleviate these problem areas.

MERBS AND CRCS/CADS

The CACI-developed MERBS Workstation and CRCS/CADS provide the tools to evaluate future weapon system improvements, to optimize the readiness-oriented logistics support infrastructure, and to reduce the total cost of weapon system ownership through spares optimization focusing on expanding this methodology to take advantage of best commercial practices such as premium transportation and Contractor Logistic Support (CLS)/Performance Based Logistics (PBL).

Multi-Echelon RBS (ME-RBS) takes the RBS concept to an additional level providing a wide range of logistic support solutions (See Figure 2). ME-RBS is a highly flexible methodology that can be applied to new or existing systems, both aviation and ground, and to commercial and non-developmental items. ME-RBS recognizes the interaction between wholesale and retail inventories, using the Logistics Response Time (LRT) as the link to optimize the total inventory. It optimizes the positioning of the spares by trading-off between retail and wholesale stockage decisions.

Figure 2 ME-RBS Inputs and Outputs



ME-RBS is a simulation-based process that is applicable throughout the equipment/weapons system life cycle

ME-RBS starts with the sparing decision based on RBS techniques including determining engineering based criticality, projection of demand considering increases and decreases in system population, and optimizing, using cost, against a given readiness objective. Once readiness targets are established, ME-RBS considers the item's Order and Ship Time (OST), wholesale requisition response time, and

transportation alternatives, and makes decisions on stockage mix and positioning. These trade-offs result in limiting inventory investments while ensuring a full range of coverage at both the retail and wholesale levels and maintaining a given level of readiness. This optimized spares selection and allowance based on maintenance capability and required system readiness has been applied successfully in provisioning and in stockage list development for major USN and USMC systems. These include Aviation Consolidated Allowance Lists (AVCALs) and the Marine Aviation Logistics Support Packages (MALSPs).

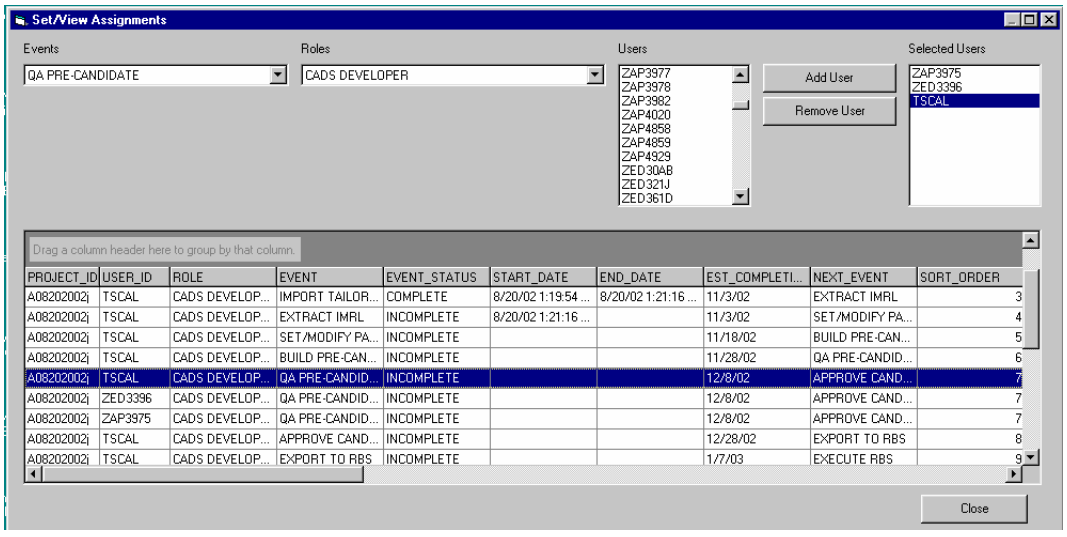
Multi-Indenture (MI-RBS) is an integrated spares computation that utilizes the weapon system parts breakdown, the parent/child relationships, to meet readiness objectives at least total cost. In support of a consumer chain that has a repair facility, MI-RBS optimizes spares selection by trading-off components with their repair parts as well as trading-off among components. With the implementation of CRCS/CADS to provide valid indentured configurations the Navy is quickly moving towards development of MI based allowances. This process is expected to reduce allowances by 20 percent while improving overall support. This process can also be linked to wholesale in a multi-echelon role, thus giving a multi-echelon, multi-indentured readiness based sparing model.

CRCS-CADS is a recently implemented (October 2003) client/server system (see Figure 3) that provides the ability to update all aviation usage rates and ITAT's every quarter and to produce

- Aviation Consolidated Allowance Lists (AVCAL)
- Shore Aircraft Consolidated Allowance Lists (SHORCAL)
- Consumables Consolidated Allowance Lists (CAVCAL)
- Marine Corps PCSP, FOSP and FISP allowances

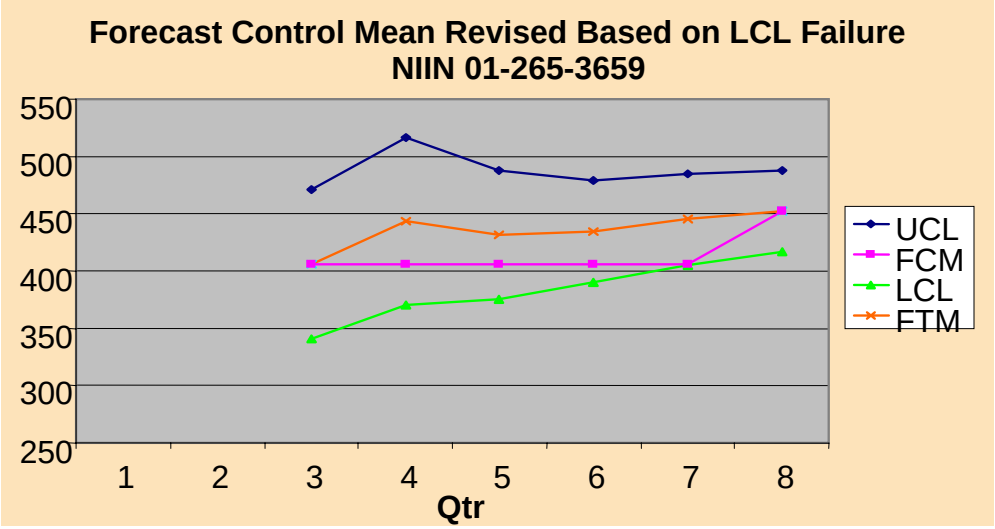
in a timely and flexible manner. It is project oriented supporting configuration management, rates updates (see figure 4), allowance computation and project workflow management through a series of key events. It assignes users roles and access, links data sources and defines business rules and controls for the overall RBS systems. It fully integrates with the MERBS Work Station and thus provides the ability to target Single Indenture, Multi-Indenture MERBS-based aviation readiness goals (see figure 5).

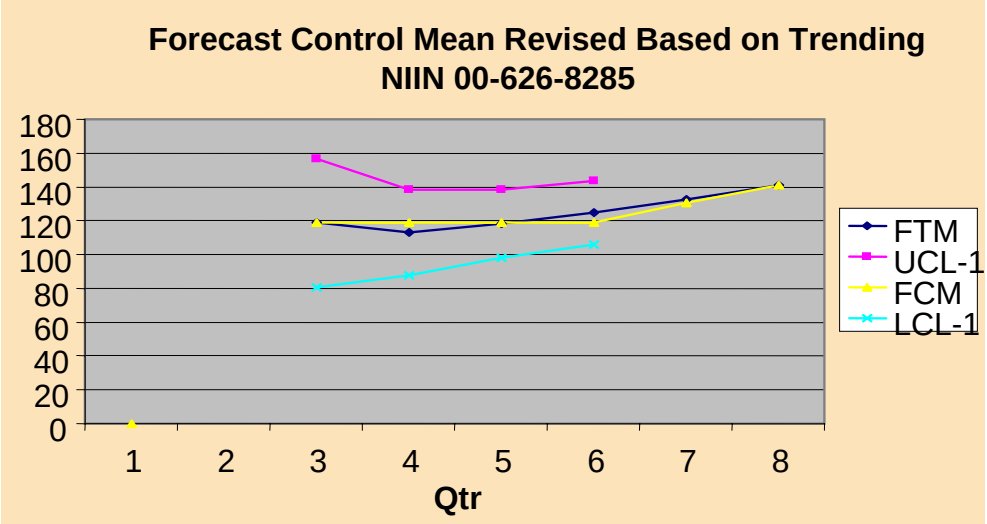
Figure 3 CRCS-CADS – MERBS Integrated Framework



Enables NAVICP to develop allowances during budget and procurement analyses

Figure 4 – CRCS-CADS Provides Forecasting, Analysis and Data Management





DISCUSSION

In order to sustain specified readiness goals for key equipments/weapons systems or sub-systems with minimum investment in spares inventories, RBS implements a structured, progressive process. **The RBS process can be applied to new or existing equipment or weapon systems and to commercial off the shelf (COTS) as well as government-developed equipment. The earlier the process is applied, the greater the benefits in terms of engineering, logistics support and total life cycle cost.**

The MERBS workstation has a series of data validation tools such as the Provisioning Technical Documentation (PTD) quality assurance, Mission Essentiality Code (MEC) validation and the Mean Time Between Failure/Mean Time To Repair (MTBF/MTTR) review tools. In addition, the RBS Work-station has tools for, or can be linked to, tools for Configuration Management (CM), Reliability, Main-tainability and Supportability (RMS) assessment, demand projection and wholesale and retail parts computation. The Computer Aided Readiness Assessment Tool (CARAT), a MERBS workstation tool,

is used to prepare Reliability Block Diagrams, RMS data, and Design Reference Mission data for use in the workstation simulator.

ME-RBS works like the single echelon RBS system except that each stock numbered item receives its own best estimate of Logistics Response Time (Customer Wait Time plus OST) values, which are carried throughout the process. This includes impacts on availability, mean supply response time, and equipment type delay times. Spares optimization takes place at the equipment type level, and individual parts are selected for each equipment type in Ao gained per dollar of unit cost. An optimum iterative procedure then finds the point that yields the weapon system Ao goal.

The above process is repeated for wholesale stock levels determined by seeking diverse Customer Wait Time goals. The resulting total (wholesale plus retail) costs are fit using a least-squares technique, and the minimum of the least-square fit equation rerun through the complete process to determine the overall least total cost inventory. The ME-RBS process has been centralized in the RBS Workstation that provides automated tools to accomplish these procedures and analyze the results.

A collateral use of ME-RBS has been applied to the analysis of CLS/ PBL by using the CARES system within the RBS Workstation to evaluate procurement and repair lead-time variations expected in contractor-managed operations. In this approach, demands from the RBS Workstation are fed to CLS/PBL performance parameters as if it were a war-gaming scenario to determine average days delay and repair quantities in CLS/PBL situations. This allows the determination of the expected value of the wholesale investment and the required performance parameters to support the retail allowances and readiness objectives. This information can be used to establish baselines against which CLS/PBL proposals can be evaluated and to establish contract incentive clauses.

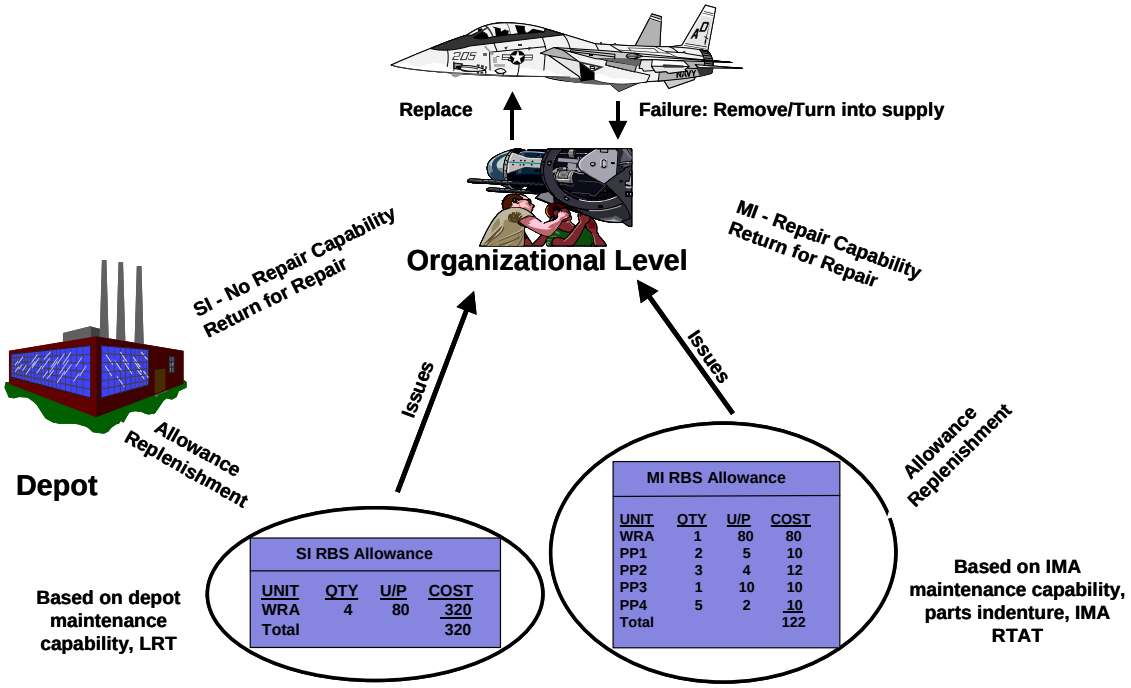
CRCS/CADS is the key integration system for RBS in the aviation arena.

Short Term RBS Application: CRCS/CADS replaces a set of NAVICP-P local unique ADP processes and manual procedures developed in the 1960's. Through the CRCS/CADS approach all rates and ITAT computations are standardized and the rates development and Q/A process proceed separately from allowance development. Thus, adequate time is now available to checkout or review rates and this effort is no longer on the critical path to producing allowances. Statistical Process Control methods and business rules have been implemented to systematically reduce unnecessary allowance churn and stabilize the rates forecasts. CADS provides a state-of- the-art allowance project development and tracking system to organize, execute and manage each step required to build, Q/A and publish the allowance product. Top Down Break Down (TDBD) configuration data by Type / Model / Series (T/M/S) is extracted from the Navy Weapons Systems File (WSF) and stored on the server along with flying hour, Navy Aviation Intermediate Maintenance Depot (AIMD) repair and aviation usage data from the 3M system. This information is coupled with Aviation Equipment Configuration List (AECL) and Allowance Requirements Register (ARR) information to provide the widest possible base for selecting allowance candidates.

Special care was taken in the design of the system to keep the system database architecture as open as possible. Thus, though the WSF may no longer exist in ERP, it seems reasonable that aircraft configuration data and TDBD would not go away since it will remain a key element to any aviation sparing process. The Configuration Data Management System (CDMS) area of CRCS-CADS is capable of supporting a wide range of TDBD and Bill of Materials (BOM) type configuration data structures. Thus, though the CRCS-CADS Extract, Transfer and Load (ETL) programs would need revision to reflect new database sources, all the programs within CRCS-CADS are largely sheltered from such outside disturbances. The same rational applies to changes in flying hour data and aviation repair and usage data. We rely to-

day on the Record-79 SICR-3 reporting system to capture aircraft flying hours and the 3M 4790-2K Vids MAF transactions to capture repair and usage information. Though ERP at NAVAIR may change the physical database source from NALDA-II to some new system or database, there likely will always be a need to record flying hours by T/M/S and to record and store aviation maintenance and parts usage data. Thus, no major problems are foreseen in mapping the ETL programs to work with the future ERP data sources.

Figure 5 – Multi-Indenture RBS optimizes readiness and cost



Improved CRCS/CADS configuration data and workstation MI-RBS capabilities allow additional alternatives to improve support and avoid costs.

Long Term RBS Application: There will always be a need to develop and maintain usage rates and to publish lists of allowed items selected to achieve some readiness goal or objective. These are fundamental mission elements of the ICP Core Business. These functions have become both very specialized and very militarized reflecting many years of technological and business process development. An enormous effort and considerable time would be required to build these capabilities into ERP with little added value above what is available today.

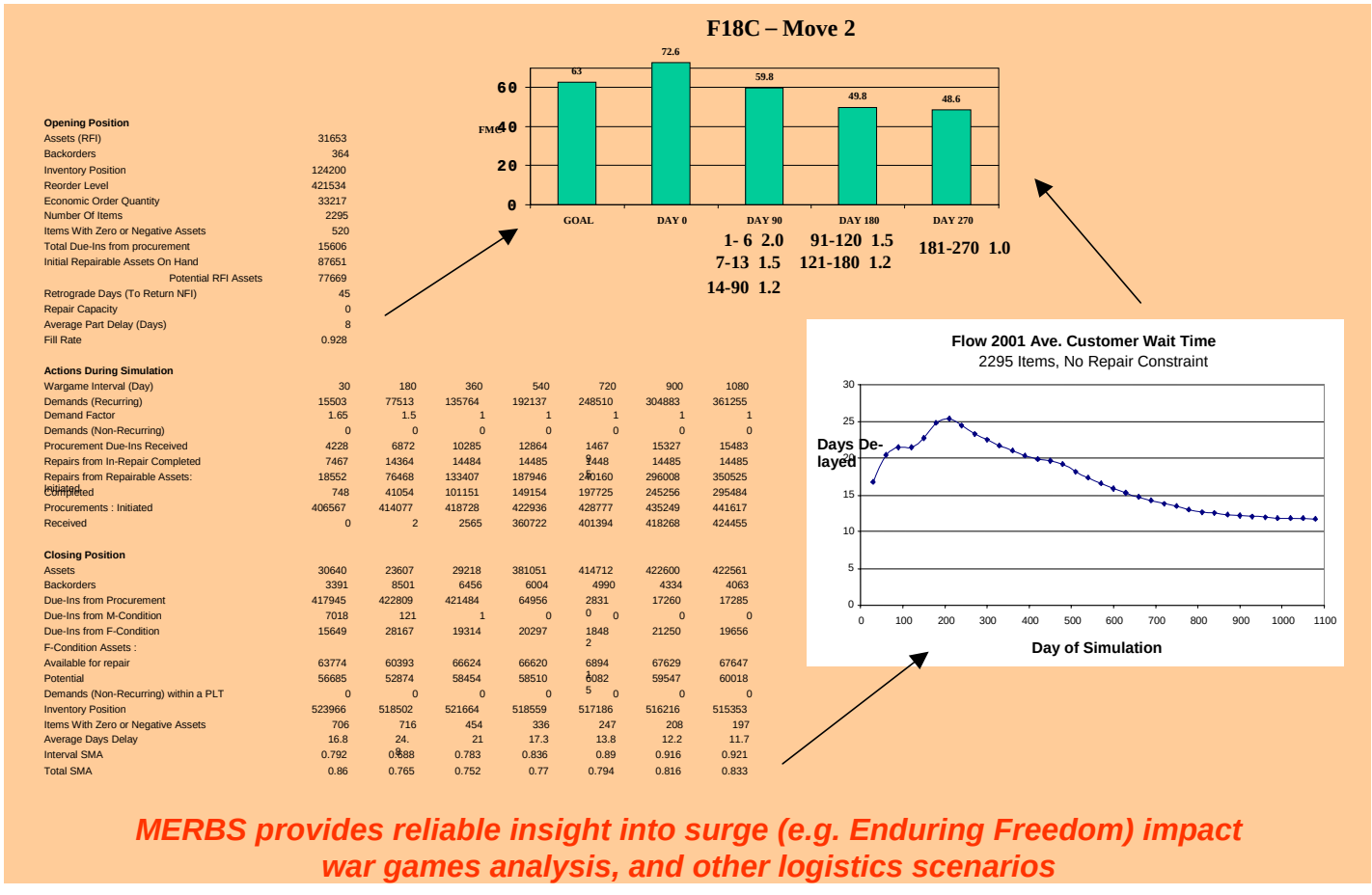
The ability to relate inventory investment to readiness is a key element missing from all ERP systems primarily because business are managed to a profit versus readiness objective. Since the RBS Work Station is an integral part of CRCS-CADS, it can develop aviation allowances that meet readiness goals by T/M/S and ACWT goals for less critical inventories. Likewise, it can import external data and evaluate the cost and readiness impact of wholesale inventories and delivery times developed by other inventory system like SAP-R3 or Manugistics. Equally important is the ability of CRCS-CADS to support the aviation Retail operations of the ICP. It has been specifically designed through a host of special features to maximize personnel effectiveness and resource utilization and thus make the timely production of accurate allowances a reality. It is therefore recommended that the CRCS-CADS system be designated as a "Bolt-On" application to ERP.

READINESS BASED SPARING BENEFITS

Where the early RBS analyses/implementation used one fixed value to represent the off-site delay time of all parts, the **ME-RBS process determines the totals of retail and wholesale inventory costs for various wholesale levels** based on delay time goals that achieve readiness objectives. ME-RBS also considers Variable Safety Level, Economic Order Quantity and repair level calculations based on total demand from other weapons systems. Thus a trade-off is made between complex weapon system considerations, such as redundancy and mission planning, and the level of support achievable at both wholesale and retail levels. **MI-RBS provides the additional capabilities of trading-off repairable components with their repair parts, thereby achieving reduced inventory investment.**

Transportation impact is integrated into RBS calculations. There are two Order and Ship Times (OSTs), one for providing direct delivery to operational forces when a spare is critical, and one for routine stock replenishment. **ME-RBS provides the ability to trade-off OST with other parameters when alternatives need to be investigated to achieve lowest life cycle cost.** ME-RBS is unique within DoD in that it provides a level setting approach to reflect the changes in both wholesale and retail levels. ME-RBS can be used to isolate and analyze any RMS parameter, including the impact of proposed configuration changes. This marginal analysis capability to calculate readiness from numerous RMS parameters or budget changes using a phased mission is a powerful tool for making logistic support and budget decisions (see Figure 6)

Figure 6 Logistics Simulation in MERBS



Opening Position								
Assets (RFI)	31653							
Backorders	364							
Inventory Position	124200							
Reorder Level	421534							
Economic Order Quantity	33217							
Number Of Items	2295							
Items With Zero or Negative Assets	520							
Total Due-Ins from procurement	15606							
Initial Repairable Assets On Hand	87651							
Potential RFI Assets	77669							
Retrograde Days (To Return NFI)	45							
Repair Capacity	0							
Average Part Delay (Days)	8							
Fill Rate	0.928							
Actions During Simulation								
Wargame Interval (Day)	30	180	360	540	720	900	1080	
Demands (Recurring)	15503	77513	135764	192137	248510	304883	361255	
Demand Factor	1.65	1.5	1	1	1	1	1	
Demands (Non-Recurring)	0	0	0	0	0	0	0	
Procurement Due-Ins Received	4228	6872	10285	12864	1467	15327	15483	
Repairs from In-Repair Completed	7467	14364	14484	14485	9448	14485	14485	
Repairs from Repairable Assets: Initiated	18552	76468	133407	187946	240160	296008	350525	
Completed	748	41054	101151	149154	197725	245256	295484	
Procurements : Initiated	406567	414077	418728	422936	428777	435249	441617	
Received	0	2	2565	360722	401394	418268	424455	
Closing Position								
Assets	30640	23607	29218	381051	414712	422600	422561	
Backorders	3391	8501	6456	6004	4990	4334	4063	
Due-Ins from Procurement	417945	422809	421484	64956	2831	17260	17285	
Due-Ins from M-Condition	7018	121	1	0	0	0	0	
Due-Ins from F-Condition	15649	28167	19314	20297	1848	21250	19656	
F-Condition Assets : Available for repair	63774	60393	66624	66620	6894	67629	67647	
Potential	56685	52874	58454	58510	6082	59547	60018	
Demands (Non-Recurring) within a PLT	0	0	0	0	0	0	0	
Inventory Position	523966	518502	521664	518559	517186	516216	515353	
Items With Zero or Negative Assets	706	716	454	336	247	208	197	
Average Days Delay	16.8	24.8	21	17.3	13.8	12.2	11.7	
Interval SMA	0.792	0.788	0.783	0.836	0.89	0.916	0.921	
Total SMA	0.86	0.765	0.752	0.77	0.794	0.816	0.833	

MERBS provides reliable insight into surge (e.g. Enduring Freedom) impact war games analysis, and other logistics scenarios

A comprehensive Business Case Analysis was completed for the CRCS/CADS Project in December of 1999. This BCA conservatively estimated a five percent decrease in allowance investment for 12 aircraft carriers (CVs) as a $55.7M cost avoidance over four years in 1999 constant dollars. This translates into a 23:1 R.O.I over the contractor development costs of $2.5M. These projections have been verified recently through comparative analyses. Given the same list of candidates and using the improved rates projections allowance costs for various platforms (CVs, LCLASS and Shore Stations) have decreased anywhere from 6.7% to 18.1%. With the improved configuration capabilities the revised candidate files produce allowances at or less than previous costs with a greater range of candidates. In addition, recent analysis of the deployed allowances has shown a decrease in off-ship requisitions and an increase in net and gross effectiveness.

SUMMARY

MERBS and CRCS/CADS can be a most valuable instrument for meeting many of today's logistics challenges in DOD and USCG. These tools make possible the intelligent decision processes and management of multi-echelon and multi-indentured supply, distribution, point of repair selection, CLS/PBL, Operations and Support cost reduction, and readiness attainment.

The CACI RBS process can be used to evaluate the results of conventional logistics information systems and will interface with multiple legacy supply / logistics systems such systems as CCSS. Minimal effort is needed to adapt these proven tools and procedures to DOD/USCG weapons and information systems, contributing to the reduction of both the logistics footprint and the Total Ownership Cost.

CACI has already achieved significant program savings through various analyses using RBS and ME and MI RBS implementation conservatively estimated in excess of **$643 million**. This type of saving and efficiency is available to other services by the application and use of RBS from CACI.

For more information see the attachments and brochures included and/or contact:

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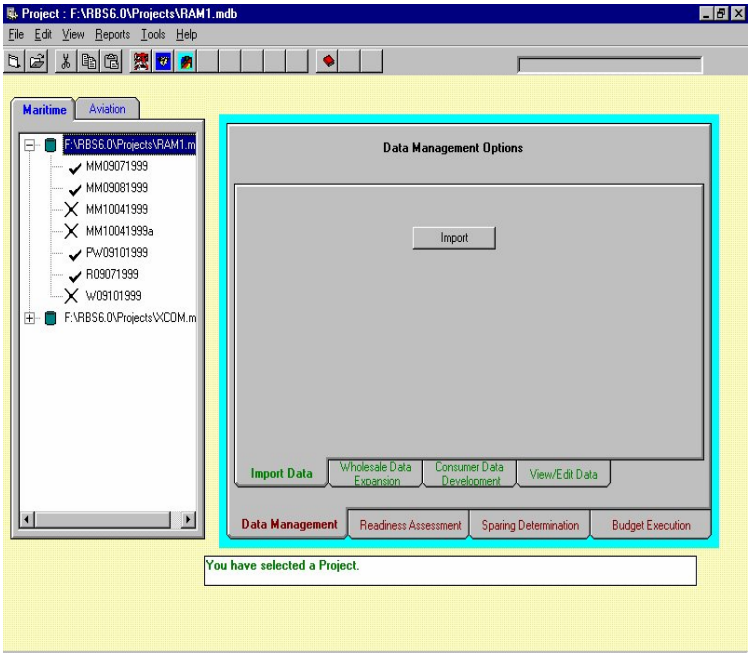
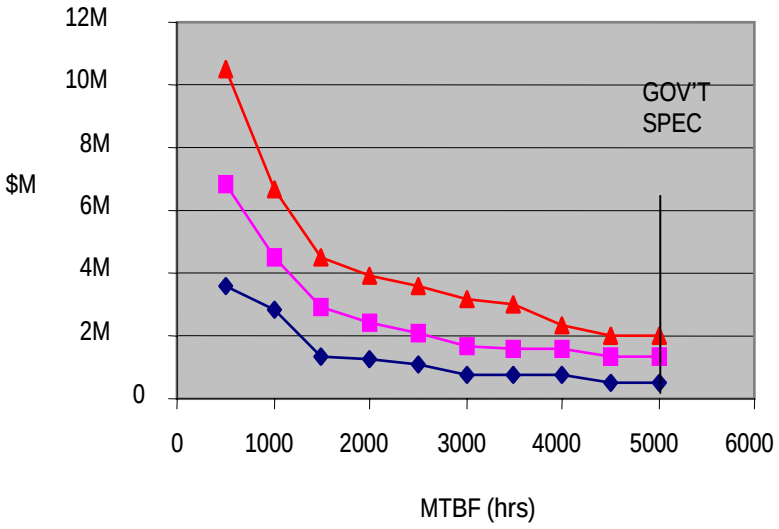
ATTACHMENT A – READINESS BASED SPARING SYSTEM

Multi-echelon Readiness Based Sparing (MERBS) is a business process and decision support system that provides the capability to achieve specified weapon system Operational Availability (Ao) or Full Mission Capability (FMC) goals and minimize investment in spares inventories. It can also maximize readiness at a fixed cost. The CACI-developed MERBS Workstation and CRCS/CADS provides the tools to evaluate future weapon system improvements, to optimize the readiness oriented logistics support infrastructure, and to reduce the total cost of weapon system ownership.



MERBS *Features*

- Project-oriented process for wholesale levels and retail allowance computation.
- Links supply echelons (wholesale and retail) in sparing and allocation decisions.
- Considers impact of customer wait time and failures on customer performance.
- Integrates DLA requirements into the process
- Considers numerous logistics elements, mission scenario and redundancy.
- Expands and contracts demand by NIIN considering out-year changes in population of applicable weapon systems.
- Links wholesale and simulation based retail models to produce multi-echelon, multi-indenture readiness based allowances.
- Provides specified readiness for lowest cost or optimum readiness for specified funding.



MERBS *Benefits*

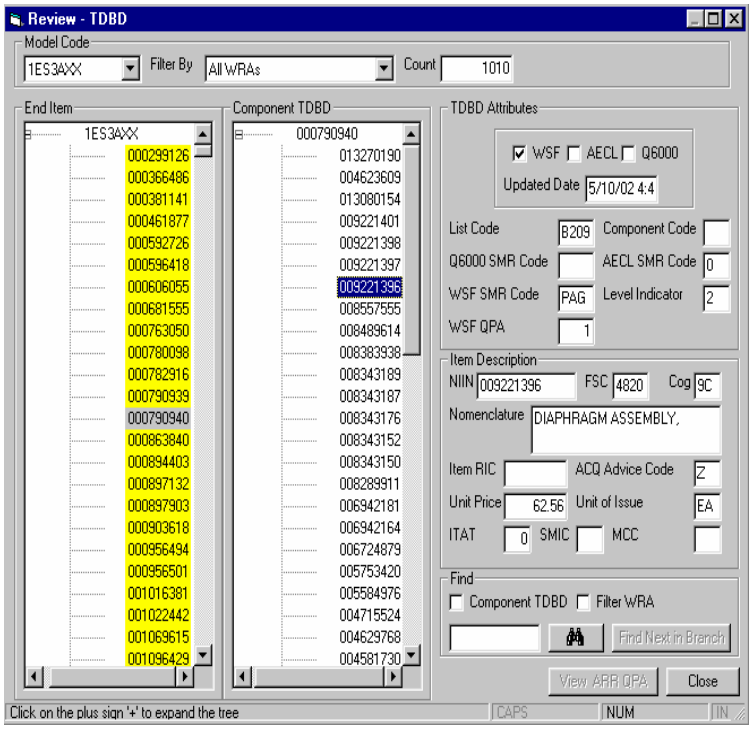
- Fosters a collaborative approach among engineering, logistics and operational communities for real-time allowance preparation.
- A proven methodology for improving weapon system readiness or reducing support costs
- Identifies potential logistics and engineering support problems and provides alternatives.
- Evaluates impact of engineering, operational, and budget plans.
- Provides capability to trade-off repairable components with applicable repair parts.
- Provides ability to rapidly assess and develop alternatives for contingency planning and war reserve budgeting.
- Provides tools to transition from legacy systems to ERP.

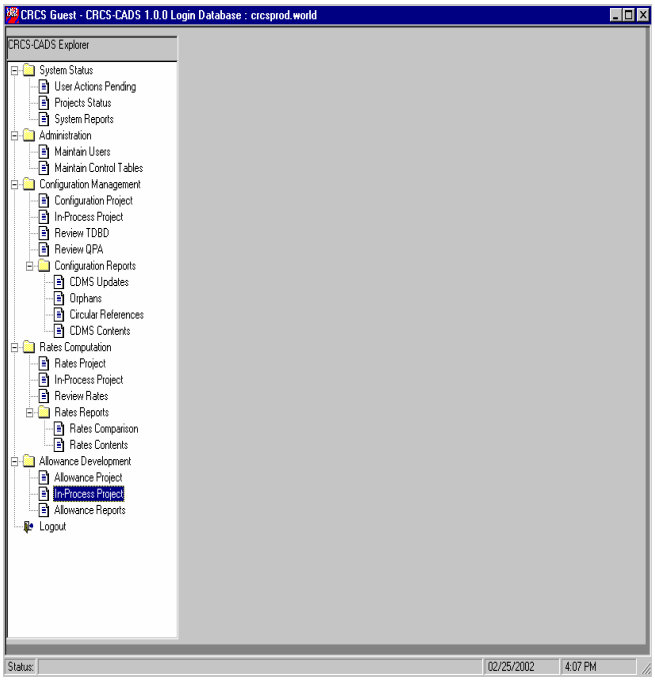
ATTACHMENT B – READINESS BASED SOLUTION SYSTEM

Common Rates Computation System/Common Allowance Development System (CRCS/CADS) is a client-server system that provides the ability to update all aviation usage rates and turn-around-times (ITAT's) every quarter and to produce AVCAL, SHORCAL , CAVCAL and Marine Corps PCSP, FOSP and FISP allowances in a timely and flexible manner. It fully integrates with the Multi-echelon Readiness Based Sparing (MERBS) Work Station and thus provides the ability to build allowances targeting single indenture and multi-indenture MERBS-based aviation readiness goals.

CRCS/CADS Features

- Project oriented process for configuration management, rates update and allowance computation.
- Workflow manages each project type through series of events.
- Imports and integrates configuration data for aircraft, engines and GSE from multiple sources.
- Imports usage data , merges with configuration data to produce failure rates by A/C and site.
- Merges configuration and rates data to create candidate file, generate allowances and store historical data.
- Links wholesale and simulation based retail models to produce multi-echelon, multi-indenture readiness based allowances.
- Access is controlled and limited to secure user lists and passwords.





CRCS/CADS Benefits

- Fosters a collaborative approach for real-time preparation, processing, and completion of weapon system support information.
- Improves configuration data giving greater range of candidate items for allowance computation.
- Improves rates through quarterly vice random updates, using tailored forecasting techniques.
- Reduces allowance costs through improved configuration and rates data.
- Allows NAVICP to meet allowance development schedules while providing enhanced products.
- Provides ability to rapidly assess and develop alternatives for contingency planning and war reserve budgeting.
- Provides tools to transition from legacy systems to ERP.