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This Note describes a prototype management system designed to help logistics managers assess wartime readiness and identify resources and policy changes that could dramatically improve it. The system, known as the Combat Support Capability Management System (CSCMS), would detect situations where theater wartime sortie capability might be jeopardized by spare parts shortages or component repair processes, and would indicate what resources or processes most degrade that capability. In addition to describing the system, this Note includes several examples of its use.



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**A RAND NOTE**

MEASURING AND MANAGING READINESS:  
THE CONCEPT AND DESIGN OF THE COMBAT  
SUPPORT CAPABILITY MANAGEMENT SYSTEM

Raymond Pyles, Lt. Col. Robert Tripp (USAF)

April 1982

N-1840-AF

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The United States Air Force



PREFACE

This Note describes a prototype management system designed to help logistics managers assess wartime readiness and identify resource and policy changes that could dramatically improve it. The system, known as the Combat Support Capability Management System (CSCMS), would detect situations where theater wartime sortie capability might be jeopardized by spare parts shortages or component repair processes, and would indicate what resources or processes most degrade that capability.

The CSCMS design concept distinguishes between planned and actual logistics support management. Logistics resources and repair capabilities are typically acquired and developed far in advance of their actual application. Numerous intervening factors can invalidate those early support plans, by changing either Operations' demands for support or Logistics' capabilities to provide support. The CSCMS iteratively revalidates and helps revise those plans as those factors evolve. In addition, it monitors the actual peacetime experience of the component support system to assure that the current support plan is being achieved.

Thus, the CSCMS design concept integrates logistics support planning and actual logistics support management. Planned resources and processes are used to monitor the performance of actual resources and processes, and actual performance is used to detect factors that may jeopardize the support plans.

The planned-actual concept of the CSCMS merits trial use and application by the major air commands, the Air Force Logistics Command,

and the Air Logistics Centers (ALCs) in conducting weapon system readiness assessments. After such trial use it may be possible to judge whether this concept should be institutionalized in the Combat Supplies Management System (CSMS) being developed by the Logistics Management Center and the Air Force Data Systems Design Center for Headquarters U.S. Air Force. Readiness assessments conducted by ALC Systems Managers might also benefit from use of this concept.

The CSCMS was developed jointly by the Pacific Air Forces, the Air Force Logistics Command, and The Rand Corporation. In addition to describing the system, this Note includes several examples of its use.

This research is part of the "Combat Support Capability Management System" study conducted under the Project AIR FORCE Resource Management Program. Other documents in this series will more fully describe the system's underlying technology and use in other readiness assessment applications.

SUMMARY

In peacetime, it is very difficult to forecast whether a force has adequate logistics support resources and processes to meet its future wartime needs. The transition from peace to war so drastically changes operational demands and support processes that logistics managers cannot merely extrapolate their peacetime experience to assure adequate wartime capability. Those managers need a management system that will help them to forecast--during peacetime--their forces' wartime capability and to detect, diagnose, and remedy factors that may degrade that capability. The Combat Support Capability Management System (CSCMS) was conceived and designed to help meet those information needs when wartime component support is initially planned and when current support is evaluated in light of those plans.

The CSCMS design concept takes into account that requirements computations for authorized (planned) resources (primarily spares) assume that the logistics system can achieve particular performance characteristics (e.g., demand rate, repair cycle time) in particular scenarios (flying and support plans). Often, those assumptions differ markedly from actual tasking (scenario) or logistics performance characteristics associated with specific combat units.

As a result, the concept suggests that combat organizations striving to assure their readiness should first assure themselves that the planned resources and performance standards will adequately support the scenarios of interest to them. Following such assurance, the concept suggests that the readiness assessment should be repeated using

the combat organization's actual resource levels and performance characteristics.

Given this concept, combat organizations can use a model of wartime component support like Dyna-METRIC (Hillestad and Carrillo, 1981; Hillestad, 1982; Pyles, 1982) to help identify and resolve conflicts in component support plans and to help evaluate whether actual resource levels and peacetime performance differ greatly from those plans. Identifying such shortfalls should lead to improved resource planning and control to assure adequate wartime capability.

The CSCMS consists of two subsystems: a Planning Subsystem (PS) and an Operational Tracking and Control Subsystem (OTCS). The PS is concerned with evaluating and improving planned component support, and the OTCS is concerned with evaluating actual peacetime performance in accordance with the planned performance standards.

Prototypes of the PS and OTCS were developed and tested in a laboratory environment. In those tests, planned and actual wartime component support to Pacific Air Forces (PACAF) F-4E aircraft were evaluated in a hypothetical scenario.

In the PS development tests, analyses were carried out that demonstrated that subsystem's ability to:

1. Forecast the expected number of degraded aircraft (those that would be Not Fully Mission Capable (NFMCA) because of component support);
2. Contrast the effects of alternative component support structures on wartime capability (e.g., compare the PACAF Centralized Intermediate Logistics System's with the standard structure);

3. Contrast various aircraft, stock, and maintenance deployment plans (e.g., compare the effects of colocating additional units, of making Peacetime Operating Stocks available to deployed units, and of late arrival of component maintenance capability);
4. Identify components whose support processes will most probably degrade aircraft availability at a critical juncture in the scenario; and
5. Predict the incremental effect of higher-than-planned sortie rates.

In the OTCS development tests, PACAF actual repair and resupply experience in May 1980 was used to demonstrate that subsystem's capability to:

1. Track actual peacetime logistics performance;
2. Compare that performance against limits and standards established by the PS;
3. Assess the effects of degraded logistics performance on projected wartime capability (e.g., relate higher-than-planned demand rates, repair times, and resupply times to expected NFMC aircraft);
4. Indicate components and support processes that would most probably degrade wartime aircraft availability if actual performance were not improved.

Based on those development tests, the planned-actual concept of the CSCMS merits trial use and application by the major air commands, the Air Force Logistics Command, and the Air Logistics Centers in conducting weapon system readiness assessments. After such experiences, it may be possible to judge whether this concept should be institutionalized in

the Combat Supplies Management System (CSMS) being developed by the Air Force Logistics Management Center and the Air Force Data Systems Design Center.

ACKNOWLEDGMENTS

Many people contributed encouragement, guidance, and assistance to the research reported here.

Perhaps the most important contributions were made by Lieutenant General James D. Hughes, Commander of the Pacific Air Forces (PACAF), and Brigadier General Vernon H. Sandrock, Deputy Chief of Staff for Logistics in PACAF, who first articulated their needs for an improved peacetime management system and a capability assessment system. Their clear, concise expression of those needs helped motivate and focus the management system concept and design.

I. K. Cohen and Thomas Lippiatt of Rand first integrated the two statements of need into a management system design concept. Their first representation of that concept remains unchanged.

Several Headquarters PACAF staff members helped design and carry out the prototype system. In particular, Colonel John Anderson, Lieutenant Colonel George Sewell, and John Barrett from the Logistics staff assured that the system design had practical payoffs, testing the proposed design against their own experience and reminding the designers of real-world, pragmatic design constraints. In addition, Robert Cunningham, Robert Coward, and Gary Lyles of the Data Automation staff assumed the Herculean task of designing, programming, and testing several data base management computer programs that collect and maintain actual logistics system performance data.

At Ogden ALC, Major Vernon Thom, Kenneth Hales, and Floyd Martinez were the prototype's first users, and they persevered through all of the

false starts, dead ends, and exasperating delays that characterize a developing system. More important, they translated a conceptual management system design into concrete actions that others can follow.

Although several Rand staff members helped design and develop this system, five deserve special mention. Rand colleagues Richard Hillestad and Manuel Carrillo conceived and designed the Dyna-METRIC model. Even though fully occupied with their own work extending and using the model in other contexts, both pitched in enthusiastically when modeling difficulties arose or when explanations were needed. Gail Halverson, Karen Isaacson, and Brian Leverich ably designed, programmed, and tested portions of Dyna-METRIC and several related interface programs.

Many others go unmentioned but not forgotten. Other Dyna-METRIC users in the Air Force and at Rand helped isolate program errors and improve overall capabilities. Secretarial and other support staffs in all organizations responded enthusiastically to what must have seemed a torrent of last-minute requests.

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## I. INTRODUCTION

Logistics managers throughout the Air Force must control a highly complex and interactive process to assure the forces' wartime readiness. They manage thousands of different resources (including facilities, munitions, fuel, spare parts, test equipment, etc.) that contribute greatly to wartime operational capability. A single aircraft mission design series (MDS) may contain several hundred line replaceable units (LRUs), each containing numerous shop replaceable units (SRUs), in turn constructed from hundreds of bits and pieces. Those managers must assure that there are sufficient repair facilities, trained maintenance personnel, supply capacity, spare parts, and consumable materials to assure adequate peacetime flying and wartime capability.

Managing peacetime support alone is very demanding because so many resources and processes must operate together to assure that operational commitments are met. Assuring wartime capability in peacetime is even more difficult because logistics managers receive little feedback about how their decisions affect the forces' ultimate wartime sortie capability. Peacetime training requires lower flying rates than wartime operations, so the force consumes fewer supply and maintenance resources in peacetime. War Reserve Materiel (WRM) and repair capability set aside for wartime use constitute a reserve capacity whose sortie-limiting effects cannot be suitably tested at peacetime flying levels. Further, peacetime degradations in component-specific repair or resupply performance are difficult to translate to an operational performance measure such as wartime sortie generation capability. Logistics

managers need a management system that will help them forecast--during peacetime--their forces' wartime capability and indicate when and where logistics resources and/or processes must improve to meet the required wartime capability.

This Note describes a management system concept and design intended to meet those needs. The Combat Support Capability Management System (CSCMS) forecasts wartime sortie capability based on planned logistics resources and processes and detailed operational plans. Further, it develops limits for those resources and processes that the peacetime system must not violate to avoid jeopardizing the wartime sortie requirements. Finally, it monitors actual peacetime operations to assure that the logistics system maintains the required levels of resources and performance.

The CSCMS design concept takes into account that requirements computations for authorized (planned) resources (primarily spares) are based on particular logistics system performance characteristics (e.g., demand rate, repair cycle time) and particular scenarios (flying and support plans). It may be that a specific combat unit's [1] planned tasking (scenario) differs from scenarios used in the Air Force Logistic Command's requirements process. Further, it might be that the performance characteristics of the specific combat organization is different from those used in the computation of resource requirements.

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[1] The CSCMS treats all collocated aircraft of a single Mission Design Series (MDS) as a single cohesive unit with common support facilities, stock, and operational tasking. Thus, a unit is usually a wing or squadron, but may be a collocated force.

As a result, the concept suggests that in assuring their readiness combat organizations should first assure themselves that the planned resources and performance standards will adequately support the scenarios of interest to them. Following such assurance, the concept suggests that the readiness assessment should be repeated using the combat organization's actual resources and performance characteristics.

Given this concept it becomes possible to identify and resolve conflicts in the several plans for wartime component support and to discover whether actual resource levels and peacetime performance are greatly different from the plans. Identifying such shortfalls should lead to improved resource planning as well as increased attention to the suitability of existing performance standards and to the means to improve current performance.

This Note also describes our initial experiences testing a development version of the system. Although we made every attempt to use the development version just as real-world managers would use a fully developed system, we present our test runs only as illustrations of how such a management system might be used; they should not be interpreted as problems requiring immediate action.[2]

The system design requires a technique to forecast how component support resources and processes would affect a unit's or a theater's wartime capability, and to identify those resources and support

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[2] In the particular development version discussed in this Note, the assessment of the "actuals" and their deviation from "plans" is intended to be at frequent (e.g., monthly) intervals. Such frequently reoccurring assessments may or may not be necessary. For example, Clarke (1981) has used the concept of "planned" and "actuals" in a one time readiness assessment.

processes that limit that capability. In the development version of the system, the Dyna-METRIC model (Hillestad and Carrillo, 1981; Hillestad, 1982; Pyles, 1982) was used to forecast daily aircraft availability and sortie levels as indicators of wartime capability. The model's "problem parts list" was used to identify components whose support limited aircraft availability.

The remainder of this Note has three sections. The first describes the overall CSCMS concept. The two remaining sections describe the system's two major subsystems with illustrations from our development tests.

## II. COMBAT SUPPORT CAPABILITY MANAGEMENT SYSTEM CONCEPT

The Combat Support Capability Management System (CSCMS) was designed to serve two purposes. First, it is a capability assessment system that forecasts the logistics system's readiness to support wartime activities. Second, it is a management information system designed to track logistics performance measures and indicate when and where corrective action may be necessary to assure performance consistent with wartime needs. The system described here is an initial version that addresses only spare parts, component repair processes, and related resources (such as test equipment and component transportation). It contains two interactive subsystems shown in Fig. 1: a Planning Subsystem (PS), and an Operational Tracking and Control Subsystem (OTCS).

The PS is designed to forecast the wartime sortie capability that a theater's force could achieve if it operated with planned resources and performance levels in a specific wartime scenario. If the forecast wartime capability were unsatisfactory, the PS would help decision makers adjust operational demand and support processes until a satisfactory capability forecast was achieved. Once the projected wartime capability met the planners' operational requirements, the planned resources and performance levels would be used as standards to judge the adequacy of actual resources and performance levels. Based on those standards and the peacetime flying program, the PS would develop limits that the OTCS would use to monitor and control actual logistics performance.

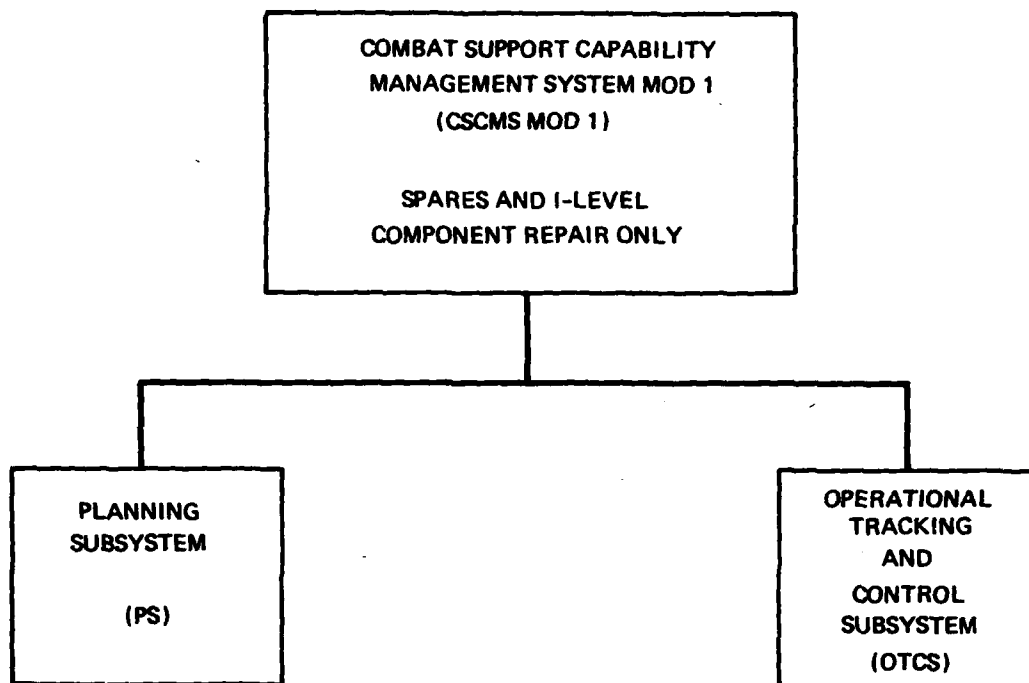


Fig. 1--Combat support capability management system MOD 1 overview

The OTCS is designed to compare actual logistics performance with those limits and to indicate when and where corrective action might be necessary. If corrective action were not possible, users of the OTCS would conduct special studies to determine the resource or performance standards that could be achieved, and communicate those new standards back to the PS. Thus, the OTCS is also designed to detect and identify erroneous planning assumptions.

Both subsystem designs use the Dyna-METRIC model (Hillestad and Carrillo, 1980; Hillestad, 1982; Pyles, 1982). This model has two capabilities particularly useful in this management system. First, it forecasts combat sortie levels and aircraft mission capability for a

wartime deployment and employment scenario as a function of component support resources and performance levels. Second, it indicates which spare parts' resource levels and performance levels may limit the logistics system's capability to achieve a scenario's target wartime capability.

Together, these two subsystems were designed to plan and control component repair and spare parts support. The PS determines the resources and performance levels needed to achieve the wartime plans, and the OTCS tracks and controls peacetime operations to assure that those resource and performance levels are maintained.

The next two sections discuss the PS and the OTCS designs in greater detail, reporting experiences in our initial developmental tests.

### III. PLANNING SUBSYSTEM: DESIGN AND INITIAL FINDINGS

#### PLANNING SUBSYSTEM DESIGN

The CSCMS Planning Subsystem (PS) design shown in Fig. 2 would start with the detailed existing war plan, including the stock levels, logistics performance standards, [1] and detailed operational deployment

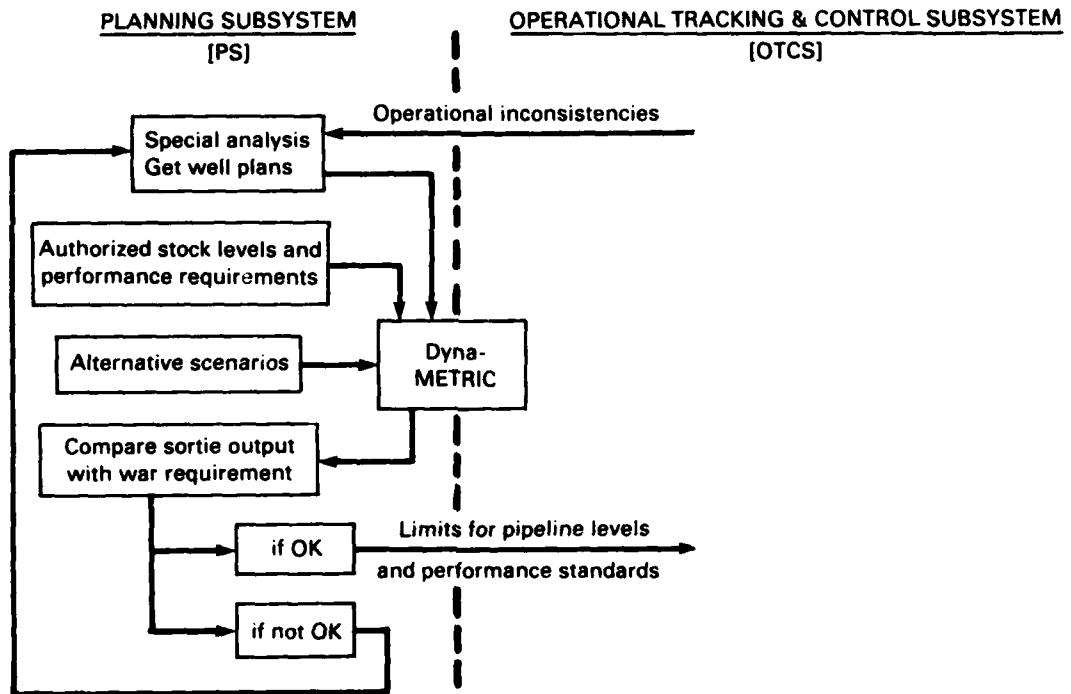


Fig. 2--Combat support capability management system Mod 1, planning subsystem

[1] Logistics performance standards include standard demand rates, repair times, transportation times, and resupply times used when wartime stock levels are computed. As such, they represent planning assumptions

and employment plans for the scenario of interest. Using the DYNAMETRIC model, the PS would forecast how component support performance will affect the operating units' daily wartime capability. (The model provides three measures of wartime capability at each base: expected sorties, expected Not Fully Mission Capable (NFMC)[2] aircraft, and the probability of achieving no more than a (user-specified) target NFMC aircraft level. Decisionmakers would use these indicators to judge the adequacy of wartime capability.)

If projected wartime capability met wartime requirements, the PS would set resource and logistics performance limits that the OTCS would use to monitor peacetime operations. Otherwise, users of the PS would initiate special studies to forecast how stock levels, component support performance standards, and operational plans could feasibly be adjusted to meet the target wartime capability. (Generally, one expects capability to fall short of the target, but the design accommodates reductions in stock levels and component support performance standards as well.) This iterative process repeatedly proposes and evaluates alternative plans until a plan is developed that would effectively achieve the target wartime capability.

When collecting input data, the PS would force close attention to integrating detailed plans developed by different Air Force planning units. It uses major air commands' (MAJCOMs) logistics and operations about how component support will perform in wartime.

[2] Fully mission capable (FMC) aircraft are capable of performing all missions for which the aircraft was designed. Other, "Not Fully Mission Capable" (NFMC) aircraft cannot perform at least one of those missions because some part essential to that mission is missing. This measure represents all component support related effects on aircraft availability.

plans with standard demand rates, repair times, and authorized stock levels developed by the Air Force Logistics Command (AFLC).

Where those disparate planning units use conflicting assumptions, the PS would highlight the effects of those conflicts to cognizant organizations. For example, when AFLC computes the War Reserve Material spare parts needed for a wartime scenario, its standard computations assume that all similar aircraft units will achieve a particular, time-dependent sortie pattern. Many MAJCOMs' plans call for a different sortie pattern or a different support structure, so the standard component support resources and processes may not assure an adequate level of wartime capability. Thus, the PS would assure that the various operational and component support plans jointly provide an adequate level of wartime capability for the scenarios of interest to the MAJCOM.

Once the input data have been collected and validated, the PS would use the Dyna-METRIC model to forecast wartime capability. If forecast sortie capability were adequate to meet wartime needs, then the PS would compute limits[3] for each recoverable item's pipeline quantities and performance measures that the Operational Tracking and Control Subsystem would monitor.

If the forecast wartime capability fell short of operational wartime needs, the PS would prompt the initiation of special analyses to determine feasible remedial alternatives. As those analyses proposed

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[3] Those limits would be statistically derived from each item's planned support characteristics (demand rate, repair time, resupply time, etc.), the peacetime flying rates, and assumed distributions for pipeline quantities and times. Limits would be set so the probability of false alarms is very low. In our development tests, we set them so there was less than .02 probability of a false alarm.

alternate support plans, the PS would use Dyna-METRIC to evaluate alternatives and select a feasible, effective plan.

Typically, the PS would operate only when some external factor changed. If the aircraft deployment and employment plan and the planned support resources and processes remain unchanged, the PS would not discover any new information about the support system's planned capability.

#### INITIAL DEVELOPMENT TESTS--THE F-4E IN PACAF

To provide more detail about the PS and its operation, we turn now to an example used to test this subsystem. The example considers one aircraft mission design series (MDS)--the F-4E--in a hypothetical Pacific Air Forces (PACAF) scenario.

#### Operations Scenario

In our development tests we investigated the performance of a force of 60 PACAF aircraft and 36 Tactical Air Command (TAC) aircraft in an imaginary wartime deployment. As shown in Table 1, the aircraft were deployed at three peacetime locations before the war: Base 5 in the war zone, Base 2 in the theater but out of the war zone, and Base 6 in the Continental United States (CONUS).

Our wartime plan calls for these aircraft to be deployed to three forward operating locations (OLs), one of which already contains some in-place PACAF forces. The remainder of the PACAF and TAC forces deploy according to the schedule in Table 2.

Table 1

HYPOTHETICAL PEACETIME BEDDOWN

Base	Location	Type of Base	Number of Aircraft
1	Outside Country	CIRF	0
2	Outside Country	OL	36 PAA
3	In Country X	OL	0
4	In Country X	OL	0
5	In Country X	OL	24 PAA
6	CONUS	TAC Base	36 PAA

Table 2

HYPOTHETICAL DEPLOYMENT SCHEDULE

Location	Day				
	0	2	3	4	6+
Base 3	0	0	0	0	18
Base 4	0	8	12	12	12
Base 5	24	36	48	66	66
Base 2	36	16	8	0	0

To meet our sortie goals for this force, we required that each wartime OL fly its authorized aircraft an average of three sorties per aircraft per day for the first ten days of the conflict and one sortie per aircraft per day thereafter for the remainder of the conflict. We assumed sufficient filler aircraft would be available to keep all OLs at their full authorized strength throughout the 30-day scenario.

Support Scenario

PACAF has a unique logistics structure for spare parts' repair--the Centralized Intermediate Logistics System (CILS). In contrast to standard logistics structures where the deploying unit has considerable intermediate level maintenance (ILM) capability, the CILS maintains much

of the component repair function at a single Centralized Intermediate Repair Facility (CIRF) outside the projected war zone. In accordance with PACAF policy, that facility would also support the deploying TAC units, so those units will send most of their deploying ILM resources (mainly personnel and test equipment) and their shop replaceable unit (SRU) spares to that facility.

Components repaired in a CILS must be transported to and from that facility, thus they encounter transportation and handling delays in addition to repair time delays. In these development tests, we assumed the wartime transportation time would equal the PACAF peacetime standards (three days each way) so that components removed from aircraft on an OL would encounter a six-day delay in addition to their normal repair time.

The standard WRM computations (AFLCR 57-18) are not strictly compatible with the CILS structure. As mentioned before, those computations provide support for standard units with colocated ILM. Thus, the computations do not set aside additional spare stocks to cover the longer effective repair time in a CILS. Further, the computation for deploying units (called a War Reserves Spare Kit or WRSK) provides some stock to compensate for the ILM deployment time, because deploying units typically can initially repair only a subset of the aircraft components. (These are called RRR parts, for remove, repair, and replace.) Other components can only be removed and replaced; therefore the unit deploying into a standard structure must have adequate spares of these RR parts to last until more extensive ILM facilities become available.

The conflicts between the CILS structure and the WRM computations' assumptions may affect wartime capability in our hypothetical example. The CILS can always repair some RR items that could not be repaired at a standard deployed unit. As a result, units deploying with a WRSK may enjoy added protection for some CIRF-reparable spare parts. However, both deploying and in-place units may experience a shortage of RRR spares because their supply of RRR parts did not include allocations for the CILS transportation times.

#### Resources Considered

For our tests, we limited the analysis to mission-essential LRUs repaired at the CIRF. Mission-essential LRUs were defined as those that appear in a WRSK. For each of these LRUs, we included all available inventory, including WRSK, Base Level Self-Sufficiency Spares (BLSS), and intra-theater Peacetime Operating Stock (POS).

#### The Analysis

To provide an accurate and detailed analysis that could help diagnose support plan problems, both the theater-wide and the individual unit performance were analyzed. For example, the hypothetical deployment plan in Table 2 indicates that Base 5 will fight with 24 in-place airplanes, 24 out-of-country airplanes, and 18 CONUS airplanes. With each increment of airplanes, additional stock would become available to be shared by all aircraft at that base. Our analysis evaluated how each increment (of stock and airplanes) would affect sortie generation capability.

We also analyzed several nonstandard scenarios to suggest how the system might be used in planning. Specifically, we investigated:

- a. How the lone TAC unit (Base 4) performed with and without the CIRF;
- b. How different ILM setup time assumptions affect that unit's performance; and
- c. How the theater force would fare if higher sortie levels were maintained from day 11 to day 20.

Baseline Theater Results. Figure 3 indicates that a large fraction of the theater's aircraft would be NFMC by day 10, just at the end of the peak sortie period. With one out of every five aircraft NFMC, the units must fly the remaining FMC aircraft at least 3.75 times each day to achieve the peak sortie goals.[4] After that peak, the NFMC level trails off because the planned sortie levels drop off.

That performance almost achieves the performance goal of 15 percent NFMC aircraft. The overall degradation to the theater's wartime capability is small enough that some Partially Mission Capable (PMC) sorties would probably adequately compensate for the FMC sorties lost.[5] If this performance were judged adequate--that 80 percent fully

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[4] The maximum sortie rate for an aircraft unit is a matter of some controversy. Flight line resources and the aircraft hourly employment pattern appear to constrain that maximum. In this development test, we assumed NFMC levels exceeding 15 percent would jeopardize wartime capability. If the average FMC aircraft could fly a moderate rate of 3.5 sorties each day, units with more than 15 percent NFMC rates could not meet their sortie commitment with FMC aircraft. Other analyses with more demanding employment plans or resource constraints may use a different target performance.

[5] Depending on the missions assigned and the components failed, most units could probably fly some of those sorties with PMC aircraft. We did not attempt to evaluate the contribution of PMC aircraft expli-

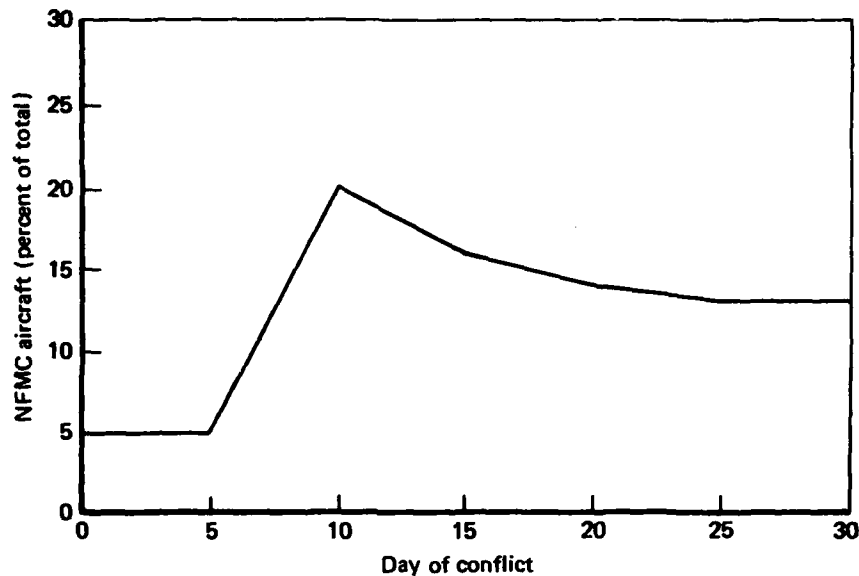


Fig. 3 – Theater wide results (percent NFMC aircraft by day)

mission capable aircraft during the peak employment period is acceptable--one may wish to know how that performance level was achieved. To explore that question, we analyzed the performance at the largest base in our deployment.

Effect of Collocating Units at Base 5. Figure 4 shows the incremental improvement in wartime capability (reduced NFMC aircraft) when additional flying units (and their stock) are collocated at Base 5. The top line in that figure shows how the in-place unit would perform if the other units and their stock were located elsewhere. With 50 percent of the airplanes NFMC on day 10, the force would have to fly the

city in these development tests, but we judged that such a small shortfall in FMC aircraft could probably be covered with PMC aircraft.

remaining aircraft over six times that day if all sorties required FMC aircraft.

The dashed line indicates the effect of collocating 24 PACAF aircraft and associated WRSK from Base 2 the Base 5 unit. Even though the total aircraft at that location only double, the projected wartime capability greatly improves so that the number of FMC aircraft nearly trebles. If the in-theater unit also deploys a proportional fraction of its Peacetime Operating Stock (POS) from Base 2 to Base 5, the two units' projected combined performance improves even more, as shown by the dash-dot line. Finally, collocating the deploying CONUS unit (and its WRSK) with those units also improves the NFMC level slightly, as shown by the dotted line.

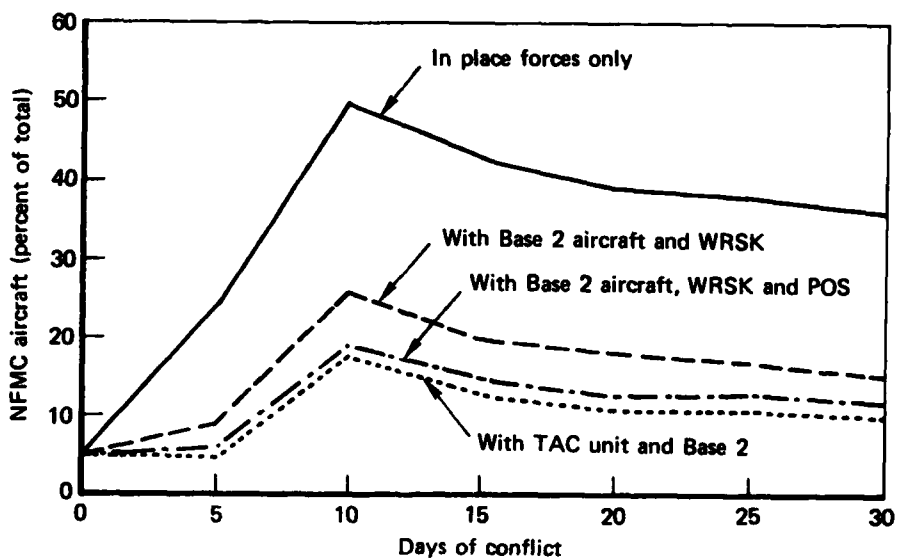


Fig. 4--Results at base 5  
(percent NFMC aircraft by day)

CILS and the Standard Structure Compared. In the hypothetical scenario, Base 3 was assumed to be a bare field with no existing support facilities. The dotted line in Fig. 5 shows how the single squadron TAC unit would perform if it deployed to that base with a standard WRSK and operated as it would in a standard logistics structure (without a CIRF). The solid line shows how that unit would perform while being supported by the CIRF. At first, the standard structure would assure greater wartime capability (lower NFMC levels), but the CILS structure would provide better support after two weeks. The standard structure's rapid repair of the few available RRR assets gives it the initial advantage; later the CILS's ability to repair RR assets more than compensates for the longer effective repair time due to transportation times.

The standard structure's initially superior performance depends on the critical assumption that the ILM capability can be deployed and set up in only one day. The dashed line in the figure shows what would happen if the unit's ILM could not become operational until the fourth day. If the ILM deployment were even modestly delayed, the unit's initial wartime capability would be degraded substantially.

The Effect of High Sortie Rate. Figure 6 shows how the theater-wide wartime capability would be affected if the force were to fly a higher sortie requirement than originally planned. In that plan, the sorties from day 11 to day 20 would be increased from 1.0 per assigned aircraft per day to 2.0.

Problem Items. In addition to broad support scenario tradeoffs like those outlined above, the system would help identify specific parts whose support must be improved to achieve the required wartime

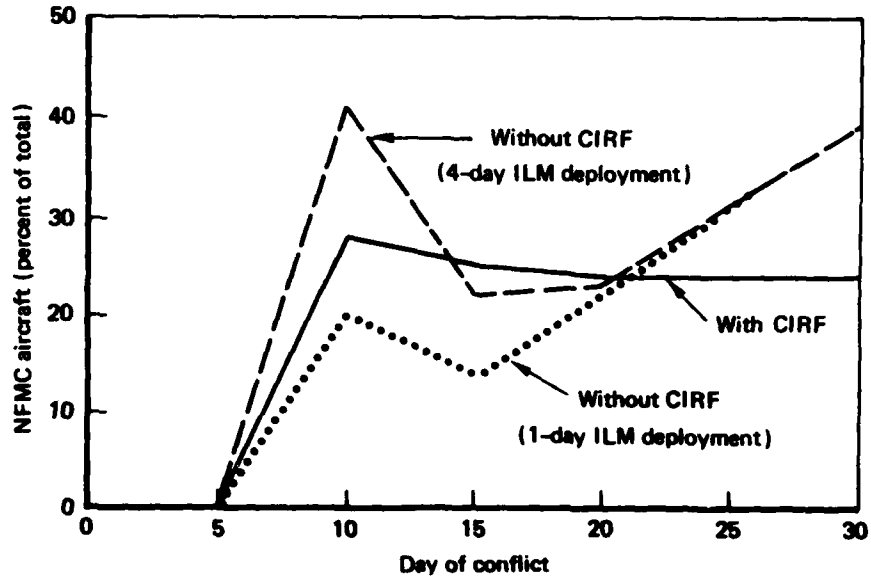


Fig. 5--CILS and the standard structure compared. (single TAC squadron)

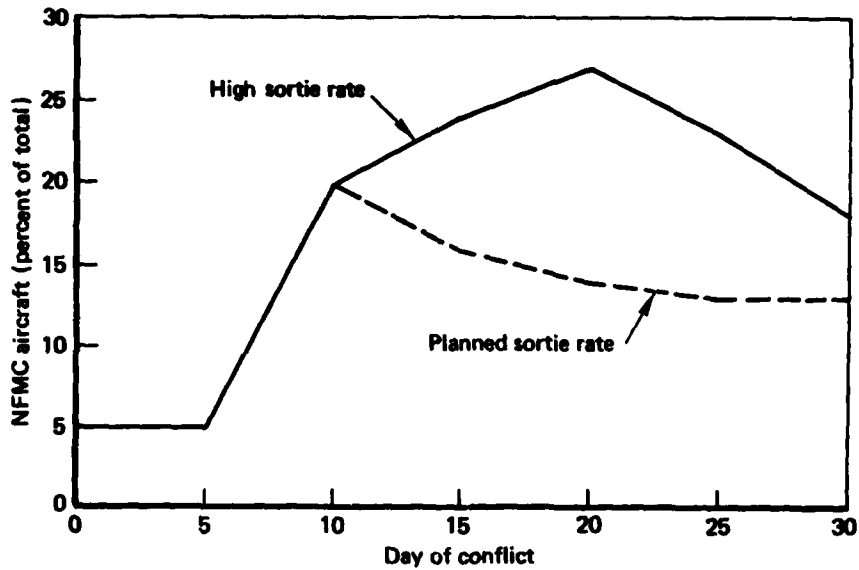


Fig. 6--Effect of high sortie rate

capability. Specifically, it would identify a minimum list of problem parts whose support must be improved to assure a target FMC aircraft availability with high confidence. Table 3 shows the problem parts that would need special management attention to assure a 15 percent NFMC level with 85 percent confidence on Day 10.

Table 3

PLANNING SUBSYSTEM PROBLEM PARTS ON DAY 10

Part	Stock Number
Computer group, ballistics	1270 00 023 8963
Computer, ballistics	1270 00 551 8452
Microwave assembly	1430 00 194 6460BF
Computer assembly	1430 00 235 6325BF
Modulator-oscillator	1430 00 264 0740BF
Antenna	1430 00 487 0827BF
Pulse transmitter	1430 00 507 2656BF
Receiver-transmitter	5826 00 082 4288
Amplifier-radio frequency	5826 00 948 5174
Amplifier-computer	6605 00 836 5333
Computer, control	6605 00 836 5335
Distribution signal	6605 00 949 7835
Computer, navigation	6605 00 994 0194

SUMMARY OF THE PLANNING SUBSYSTEM

During this developmental test we demonstrated the Planning Subsystem's ability to:

1. Assess whether planned logistics resource levels and performance standards were sufficient to carry out a (hypothetical) war plan.
2. Evaluate the incremental contributions of several squadrons' aircraft and spare parts collocation.
3. Compare alternative logistics structures.
4. Evaluate alternative support scenarios (changing ILM deployment time).
5. Predict the incremental effect of higher-than-planned sortie rates.

IV. OPERATIONAL TRACKING AND CONTROL SUBSYSTEM:

DESIGN AND INITIAL FINDINGS

OPERATIONAL TRACKING AND CONTROL SUBSYSTEM DESIGN

As shown in Fig. 7, the Operational Tracking and Control Subsystem is designed to use the PS limits as criteria to judge actual peacetime logistics performance. Whenever actual performance for some component exceeds one of those limits, the OTCS would ring alarms that indicate which components' logistics support were out of tolerance, which performance measures (such as repair time, resupply time, etc.) for each component exceeded their limits, and which theater-wide support facilities (e.g., a base or CIRF) contributed to each component's logistics support shortfall. Often, a logistics manager could use that initial information to implement remedial action immediately. Other times, he would need a special analysis to develop an effective get-well plan. A special analysis would probably require extraordinary activities to identify the underlying causes of the poor performance and to suggest alternative getwell and workaround plans to improve that performance in the long and short run. As those plans are proposed, the Dyna-METRIC model would be used to forecast how close they come to meeting the overall wartime capability goals.

The special analyses may detect that current operational conditions prevent the component support system from achieving the planning standards. Then, logisticians using the OTCS can formulate more realistic assumptions that can be incorporated in improved, more realistic plans.

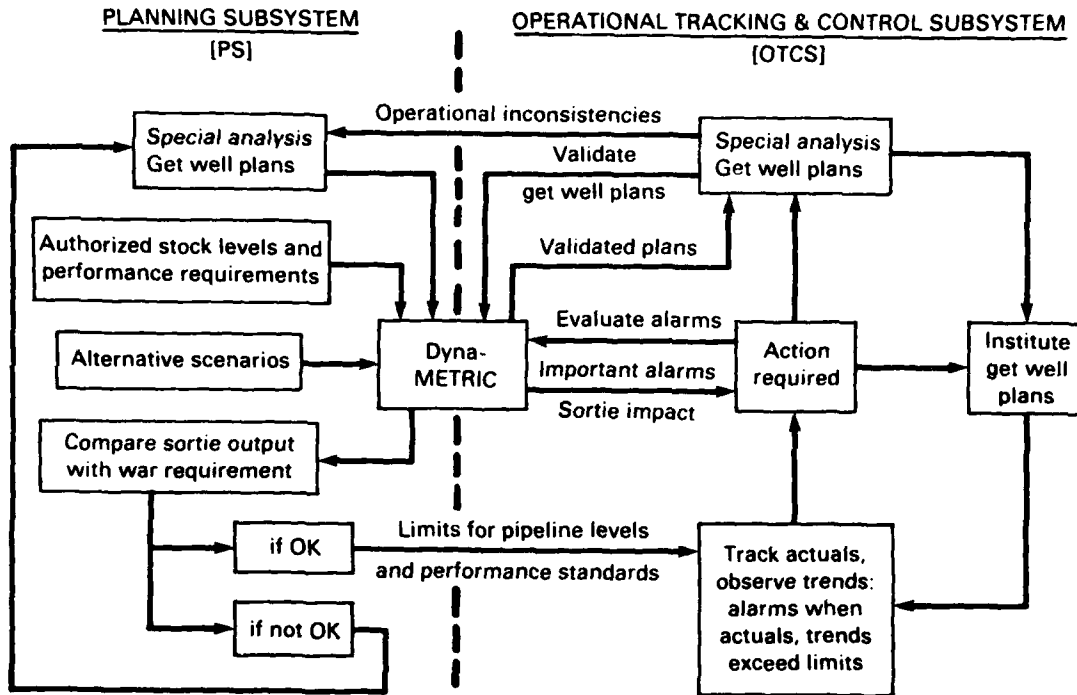


Fig. 7--Combat support capability management system MOD 1

Finally, the OTCS may ring so many alarms that the decisionmaker cannot immediately identify and implement remedies for all alarms at once. Then he could use the model's "problem parts" feature to obtain a ranked list of parts whose current support performance most affect wartime capability. Using such a list, the logistics decision makers and analysts could concentrate their attention and efforts toward developing get well plans for those more critical parts first.[1]

[1] Although the OTCS subsystem was conceived as a cyclic process that continuously monitored peacetime operations, a less frequent "snapshot" approach could also be used effectively. For example, Clarke (1981) compared actual and planned stock support for an aircraft modification program based on current and projected stock procurements.

INITIAL DEVELOPMENT TESTS--PACAF ACTUAL PERFORMANCE

To test the OTCS, we used the PACAF monthly peacetime flying activity to develop limits for the same components used in the PS development tests. This example considered the same aircraft, range of components, and component standards as the PS. Actual May 1980 PACAF experience for those components was compared against the limits.

The OTCS would monitor individual components' monthly activity levels at each peacetime base, average quantities in repair and on order at each base and CIRF, and average base-to-CIRF transportation times using data generated in the Standard Base Supply System computers at those facilities. By comparing these performance measures against the PS limits on a component-by-component basis, the system would detect inconsistencies between the actual peacetime support processes and wartime planning standards.

Because the OTCS data would be collected for each component, those data could be aggregated over various locations and pipeline segments. Typical cuts might include not only theater-wide quantities, but also bases' and shops' quantities. Moreover, the alarms themselves could be counted and aggregated to identify systematic problems with some pipeline segment.

When we first evaluated the OTCS alarms with the actual PACAF data, we observed so many alarms that we could not evaluate and analyze them all. So we used the model both to assess how those actual performance levels would have affected wartime capability and to select and rank the most severe problem parts.

As shown in Fig. 8, the OTCS indicated that both repair times and demand levels degraded expected wartime capability from the planned level. Actual component (LRU) resupply times did not materially degrade performance, once the higher demand rates and longer repair times were taken into account. (However, the repair times did include some awaiting parts delays because of CONUS resupply problems.) Together, the higher component demand rates and repair times degrade a wartime capability to the point that every OL would need to fly its FMC aircraft at least six times on day 10 if all the planned sorties required FMC aircraft.

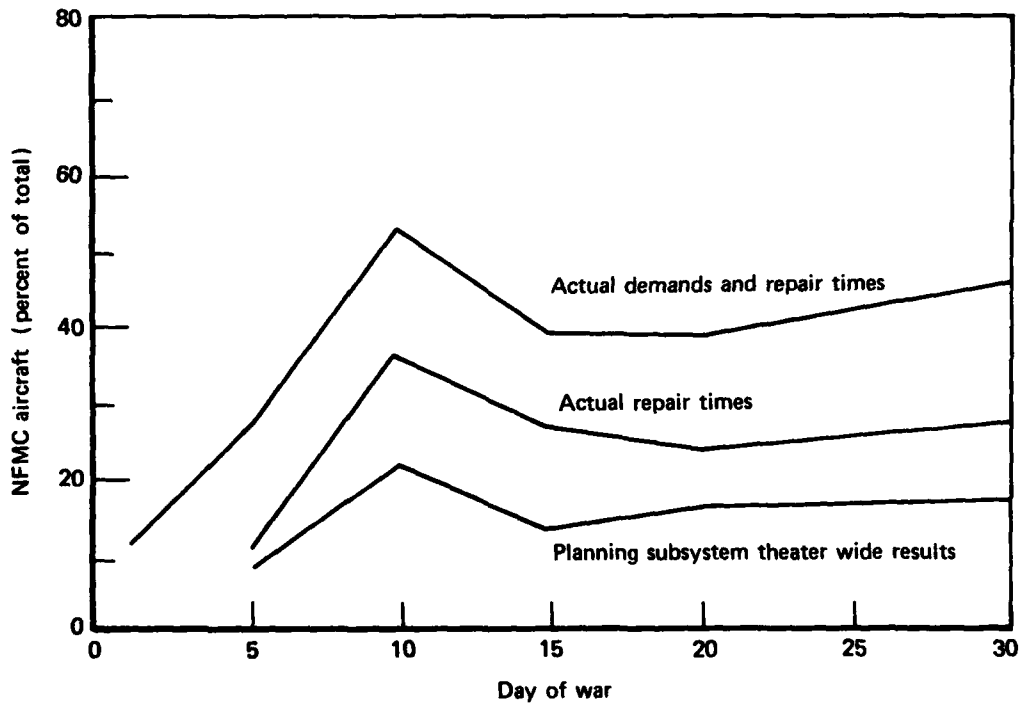


Fig. 8--Illustration of OTCS results

OTCS Diagnostics

The overall wartime capability assessment does not suggest specific remedial actions that logistics decisionmakers can implement, it only forecasts the performance if nothing is done. To help managers examine specific actions that would lead to improved wartime capability, the model provides a ranked list of "problem parts" that prevent attaining a wartime capability goal. To determine what components most constrained wartime capability we requested a Dyna-METRIC problem parts list that indicated any component whose actual support prohibited achieving less than 20 percent NFMC aircraft (at the 85 percent confidence level).

Table 4 indicates that 11 of the 108 parts degraded performance below that target. The parts are listed in ranked order, and the affected subsystems are indicated in the second column. The third and fourth columns forecast approximately how many aircraft holes would occur for each component on the 10th and 30th days in this scenario. The matrix of check marks at the far right indicates which performance parameters were above their limits: demands, awaiting maintenance and in work time, awaiting parts time, CONUS resupply time, and base evacuation times.

In a real logistics decisionmaking situation, several alternatives are available to "fix" these problems, including:

- a. reducing the parts' repair times through changes in training, test equipment, or procedures;
- b. reducing the intra-theater transportation time;
- c. reducing the fraction of parts repaired out of theater;

- d. reducing the ILM deployment time (for day 10 in non-CIRF deployments only); and
- e. purchasing additional stock.

Thus, the OTCS would use the model to evaluate how alternative support processes for each component might affect overall wartime capability.

#### Possible Special Analyses

To suggest how decision makers might use the OTCS information, consider the CP-733 navigation computer in Table 4. According to the table, that LRU had high awaiting maintenance and in-work time, high awaiting parts time, and long base evacuation time. First we will analyze the part's repair time (including awaiting parts time), and then its base evacuation time.

As shown in Fig. 9, this part experienced an average of 5.1 days total repair cycle time during May 1980. Even if the awaiting parts time and awaiting maintenance time were removed, the in-work time would still exceed the limit by over half a day. This may represent either poor maintenance performance or an unrealistic standard. To determine which, one might initiate a field study to analyze that part's repair process in detail. If that analysis indicated the work standard was too optimistic, the further analysis of the field data could suggest a revised standard to the PS. Otherwise the repair resources or procedures would be modified to meet the repair time standard.

Table 4  
 OTCS ACTUAL PERFORMANCE:  
 PARTS THAT INHIBIT ATTAINING PLANNED PERFORMANCE

Part Name	Sub-system	Day 10 "Holes"	Day 30 "Holes"	Demands	Awaiting Maintenance and In Work	Awaiting Parts	CONUS Resupply	Base Evacuation Time
Target intercept computer	APQ-120	41	26	X	X	X		X
Navigation computer, CP-733	ASN-63	33	14	X	X	X		X
Micro wave waveguide	APQ-120	29	15	X		X		X
Modulator/oscillator	APQ-120	16	13	X	X	X		X
Antenna Control Servo	APQ-120	14	5	X		X		
Radar pulse transmitter	APQ-120	3	2	X				
Signal distribution unit		10	10		X	X		X
LRU 16	APQ-120	1	2			X	X	X
Cylinder assembly, actuator	Arrst. Gear	1	1	X	X	X		X
Ballistic computer group	ASQ-91	1	-	X		X		X
Control computer	ASN-46A	-	1		X	X		X
				<u>8</u>	<u>6</u>	<u>10</u>	<u>1</u>	<u>9</u>

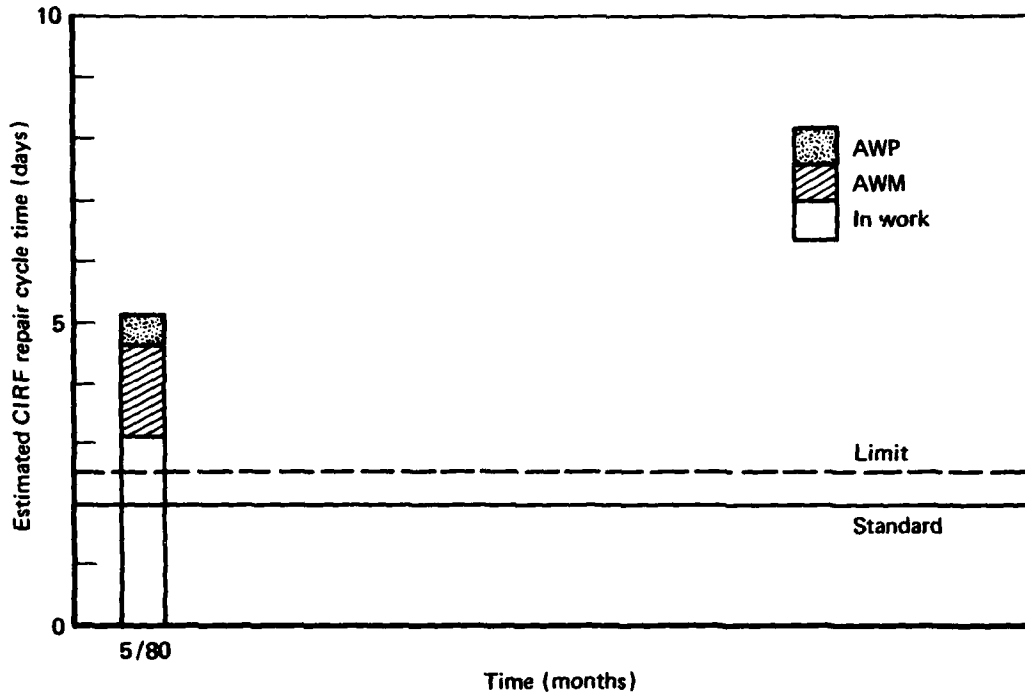


Fig. 9--CIRF repair cycle time: navigation computer

Figure 10 shows that all PACAF bases experienced extended base evaluation times with this component during May 1980.[2] Again, a field study may be necessary to indicate the cause of such long base evacuation times.

[2] Base evaluation time is the time a base needs to remove a failed component and deliver it to the transportation system when it is repaired at a CIRF. The Kadena base evacuation times appear to be "contaminated" by an exercise involving one squadron's temporary deployment. As a result, the figure indicates some doubt about the measured value. In that deployment, the squadron may have retained all failed parts until returning to home base, increasing the average base evacuation time. (If that squadron's behavior during a deployment represents planned war-time support policy, the logistics planners might use the CSCMS to evaluate the efficacy of that policy.)

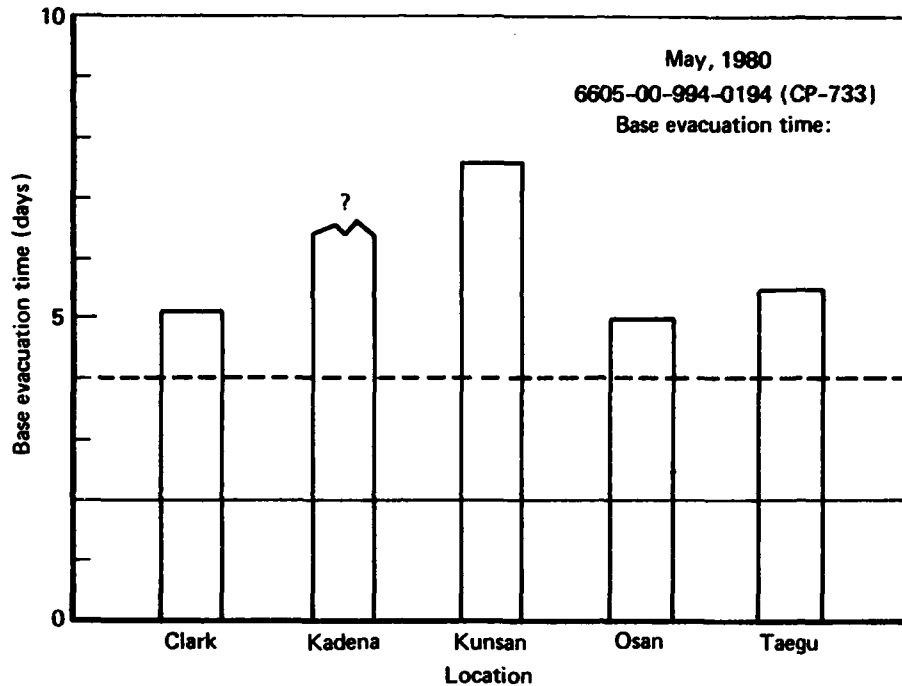


Fig. 10--May 1980 base evacuation times: navigation computer

SUMMARY OF THE OPERATIONAL TRACKING AND CONTROL SYSTEM

During this developmental test, we demonstrated the OTCS's ability to:

1. Track actual peacetime logistics system performance;
2. Compare that performance with limits and standards established by the PS;
3. Assess the effects of degraded logistics performance on projected wartime capability; and
4. Indicate those parts and processes most affecting projected wartime capability.

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