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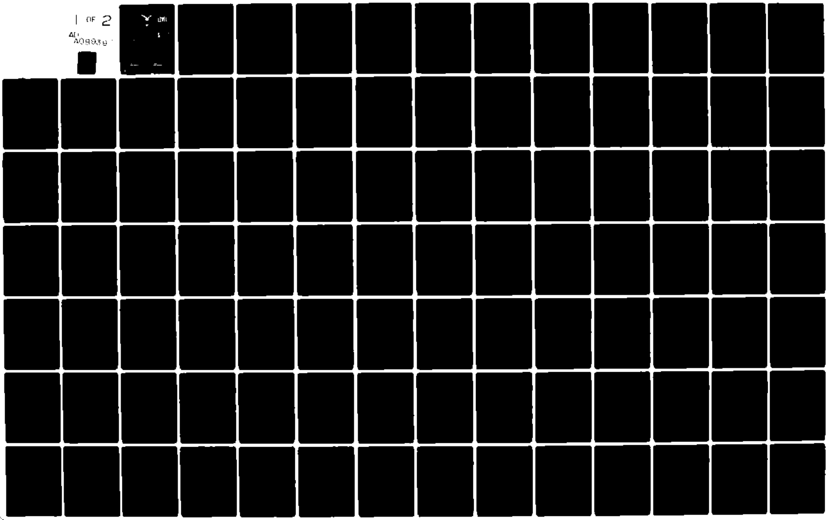

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# AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

MACRO AIRCRAFT SPARES READINESS ANALYSIS.

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LSSR-56-80

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This thesis presents an aircraft weapon system spares support model for determining the number of days of contingency operations which are supportable. Contingency spares support is of paramount concern to Air Force readiness. The translation of current or predicted inventory positions into meaningful measures of military capability is crucial to both operational and logistics planning. Currently the Air Force has no management information system which can accurately assess spares support for its deployed weapon systems. The authors have developed a practical interim planning structure and preliminary decision support model which provides for mid to long-range (i.e., 3-10 years) spares readiness assessment. It is further demonstrated how a more comprehensive system can be developed for immediate, short-range assessments in support of contingency deployments.

LSSR 56-80

# MACRO AIRCRAFT SPARES
# READINESS ANALYSIS

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By


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has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degrees of

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT
(First Lieutenant Charles Middleton)
(Wing Commander Nazar Muhammad)

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT
(ACQUISITION LOGISTICS MAJOR)
(Mr. Ronald C. Wilson)

DATE: 9 June 1980

John R Folkeson

COMMITTEE CHAIRMAN

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# CHAPTER I

# INTRODUCTION

## Statement of the Problem

*". . . For want of a nail a shoe was lost . . ."*

This familiar quotation points out the importance of small things often ignored until they wreak a disproportionate vengeance. Even in the "good old days" of errant knighthood, spare bits and pieces could mean the difference between victory and defeat. Today, national defense is the slave of sophisticated technology, and costly spares are even more critical. They might even be called the Achilles' heel of modern air warfare. Inasmuch as the gods blessed us with the genius to create and employ flying machines, they cursed us with reliance on cogs, wheels, bits and other parts. These items are the essential non-consumable spares or repair parts often replaced on the flight line due to failure that are critical to the combat capability of our modern aircraft weapon systems.

Although the Air Force has reliable management systems for maintaining cognizance of consumable material such as petroleum and ammunition, there remains an analysis vacuum in the area of spares and reparable items. The management of Air Force spares is the responsibility of Air Force Logistics Command (AFLC) which maintains the ability to replenish base stock levels throughout the world both for our forces and in some cases our allies (23:2-2). AFLC manages approximately 1.9 million line items worth over nine billion dollars (6:34). The Air Force problem in spares assessment became particularly apparent at the recent first Air Force Sortie Surge Conference when none of the participants including AFLC were able to project the impact of their war readiness material (WRM) spares asset posture on combat surge capability (22:1). Yet the adequacy of spare parts support, with respect to the demands of contingent military operations is undeniably a predominant factor in determining Air Force capability and readiness. Further, the exponential acceleration of spares costs (5:2) driven by inflation combined with, until recently, a steadily declining (in constant dollars) defense budget, makes reliable forecasts for spares support critical (3:22).

In recent years, AFLC has made considerable progress in war readiness requirements computation. The most noteworthy achievement has been in the area of war readiness spares kits (WRSK) computation. The D029 system which relies on marginal analyses techniques can compute a WRSK for an aggregate thirty-day flying hour profile. The most recent AFLC spares assessment initiative is a "WRSK/BLSS Assessment Analysis" which can be used either in conjunction with the D029 WRSK computation system or with actual unit asset data from the AF Recoverable Assembly Management System (AFRAMS). In 1978 an impressive simulation model designed to test WRSK capability at unit level was developed as a master's thesis topic for the School of Systems and Logistics of the Air Force Institute of Technology (18:1). None of these systems, however, provides a total (peacetime spares plus WRM) spares assessment. These systems will both contribute to this study and provide an excellent baseline for future simulation models which deal with total war surge capability (9:2).

Unfortunately, a concrete, finite determination of the limitations of spares support is presently beyond the capability of Air Force logistics planners and data systems. Such an effort would involve cognizance of hundreds of thousands of items many of which would be used in several different aircraft with different failure rates. It is conceivable, however, that within the next five years current data processing systems will be altered or new ones will be created that will allow logisticians to definitize total war spares supportability. The effort will be monumental, time-consuming, and expensive; moreover, there is the ominous problem of dealing with the present. The Air Force is constrained by an austere procurement/support environment which necessitates maximum benefit acuity in dollar allocation. We must fit a fragile glass slipper to the foot of an unruly and, in the area of mission support spares, largely undefined beast.

The present need is for a reasonably accurate method for obtaining a "best estimate" command/planning indicator for spares supportability. The method should be as simple, fast, and inexpensive as possible. Fortunately, much of the planning and data gathering required to develop such a system has already been accomplished. Standard requirements for combat operations and spares levels may be derived from war planning and Air Force program documents. From these documents a "best estimate" for total contingency spares supportability for discrete aircraft has been derived as in Figure 1.

$$\begin{array}{l}\text{DAYS OF WAR}\\ \text{SPARES SUPPORT}\\ \text{AVAILABLE}\end{array} = \text{WRM} + \begin{array}{l}\text{PEACETIME}\\ \text{SPARES}\end{array}\left[\frac{\text{FLYING HR/ACFT/DAY PEACE}}{\text{FLYING HR/ACFT/DAY WAR}}\right]\left[\begin{array}{l}\text{\# DAYS}\\ \text{OF WAR}\end{array}\right]$$

Fig. 1. Basic Aircraft Spares Support Equation

As shown, the estimate is in the form of a simple linear equation which will be discussed in detail later, and further developed in this study. At this point the model is hypothetical and merely delineates the major components or resevoirs of potential spares support. As such, it has the advantage of simplicity and lends itself to preliminary comprehension but at the same time it is restricted by numerous assumptions which are listed below.

## Operational Assumptions

1. War Readiness Spares Kits (WRSK) are pacing failure items; i.e., items most likely to fail.

2. Cannibalization will be allowed and aircraft will be subject to attrition as programmed for in War Readiness Spares Kit formulation.

3. Date of deployment of forces to date of increased productivity spares (D to P) will exceed 180 days.

4. No additional resources are diverted to support the contingency under consideration.

5. All weapon systems considered are provided with WRSK.

6. Mission requirements will be constant and as prescribed in the Operations Plan under analysis.

7. Pipeline requirements will be negligible and base of deployment will provide repair commensurate with base of origin (no enemy interdiction).

8. All War Readiness Spares Kits (WRSK) are capable of supporting a combat mission for thirty days.

9. No major deficiencies exist in spares support for the peacetime flying program; i.e., peacetime spares support requirements are 100 percent funded.

## Research Objective

The primary purpose of this research effort is to reduce the aforementioned assumptions to mathematical terms and/or explain their validity in order to incorporate them into the basic equation to provide a quantitative approach to evaluate unit spares support capability in a given contingency. Although it is not anticipated that the final equation will provide a precise model of spares supportability, it is envisioned that it will serve to provide good long-range management indicators.

## Premise and Research Assumptions

In any given contingency, spares support comes from two sources: war readiness material (WRM) and peacetime flying program inventory assets (5:2). WRM currently provides up to thirty days of spares support and the peacetime flying program provides a measure of spares support which can be expressed as a ratio of the wartime flying requirement. When these quantities are added together, they provide the total spares asset availability for a given weapon system for a contingency (25:22). The contingency plan defines the required period of support. If the total spares assets available to support the contingency are equal to or are greater than the requirement, the contingency has a high probability of supportability. Conversely, when the requirement is greater than the asset availability, the contingency plan has a poor probability of supportability.

Based upon this premise, an estimate for contingency spares supportability was developed for an overall logistics appraisal of an operations plan (OPLAN) that was analyzed by the Requirements Planning Division (XRXX), Deputy Chief of Staff (DCS) for Plans and Programs of the Air Force Logistics Command (AFLC) in late 1975 (5:11). The overall logistics appraisal was conducted as a pilot program to develop techniques for logistics appraisals of operations plans, etc. At that time it was apparent that both strategic and tactical analysis were severely constrained by the lack of an appropriate finite spares analysis technique.

Few efforts have been made to trace spares support for discrete aircraft. Such a system was developed for the C-5 Galaxy but it covered only spares which were peculiar to the C-5. Further, the system was expensive to run and was based on D041 historical data which is not only inherently general (does not segregate spares requirements by aircraft), but is based upon simple flying hour versus consumption historical data (19:1-2). The system was costly and lacked accuracy and timeliness. Consequently, to provide spares supportability estimates for all USAF weapon systems, XRXX planners developed the technique described below.

The WRM spares dedicated to the OPLAN analyzed by XRXX consisted of war readiness supply kits (WRSK).

(For the sake of simplicity, only (WRSK) war readiness material (WRM) will be addressed in this study.) By definition, a WRSK provides those spares which will, within a prescribed probability, be required to prevent a Not Mission Capable Supply (NMCS) or Partial Mission Capable Supply (PMCS) situation (aircraft grounded due to lack of supply support or unable to perform in primary mission, respectively) for a period of up to thirty days at the standard war flying rate (24:14-57). It follows from this that WRSK items are the critical pacing spares for any given weapon system. When these pacing assets are supportable, it is highly probable that all other assets will be supportable (27:11).

USAF War Mobilization Plan 6 (WMP-6)(3) establishes the flying hour/sortie requirements for each weapon system for thirty war days (27:12). Hence, the planned or anticipated daily wartime flying hour requirement per aircraft can be defined. Further, the daily flying requirement in flying hours corresponds exactly to one-thirtieth of the WRSK spares dedicated to the support of a given weapon system. In other words, each day an aircraft flies the standard sortie rate for war operations, it will theoretically use one-thirtieth of the spares dedicated to it in the WRSK. This one-thirtieth of a WRSK is defined as the daily war requirement for spares, and it can be expressed as a function of sorties or hours flown. This is shown graphically in Figure 2. The function y=x defines the cumulative requirement for spares support. Also, the cumulative requirement for spares support exceeds the WRSK thirty-day support level after thirty war day equivalents (derived from WMP-6 for the weapons system under consideration) are flown.

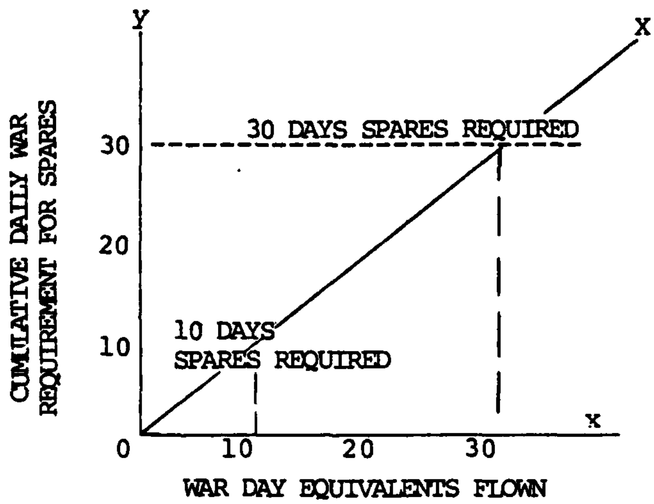


Fig. 2. Daily War Requirement for Spares (27:11)

Let us now turn our attention to the peacetime flying program for a weapon system. USAF PA 78-1 (S) provides the total peacetime flying program for each weapon system (27:11). From this document, the number of flying hours per aircraft per day can be determined by dividing the total number of flying hours for the system by the total number of aircraft times 365.

Spares for the peacetime flying program of an aircraft are determined via the D041 automatic data system which provides a history of required spares per flying hour. Spares requirements are derived as a function of flying hours. Thus, the spares acquired to support the peacetime flying program can most logically be expressed in terms of flying hours (19).

Let us assume that the peacetime flying program is funded at 100 percent (an exact figure can be determined) and that no difficulties are incurred in obtaining the required spares (current information systems will provide information on shortages). This means that each programmed flying hour is fully supported by spares assets. Moreover, these supported peacetime flying hours per day can be expressed as a percentage of the spares support required for each war day requirement. Each peace day spares support will equal the percent of the war day spares requirement in direct proportion to the percent that the peacetime daily flying time is of the required daily war flying time. This is expressed by the equation in Figure 3.

$$\frac{\text{Daily Peace Spares Accumulation}}{\text{Daily War Spares Requirements}} = \frac{\text{Peacetime Program Flying Time Per Day}}{\text{War Program Flying Time Per Day}}$$

= That fraction of the daily war requirement that is accumulated each day via the peacetime flying program.

Fig. 3. War Day Spares to Peace Day Spares Ratio (27:11)

For example, if the peacetime flying program accumulates one hour's worth of spares per day and the wartime requirement is for two hours, it follows that for each day of war the peacetime flying program will provide one-half of the spares required. This accumulation is provided in Figure 4 for the factor of .5.

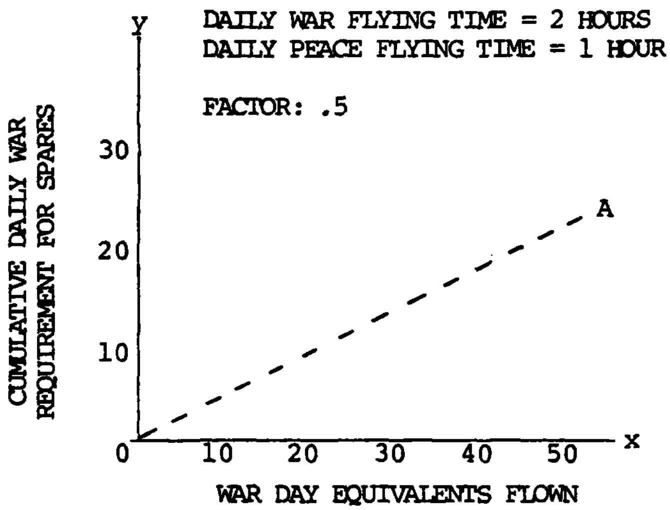


Fig. 4. Peacetime Spares Expressed in War Day Equivalents (27:12)

As shown in Figure 4, after twenty days of combat the spares accumulation via the peacetime flying program equals ten days of wartime spares requirements. y=(F)X defines the line 0A in relation to the x-y axis when F=.5; daily peacetime flying hour per aircraft/daily wartime flying hour per aircraft equals .5. That is, the slope of OA is F.

We have determined a common denominator for war versus peace spares; i.e., flying hours. The next step is to show how peacetime spares accumulate in relation to the war spares requirement. This will be demonstrated graphically in Figure 5 and then mathematically.

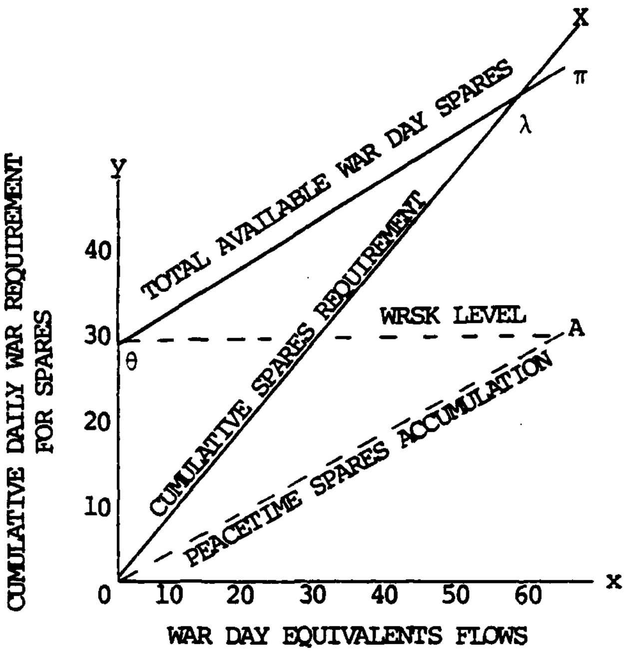


Fig. 5. War Requirement versus Available Spares (27:12)

From the day of deployment, peacetime spares will accumulate at a rate equal to (F) times the number of days or at a specific fraction per day of the war requirement. Using a factor (F) of .5 we see that after twenty days, the equivalent of ten war days' worth of spares would be accumulated in the peacetime flying asset program.

Hence, at the end of twenty days the total spares available to the contingency equals the thirty days' worth of spares provided initially (by the WRSK) plus ten days' worth of spares from the peacetime flying program for a total of forty days' worth of war spares support. The peacetime spares can be added to the WRSK or WRM on a daily basis to produce or plot a total war days assets line $\theta\pi$ (cumulative). This line is expressed by the equation

$$y = 30 + (F)x \qquad (1)$$

where,

$y$ = number of war days spares support available;

30 = number of war days spares from WRSK;

$X$ = Number of days of war;

$F$ = Peace/war flying hour fraction.

In Figure 5 where $\theta\pi$ intersects OX ($\lambda$), the amount of assets on hand equals the amount of support required. As previously indicated, line OX is expressed by $y=x$. Hence, (substituting x for y) the point of intersection is indicated by $x = (F)x + 30$. If, as in our example $F = .5$, x or the number of combat day equivalents flown is $\lambda = 60$. If $F = .5$ the cumulative spares requirement ($y$, where $y=x$) will be greater than spares availa' e ($y$, where $y=30+(F)x$). This indicates that there is a high probability of spare support deficiency for a weapon system with an F of 0.5 after sixty days' operations.

For all contingency plans wherein the flying hours required per day of conflict equal the standard required flying hours per day used in computing WRM, the date at which spares support will have a high probability of deficiency can be computed by solving for x in the equation found in Figure 6.

$$x = -\frac{30}{F-1}$$

Fig. 6. Aircraft Spares Support Equation (27:12)

Where F >1 the value of x will be negative. This indicates that there is theoretically no possibility of an unsupportable condition due to lack of spares; an oversupport situation would exist. If F $\geq$ 1, then the peacetime flying rate is at least equal to the war flying rate, and there should be at least comparable spares requirements. Hence, with WRSK added, there should exist an oversupport status.

In contingency plans which have weapon systems which fly for more or less than the WRM standard, the WRM or WRSK level of support must be adjusted accordingly. For example, if the WRM standard is two hours per day and the OPLAN requirement is one hour per day, it follows that F should be determined based on the one hour requirement and the programmed WRM or WRSK will last twice as long or sixty days.

## Preliminary Analysis of Assumptions

Most of the operational assumptions listed on page 5 of this chapter can be examined as matters of accepted definition rather than by new in-depth analysis. In this section these preliminary peripheral aspects will be covered to allow for greater clarity and attenuation in the definition and treatment of those specific areas of interest which are to be pursued in greater detail; i.e., assumptions 8 and 9.

1. WRSK, Pacing Failure Items. The acceptance of WRM/WRSK items as pacing failure items for all reparables under consideration is necessary to the model equation because only WRM components are defined by Air Force planners in terms of war requirements or consumption rates. As indicated previously, WRM/WRSK is used as the war requirements baseline. In essence, it is the only measuring stick available because no definitive attempt has been made to define wartime support requirements for non-essential reparables (non WRM items).

Albeit WRM is the only readily available baseline, the question remains as to its acceptability. Unfortunately, there is considerable fallibility in determining what is or is not war critical; and, many items not included in WRM/WRSK could conveivably cause a Not Mission Capable (NMC) situation. Further, there are considerable differences between peacetime and combat demand forecasting in the D041 (peacetime reparables) requirements computation data system (16:22). The steady state assumed in computing peacetime inventory requirements does not necessarily hold for combat operations which are frequently limited in duration, reflect specific/peculiar strategic planning and decision making, and frequently engender intensive overload of the capacities for maintenance and overhaul in the theater of operations environment (12:12-13). Hence, the transposition of peacetime consumption rates to wartime requirements in a direct sense to estimate war requirements appears inappropriate. Also, the unrestrained use of WRM/WRSK as an absolute indicator of war reparables requirements is not justified. Rather, it must be accepted as an expedient (no other viable options) and reasonable indicator provided substantive evidence can be presented to show that if WRM/WRSK items are supportable then it is likely that other items are also supportable.

It is accepted by definition that WRM/WRSK items are the most critical support items in war. It has also been argued/suggested that they are with few exceptions the most critical items in peacetime (17:45). This is supported by the information in Table 1. Approximately one-fifth of the total number of items caused over 70 percent of recorded Not Mission Capable Supply situations. From this it can be inferred that a given WRM or WRSK item is over nine times more likely to cause a NMCS than

TABLE 1

IMPACT OF WRM ITEMS (16:15)

| | Number of WRM Items | % of Total Items | % of NMCS Incidents |
|---|---|---|---|
| All Degrees of Base Repair Capability | 7889 | 21.5 | 70.3 |

a non-WRM item. It thus appears that using WRM/WRSK as pacing failure items to determine mission support capability is fundamentally sound.

2. Cannibalization and Attrition. Specific attrition and cannibalization rates for aircraft in combat are of course subject to the fortunes of war. Whether or not a unit can field the required number of aircraft for a mission for reasons other than reparables supply is, however, beyond the scope of this project. Hence, it is assumed that if the spares are available to support a mission then all other requirements are met.

Current Air Force WRSK computation systems such as D029 and the Air Force Recoverable Assembly Management Systems (AFRAMS) assume 100 percent cannibalization in order to maximize the sortie generation potential (13:6). Under D029, if a system fails, it will be cannibalized to minimize the number of NMCS aircraft. Further, the system checks other battle damaged or grounded aircraft for usable spares before it will allow an NMCS to occur. This appears to be a reasonable model for wartime flight-line repair operations in which grounded or damaged aircraft would be 100 percent cannibalized in order to ensure that the largest possible number of aircraft were available and mission-ready. This is critical to our research model because it ensures that all available spares will be used prior to a NMCS.

3. D to P. Many of our military leaders have expressed concern over the length of time required to gear up production to meet war surge requirements. General Mullins (previous DCS Plans & Programs, AFLC/XR) indicated that the Air Force will be in a "come as you are" predicament if there is another war. This would be true because by the time production levels are high enough to meet wartime requirements it is likely that the emergency will be over (17:2). This is not surprising,

> A military contracting officer would be fortunate indeed if he could process a large advertized procurement for hand tools in less than sixty days; ninety days would not be uncommon [15:574].

Even the use of letter contracts would not permit the tooling up and subcontracting necessary to produce far more complicated/sophisticated repair components such as avionics in less than six months.. Our Industrial Preparedness Program deals mainly with major systems, hence there is likely to be a considerable gap between date of deployment to date of increased production for reparables.

Maintenance surge could have a short-term effect on repair parts available; however, no effort has been made to stock emergency levels of the component repair parts necessary to sustain increased maintenance levels. Hence, the model considers only those reparables either in the system at date of deployment or previously on order to support the peacetime flying program or WRM replenishment.

4. No Additional Resources. It is recognized that in a condition of less than general mobilization, peacetime flying program operations could easily be slowed or halted in order to provide additional reparable parts for deployed aircraft. For the purposes of this research however, this option will not be allowed. This will serve to isolate the support capability available for specific aircraft and allow for the determination in flying hours and combat days when and how much (in a macro sense) additional support would be required to support a given contingency operation.

5. All Weapon Systems have WRSK. This research is primarily concerned with weapon systems which would be deployed for contingency operations. Such aircraft due to their mission require either predeployed WRM or WRM which can be transported with deploying forces. WRSK are defined and designed for deployment purposes and, as such, constitute the baseline spares support for this research. Hence, it is assumed that all aircraft units under

consideration are provided with WRSK and consideration of WRM will be limited to WRSK.

6. Mission Requirements as Planned. It is recognized that actual combat requirements will dictate the number and types of sorties flown. Hence, actual reparable requirements could have considerable variance from expected need levels. On the other hand, both conventional WRSK and WRSK generated by D029 marginal analysis supported primary mission requirements for the F-4 in recent tests, as indicated in Table 2. For the purposes of this research it is assumed that Air Force War Planning documents provide adequate/reasonable estimates and, further that, as shown above, WRSK if properly filled/stocked will support mission requirements.

TABLE 2

F-4 WRSK SABRE READINESS TEST RESULTS (11:12)

| | Conventional WRSK | Marginal Analysis WRSK |
|---|---|---|
| Primary Factors | | |
| Sorties Req. vs Sorties Flown | 100% | 100% |
| Sortie Effectiveness | 99.1% | 98.9% |
| Secondary Factors | | |
| Mission Capable Aircraft | 5% | 11% |
| Inoperable Subsystems | 50 | 30 |
| Percent WRSK Demands Satisfied | 98.7 | 98.9 |
| WRSK Zero Balance | 54 | 21 |
| # of Cannibalizations | 79 | 60 |
| Manhours Req. Per Flying Hour | 22.6 | 20.5 |

7. Pipeline Requirements and Host (base) Nation Support. The capability of the base of deployment to provide repair commensurate with the base of origin will be dependent upon numerous factors including but not limited to:

a. Location and pipeline difficulties.

b. Political, cultural and language differences.

c. Compatibility of technology, tools, measurement/calibration equipment, etc.

d. Availability of skilled workers and bit and piece repair parts.

These factors encompass issues far beyond the resources available to this research. Consideration of host nation support is consequently limited in our primary research to those areas where very high compatibility is anticipated; i.e., U.S. air bases overseas.

## Summary

The need for a reasonably accurate method of determining spares support during contingency operations has been established and a preliminary model for spares support has been introduced. Assumptions regarding the model have been discussed with the exception of those intended for detailed statistical analyses; i.e., assumptions which generated the following research questions:

1. How many war days will a WRSK support? (Assumption #8)

2. What percent of the peacetime flying hour program is not supported due to lack of spares support or degradation in the readiness due to lack of spares support? (Assumption #9)

It is intended that this model should provide commanders and planners with a preliminary hardstick for long-range contingency spares support analysis. Applications of the model could be manifold. Not only would it show when shortages which affect mission performance are likely to occur, it also would indicate in flying hours the amount the peacetime flying program for a particular aircraft type would have to be reduced in order to support a given contingency effort. Further, the model would reveal the untoward results of both poor WRSK readiness and low peacetime flying programs. Hence, the model would provide for timely command and funding decisions before mission performance would be adversely affected.

At this point the model is still largely hypothetical. In the next chapter a statistical approach and methodology for answering the research questions and incorporating findings into the basic model will be discussed.

## CHAPTER II

## APPROACH AND METHODOLOGY

### Introduction

Total spares supportability may be expressed as WRSK (thirty days) plus whatever is available in the peacetime supply support system (provided resupply is available prior to the end of the first thirty days of deployment and at reasonable/adequate levels thereafter). This phenomena is expressed in the model as:

$$y = \omega + Fx(\varepsilon) \qquad (2)$$

where,

$y$ = total days of spares support available;

$\omega$ = the number of war days spares support immediately available from the WRSK provided the WRSK is 100 percent filled. (The current planning assumption is $\omega = 30$.);

$F$ = the proportion of flying hours in a peacetime day to the number of flying hours in a war day;

$x$ = Number of days of contingency operations (war days); and

$\varepsilon$ = the inherent variability due to degradation of actual peacetime support.

The substantiation or improvement of this equation as a model for contingency spares support was the research objective.

The independent variables were broken down into three basic research components to facilitate further analysis:

1. $\omega = 30$ = WRSK support at 100 percent fill.

2. FX = support available from peacetime flying program at 100 percent support (measured in war days of support).

3. $\varepsilon$ = support degradation; i.e., peacetime flying program degrdation due to lack of spare parts.

Each component has been statistically analyzed. Components "1" and "2" above correspond direct to the two research questions listed in Chapter I. The analysis of the equation components provided the empirical basis for more accurate components.

## Universe Defined

The universe considered in this research was limited to reparable spares support over the past four years (1976 to 1979) due primarily to the availability of reasonably attainable and accurate data.

## General Population Defined

1. The spares considered in this research were primarily recoverable items--items that can be repaired by maintenance activities at base or depot when unserviceable, and reissued. These items are distinguished from end items which do not become part of a larger operating system when in use and lose their identity. Further, these items are

distinguished from Economic Order Quantity items (EOQ) which are obtained on a consumption basis and thrown away when they become inoperable. From the management and budgetary standpoints respectively, reparables are the Air Force's most complex and expensive items (7:22).

2. Primary emphasis was placed upon WRSK reparables. This research was concerned with contingency operations; hence, as indicated in Chapter I, deployment was a major consideration. War Readiness Spares Kits (WRSK) are one element of the War Readiness Material (WRM) program. WRM is defined as:

> . . . that quantity of stock required, in addition to normal peacetime operating assets, to assure logistics support of contingency of wartime missions until production can assure the continuity of resupply [24:2].

WRSK are defined as:

> . . . <u>air transportable</u> package(s) of WRM spares, repair parts and related maintenance supplies required to support planned wartime or contingency operations of a weapon or support system for a specified period of time (30 days) pending resupply [24:14-12].

3. The populations considered also complied with the following pragmatic limitations:

a. Spares for which source data existed which was relevant to mission (war) capability.

b. Spares which had traceable impact data in terms of Not Mission Capable/Supply (NMC/S) or Partial Mission Capable/Supply (PMC/S).[1]

[1] See definition, page 27.

c. Items which could be analyzed within the time and funding constraints applicable to the research effort.

War Readiness Supply Kit (WRSK) Analysis

Research Goals

1. To determine the lower bound of number of war days which can be supported via WRSK with 95 percent confidence.

2. To determine the constancy of the lower bound 95 percent confidence level of WRSK support over time.

3. To determine the probability of selecting a mission capable WRSK from the general WRSK population.

Specific Research Objectives

1. Determine the lower bound of percent WRSK fill (percent of WRSK which is available) with 95 percent confidence.

2. Determine if the variance of percent of WRSK fill over the past three years has been significant; i.e.,

$$H_0: \mu_1 = \mu_2 = \mu_3$$

or

$$H_1: \text{not all } \mu_j\text{'s are equal.}$$

3. Determine binomial probability of selecting a Mission Capable versus Non Mission Capable WRSK.

## Peacetime Flying Program Support Analysis

### Research Goals

1. To determine the lower bound of war days which can be supported (reparable spares) via the peacetime flying program with 95 percent confidence.

2. To determine the constancy of the lower bound (99 percent confidence level) for different aircraft at different bases.

### Specific Research Objectives

1. To determine the upper bound of the percent of the peacetime flying hour program which is not accomplished due to Not Mission Capable Supply (NMCS)[2] or Partial Mission Capable Supply (PMCS)[3] with 95 percent confidence. This was evaluated by determining the upper bound percent of unsupportable flying hours (95 percent confidence) and subtracting from 100 percent.

2. To determine if the variance of NMCS and PMCS over the past four years for different aircraft at

---

[2]NMCS--"The aerospace vehicle cannot fly any of its assigned missions due to lack of parts for subsystems . . . [1:5-2]."

[3]MPCS--"The Aerospace vehicle can fly at least one of its missions but not all missions due to lack of parts for systems . . . [1:5-2]."

"NMCS or PMCS time will start when a part(s) is/are required, a valid demand is made on supply and is verified NMCS or PMCS. Time will stop when the part(s) is/are received or made available from supply . . . [1:5-2]."

different bases (including foreign bases) has been significant; i.e., $H_0$: $\mu_1 = \mu_2 \ldots = \mu_j$ or $H_1$: not all $\mu_j$'s are equal.

## Summary

This chapter covered the approach which was employed to answer the basic research questions:

1. How many war days will a WRSK support?

2. What percent of the peacetime flying hour program is not supported due to lack of spares support? or What percent of degradation of spares support occurs due to actual, i.e., less than 100 percent, peacetime flying program support levels?

These research questions correspond directly to the basic components of the model for contingency spares support presented in Chapter I (i.e., Y = 30 + FX) to which a new component $\varepsilon$ was added which reflected the variability inherent in question number 2 above. The statistical analysis conducted in Chapters III and IV served to answer the research questions and provided more realistic factors for the basic model. In Chapter V the results of the WRSK analysis are discussed.

# CHAPTER III

# WAR READINESS SPARES KITS (WRSK) ANALYSIS

## Introduction

### Background

This chapter deals with the determination of the actual number of war days of spares support which can be anticipated (conservative estimate with 95 percent confidence) from Air Force WRSK. As previously indicated, during the first thirty days of contingency deployment, spares support for Air Force weapon systems is provided from War Readiness Spares Kits (WRSK). These kits have been tailored to prevent otherwise combat ready systems from being grounded due to lack of spare parts, particularly when normal resupply is disrupted. Hence WRSK are critical to our initial war effort and provide the baseline for spares support; i.e., thirty days if WRSK are 100 percent filled.

### Problem Statement

This chapter deals with the determination of the credibility of the spares support baseline; i.e., thirty days of spares support. The research goal was to determine the number of war days which can be supported via WRSK with 95 percent confidence. The figure derived was used to replace thirty (assumed for $\omega$) in the model. In order to verify the time consistency of the new baseline it was necessary to compare WRSK populations over time (1976-1979) to determine variance, and any significant trend which existed.

## Approach and Methodology

### Introduction

Total spares supportability may be expressed as WRSK (thirty days) plus whatever is available in the peacetime supply support system (provided resupply is available prior to the end of the first thirty days of deployment and at reasonable/adequate levels thereafter). This phenomena is expressed in the equation as: $Y = \omega + FX(\varepsilon)$ (see equation (2), page 23).

The components of the equation correspond directly to two research questions:

1. How many war days will a WRSP support? . . . $\omega$. (question #1)

2. What percent of the peacetime flying hour program is not supported due to lack of spares support? . . . $F(\varepsilon)$. (question #2)

This chapter, however, treats only research question #1. The next chapter will deal with peacetime spares support. Specifically, in this chapter a more realistic WRSK factor than the assumed thirty (days of support) will be derived.

## General Population Defined

The spares considered in this research were primarily recoverable items--items that can be repaired by maintenance activities at base or depot when unserviceable, and reissued. Emphasis was placed upon WRSK reparables. This research was concerned with contingency operations; hence, as indicated in Chapter I, deployment was a major consideration (see page 25).

## War Readiness Supply Kit (WRSK) Analysis/Methodology

### Research Goals

1. To determine the lower bound of number of war days which can be supported via WRSK with 95 percent confidence.

2. To determine the constancy of the lower bound 95 percent confidence level of WRSK support over time.

3. To determine the probability of selecting a mission capable WRSK from the general WRSK population.

### Specific Research Objectives

1. Determine the lower bound of percent WRSK fill (percent of WRSK which is available) with 95 percent confidence.

2. Determine if the variance of percent of WRSK fill over the past three years has been significant; i.e.,

$$H_0: \mu_1 = \mu_2 = \mu_3$$

or $$H_1: \text{not all } \mu_j\text{'s are equal.}$$

3. Determine binomial probability of selecting a Mission Capable versus Non Mission Capable WRSK.

General Statistical Methodology

1. Universe--all Air Force WRSK (reported in D005 over the past three years).

2. Populations--

a. WRSK year three, mean percent fill per year three.

b. WRSK year two, mean percent fill per year two.

c. WRSK year one, mean percent fill per year one.

3. Units Measured (independent variable)--percent WRSK fill; i.e., subjectively determined (by the unit commander) amount/percent of a WRSK available at the time of a given WRSK readiness report (D005).

4. Sampling Plan--fifteen composite (mean) samples were derived from each population. Each mean sample was derived from five random samples taken from the respective populations. Since the percent of WRSK fill is highly skewed to the right, averaging simple random samples ensures an approximately normal distribution.

5. Statistical Technology--

a. A chi-square test (continuous probability distribution) was run on the forty-five smoothed samples (fifteen from each year) to determine distribution normality.[1] Variance and standard deviation were estimated from the analysis of variance data of the three populations (year one, year two, and year three). This technique indicates normality (or lack thereof) and allows for the determination of the lower bound of WRSK percent fill with 95 percent confidence. This factor (lower bound) indicates the minimum percent WRSK available with 95 percent certainty (provided variance over time is insignificant). The lower bound indicates the percent of whole WRSK and by inference whole thirty days of support available. Hence the baseline of thirty days of wartime support can be modified according to the lower bound percent fill. For example, if the lower bound is 50 percent, then it follows that the part of the whole WRSK or thirty days of support available is 50 percent or fifteen days of support.

The condescriptive technique used without mean samples (using fifty simple random samples from year one) indicated the percentages of WRSKs which have specified fill levels (in increments of 10 percent). This permits an analysis of WRSK by M rating. WRSK readiness is evaluated using the rating system described in Table 3.

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[1] $\alpha$ risk controlled at .01.
$H_0$: the probability distribution is normal.
$H_1$: the probability distribution <u>is not</u> normal.

TABLE 3

WRSK M RATINGS (24)

| | | | | |
|---|---|---|---|---|
| 1. | M-1 | (100-95% Fill) | Combat Ready | No Limitations |
| 2. | M-2 | ( 94-80% Fill) | Combat Ready | Minor Deficiencies |
| 3. | M-3 | ( 79-70% Fill) | May be Committed | Major Deficiencies |
| 4. | M-4 | ( 69- 0% Fill) | Not Combat Ready | |

Kits with ratings of M-1 and M-2 are combat ready and will be able to support mission objectives. Conversely, kits with ratings of M-3 and M-4 either cannot support the mission or would entail serious degradation. Analysis of supportability was handled as a binomial probability distribution, i.e., two basic outcomes: either M-1/M-2 (Combat Ready, Success) or M-3/M-4 (Not Combat Ready, Failure). Further, the condition of each WRSK constitutes an independent event and the probability of randomly choosing one or more defective WRSKs from the total population remains approximately constant from trial to trial; hence, the process may be considered stationary. Although the process is hypergeometric its probability distribution can be approximated by the binomial probability distribution because samples will be restricted to n such that $n/N \leq .1$ (of total population).

b. An analysis of variance (simple one way classification) was conducted on the three separate populations to determine if $H_0$: $\mu_1=\mu_2=\mu_3$; i.e., there was no significant variance, $\alpha$ risk = .01 (99 percent confidence level) over time.

c. In the event $H_0$ was rejected a trend analysis would have been required to determine the validity of using a constant WRSK readiness factor.

WRSK Analysis Limitations

1. Due to the classification of WRSK percent fill data (SECRET-D005) aircraft, aircraft locations, current data and precise D005 report times are not indicated.

2. For analytical purposes it was assumed that percent WRSK fill was a direct measure/indication of the percent of support capability.

3. There exists the inherent possibility of inaccuracy of data reported in the D005 system. This is particularly true because of constant pressure on unit commanders to both maintain WRSK in a high state of readiness and high performance in peacetime flying operations (maintaining low Not Mission Capable (NMC) status). Further, one of the characteristics of current Air Force supply procedures is that WRM/WRSK assets are required to augment and support daily peacetime flying operations (11). Hence, the most critical operational items are likely to be those taken from WRSK. Pressures to maintain high standards of readiness could cause commanders to overestimate the support capability of their unit's WRSK. Hence, there is not a direct

relationship. Percent fill is the best empirical indicator available to indicate readiness in a quantitative manner; however, if the items missing are high failure/hard to replace/short supply items, as is likely to be the case, it is possible that the percent missing would have greater adverse impact than otherwise indicated in determining WRSK readiness. Hence, each Air Force unit commander provides a subjective analysis of their unit's WRSK to determine an appropriate M readiness rating (as previously described). There is a correlation between M ratings and percent fill as previously indicated but the relationship should not be construed to be exact. For this reason, the binomial approach using M ratings was employed to reinforce the direct percent fill to percent mission capability analytical approach.

## Summary

The approach and statistical methodology which was employed to answer the basic research question: How many days of contingency operations will a WRSK support with 95 percent confidence has been covered. The next section addresses the investigation question: What is the probability of selecting a mission capable WRSK from the general WRSK population?

## Probability of Mission Capable WRSK

From D005 data (not presented due to security classification) it was determined that five of 115 WRSKs were M-3 or M-4 (Failure). Hence, 4 percent would not be able to perform all assigned missions. This is born out by the frequency distribution for percent of WRSK fill shown in Figure 7 (condescriptive data).

```
     I
  1. ** (     1)
     I  1 TO 10
     I
     I
  7. ** (     2)
     I  10 TO 70
     I
     I
  8. ** (     2)
     I  70 TO 80
     I
     I
  9. ************** (     25)
     I  80 TO 90
     I
     I
 10. ******************************************* (     84)
     I  90 TO 100
     I
     I.........I.........I.........I.........I.........I
     0        20        40        60        80       100
     FREQUENCY

     VALID CASES = 114; MISSING CASES = 0
```

Fig. 7. Frequency of WRSK Percent Fill

The frequency was significantly skewed to the left (-5.826). Eighty-four WRSKs are 90 percent or better, and 109 are 80 percent or better.

It was determined that the probability of randomly selecting a "Failure" WRSK out of the total population was equal to the percent of the population represented by the total number of "Failure" kits or

$$05/114 = .04 = p$$

Using binomial probability tables, it was found that if five random units were deployed, the probabilities would result as indicated in Table 4.

TABLE 4

PROBABILITY OF SELECTION OF "FAILURE" WRSK

| | | | |
|---|---|---|---|
| None | of the units would have "Failure" WRSKs | = | .815 |
| One | of the units would have "Failure" WRSKs | = | .170 |
| Two | of the units would have "Failure" WRSKs | = | .014 |
| Three | of the units would have "Failure" WRSKs | = | .001 |
| Four | of the units would have "Failure" WRSKs | = | .000 |
| Five | of the units would have "Failure" WRSKs | = | .000 |

(p=.04); n=5; N=114 and $5/114=.04 \geq .10$)

Hence, although 96 percent of the units appeared combat ready, only about 82 percent success could be anticipated for a randomly chosen medium size task force.

### Analysis of WRSK if Each WRSK is Degraded by 10 Percent Due to Gaming and High Failure Items

Unfortunately however, WRSK ratings could be inflated by as much as 10 percent. Exact data is not available to determine a more exact, realistic figure, presumably less than 10 percent.[2] Consequently, a worst case estimate was developed. The results are indicated below:

1. VALID OBSERVATIONS: 114, none missing
2. MEAN: 88.217
3. VARIANCE: 106.333
4. RANGE: 94
5. STD DEVIATION: 10.312
6. SKEWNESS: -5.826

The expected value or mean for the distribution dropped from ninety-three to eighty-eight or five units. Standard deviation dropped from eleven to ten. However, skewness was unchanged indicating that the frequency distributions had not changed significantly. As shown in Figure 9, the .90 to 1.0 range lost seventeen kits, the .8 to .9 range gained twelve kits, and <u>most</u> (as will be shown later) importantly, five kits had dropped to the "Failure" range. Hence, the probability of selecting a "Failure" WRSK from the total sample became 10/114 or .9. It follows that

---

[2] It was found (from D005) that unit commanders reported "M" ratings appropriate to WRSK percent fill in nineteen out of 225 random sample cases. Hence in approximately 8 percent of the cases unit commanders felt that actual WRSK readiness was below the readiness level implied by percent fill. It is assumed that "gaming" would tend to make unit commanders overevaluate WRSK. Hence, we assume that underrating is bonafide. If unit commanders devaluate "M" ratings for 8 percent of reported WRSK, the devaluation factor used here, i.e., 10 percent seems appropriate.

```
NPERCENT EACH WRSK LOST 10% DUE TO HIGH FAILURE ITEMS
CODE
     I
  1. ** (      1)
     I
     I
     I
  6. ** (      2)
     I  50 TO 60
     I
     I
  7. ** (      1)
     I  60 TO 70
     I
     I
  8. ********* (     16)
     I  70 TO 80
     I
     I
  9. ************************************************ (     94)
     I  80 TO 90
     I
     I.........I.........I.........I.........I.........I
     0         20        40        60        80        100
     FREQUENCY

     VALID CASES = 114; MISSING CASES = 0
```

Fig. 8. Frequency of WRSK Percent Fill (10 Percent Degradation)

(as in the previous analysis) if five random units were deployed, the resultant probabilities are as depicted in Table 5. Although 91 percent of the WRSKs were still combat ready subsequent to 10 percent decrement, the probability of randomly choosing five combat ready units was only .62.

<u>Results of High Failure Items and Gaming</u>

1. For random selection of Air Force units:

TABLE 5

PROBABILITY OF SELECTION OF "FAILURE" WRSK
(10 PERCENT DEGRADATION)

| | | |
|---|---|---|
| None of the units would have "Failure" WRSKs | = | .624 |
| One of the units would have "Failure" WRSKs | = | .309 |
| Two of the units would have "Failure" WRSKs | = | .061 |
| Three of the units would have "Failure" WRSKs | = | .006 |
| Four of the units would have "Failure" WRSKs | = | .000 |
| Five of the units would have "Failure" WRSKs | = | .000 |

(p=.09; n=5 and N=114)

a. The number of failure risks increased from five to ten or doubled.

b. The probability of selecting a "Failure" WRSK from the total population increased from .04 to .09, i.e., increased 225 percent.

c. The probability that out of five randomly selected WRSKs none would have a "Failure" WRSK decreased from 82 percent to 62 percent; i.e., decreased 24 percent.

d. The probability that out of five randomly selected WRSKs one would have a "Failure" WRSK increased from 17 percent to 31 percent; i.e., increased 182 percent.

2. For discrete selection of units: appropriate regulations were checked to determine the implications of M-3 and M-4 (Failure) ratings. It was found out that units with M-3 and M-4 WRSK were not considered combat ready and, subsequently, would not be deployed except in time of

extreme emergency. Hence, they would not be considered for deployment in minor contingencies unless other factors prevented deployment of other combat ready units. Statistically this would reduce the population (114) of available units by the number of M-3 and M-4 kits. In this case the population declines to ninety-five units. The probability of selecting any number combat ready units up to ninety-nine for deployment would be unity or 100 percent as long as proper M ratings were assigned. Therein is the crux of the impact of inflating WRSK ratings. By inflating M ratings, there exists the possibility that "Failure" WRSKs will be chosen to perform missions even though combat ready units may be available. It was determined that the impact of inflating WRSK evaluations by 10 percent in the sample population caused five M-3 WRSKs to be rated M-2. Hence, five out of ninety-nine WRSKs were not combat ready and could conceivably be assigned critical combat missions. The probability of selecting one of these WRSKs would be

$$\frac{5}{99} \text{ or } p = .05$$

The probability of randomly selecting five WRSKs out of those designated M-1 and M-2 which were truly combat ready would be .77. The probability that one of the five WRSKs would be a "Failure" would be .20.

From this analysis and interpretation of WRSK percent fill data it is apparent that it cannot be assumed that all WRSKs are mission capable. Indeed it was demonstrated that a significant possibility exists that in a medium size task force either a single unit will not be mission capable or, possibly, due to the collective degradation of all units in a task force there would exist an equivalency to having one unit not fully mission capable. Concomitant to this realization is the desire to know what degradation is expected in the average WRSK. This knowledge will serve to indicate the percent of combat capability expected from a WRSK. Further, this can be expressed in probable numbers of war days of spares supportability available vice the thirty days assumed in war planning. The next section will address the assumption of normality in the smoothed sample of WRSK percent fill.

## Normality of the Smoothed WRSK Sample

### Analysis

From smoothed samples of D005 WRSK data (Table 6) it was determined that the probability distribution was approximately normal.

The goodness of fit test employed was the chi-square test for continuous probability distribution:

Hypothesis

$H_0$: the population is normally distributed

$H_1$: the population is not normally distributed

TABLE 6

WRSK PERCENT FILL
(SMOOTHED FROM D005 DATA)

| | | | | |
|---|---|---|---|---|
| 1. | Year #1 | 96.6 | 95.2 | 94.0 |
| | | 90.8 | 96.0 | 86.8 |
| | | 95.2 | 93.0 | 88.8 |
| | | 87.6 | 96.0 | 95.8 |
| | | 94.0 | 99.0 | 92.6 |
| 2. | Year #2 | 95.6 | 96.6 | 89.8 |
| | | 93.2 | 84.6 | 94.8 |
| | | 96.4 | 92.0 | 91.3 |
| | | 93.7 | 93.6 | 93.8 |
| | | 91.6 | 96.8 | 91.6 |
| 3. | Year #3 | 98.6 | 95.0 | 92.2 |
| | | 93.8 | 97.2 | 96.6 |
| | | 95.6 | 94.6 | 92.8 |
| | | 93.0 | 86.2 | 93.4 |
| | | 93.4 | 93.9 | 89.0 |

Decision Rule

If $X^2_{calc} \leq X^2$ $(1-\alpha;\ k-m-1)$, conclude $H_0$

If $X^2_{calc} > X^2$ $(1-\alpha;\ k-m-1)$, conclude $H_1$

Estimated Parameters (from ANOVA section)

Mean = $\bar{X}$ = 93.904

Std. Deviation = s = 3.0692

Alpha Risk

Controlled at $\alpha$ = .01

Chi-square Calculations

The chi-square calculations for goodness of fit are presented in Table 7.

TABLE 7

CHI-SQUARE CALCULATION TABLE (WRSK)

| Class $i$ | Percent WRSK Fill $x$ | Observed Frequency $f_i$ | Probability Under $H_0$ | Expected Frequency Under $H_0$ $F_i$ | $f_i-F_i$ | $(f_i-F_i)^2/F_i$ |
|---|---|---|---|---|---|---|
| 1 | Under 91.326 | 8 | .2 | 9 | -1 | .111 |
| 2 | 91.326 to 93.826 | 13 | .2 | 9 | +4 | 1.778 |
| 3 | 93.826 to 93.982 | 5 | .2 | 9 | -4 | 1.778 |
| 4 | 93.982 to 96.482 | 11 | .2 | 9 | +2 | .444 |
| 5 | Over 96.482 | 8 | .2 | 9 | -1 | .111 |
| | | | | | | $X^2_{calc} = 4.222$ |

<u>Decision</u> (two paramaters, $\mu$ and $\sigma$, estimated)

$$X^2\ (.99;\ 5-2-1) = (.99,2) = 9.21$$

$$X^2_{calc} = 4.222 \leqq X^2 = 9.21$$

Hence $H_0$ is concluded; i.e., with 99 percent confidence the population of smoothed samples is normally distributed.

## Conclusions

The selection of a medium sized task force (three to five units with WRSK) may be considered as a single smoothed random sample from the population of AF WRSK. Such a sample is analogous to the smoothed samples taken above. Hence, it may be inferred that the probability distribution of the population of Air Force WRSKs for medium task forces picked at random is approximately normal.

## Determination of Confidence Interval

## Analysis

Provided that the task force population of AF WRSK is normal, it follows that by employing the unbiased estimators for the mean and standard deviation (93.904 and 3.0692 respectively) a 95 percent confidence interval for WRSK percent fill for task forces can be constructed.

To whit:

$$z(.95) = 1.645$$

$$1.645(3.0692) = 5.05$$

Then, with 95 percent confidence: 88.85 $\leq$ WRSK Percent Fill $\leq$ 98.95.

It can be concluded with 95 percent confidence that the WRSK Percent Fill for a task force is equal to or greater than 88.85--which may be considered a pessimistic lower bound of probability.

Conclusions (Development of WRSK baseline vice thirty)

We can anticipate that WRSKs are at least 88.5 percent filled for contingency operations. Using the logic presented earlier, i.e., WRSK percent fill is an indicator of probable WRSK mission support, it follows that it can be anticipated with 95 percent confidence that WRSK will provide .8885 times thirty or 26.66 days of spares support for contingency operation. If the variance of percent WRSK fill is insensitive to time, i.e., variance over time is insignificant, it follows that 26.66 days of support from WRSK may be considered as a pessimistic contingency spares support baseline vice thirty days. In the next section an analysis of variance will be conducted to determine the constancy of the derived baseline.

## Analysis of Variance Over Time

### Analysis

To determine if percent WRSK fill is constant over time a simple one-way analysis of variance was conducted on the data presented in Table 6.

Hypothesis

$H_0$: $\mu_1=\mu_2=\mu_3$

$H_1$: not all $\mu_j$'s are equal

Note: $\mu_1$ = population mean year one

$\mu_2$ = population mean year two

$\mu_3$ = population mean year three

Decision Rule

$F^* = \frac{MSTR}{MSE}$ (derived from data)

If $F^* \leq F\ (1-\alpha;r-1,n_T-r)$, conclude $H_0$

If $F^* > F\ (1-\alpha;r-1,n_T-r)$, conclude $H_1$

Alpha Risk

Controlled at $\alpha$ = .01, confidence level = .99

Calculations

r = number of treatments = 3

$n_T$= 15 + 15 + 15 = 45

$F(.99;\ 2,42) = 5.050$

$\frac{MSTR}{MSE} = \frac{.0170}{9.8678} = .0017 = F^*$

Decision

$.0017 \leq 6.060$

Conclude $H_0$: $\mu_1=\mu_2=\mu_3$ with 99 percent confidence.

Conclusions/Results

From the test results it is clear that the population means may be considered equal.

It follows that WRSK percent fill appears to be fairly constant over time. Thus the derived baseline of 26.66 days of spares support may be considered relatively constant over time; i.e., three-year periods.

## Summary

### Background

The primary aim of this chapter was to determine the validity of WRSK readiness; i.e., how many days of war would a WRSK actually support, with 95 percent confidence? In order to answer this question and to determine the WRSK baseline factor vice thirty days for the contingency spares support equation model ($Y = \omega + FX(\varepsilon)$) three research questions were developed:

1. What is the probability of randomly selecting a combat capable WRSK?

2. What is the lower bound (95 percent confidence) of probable percent WRSK fill?

3. What is the variance of percent WRSK fill over time?

### General Findings

1. The expected value of the mean WRSK percent fill ranged from 93 to 98 percent. Hence there was significant degradation of readiness due to missing spares and possible gaming.

2. The smoothed distribution of WRSK percent fill was normal with a mean of almost ninety-four and standard deviation of three. With 95 percent confidence it was determined that the lower bound of WRSK percent fill was 89 percent.

3. It was determined that the variance of percent WRSK fill over the past three years was insignificant. Hence WRSK percent fill appears to be fairly constant over time.

4. Finally, it was determined that the lower bound of WRSK support likely for small/medium task forces in terms of war days of support was 26.66 days vice thirty days.

5. The preliminary model was consequently changed to:

$$Y = 26.66 + FX\ (\varepsilon) \qquad (3)$$

This research chapter constitutes step one in the development of improved factors for the above equation. The 95 percent confidence level developed for WRSK Percent Fill is depicted in Figure 9; 26.66 $\leqq$ # days spares support from WRSK $\leqq$ 29.69.

At this point, however, the model is still largely hypothetical. Albiet a better factor has been determined for WRSK readiness, the other factors, peacetime spares support degradation must still be addressed and will be covered in Chapter IV.

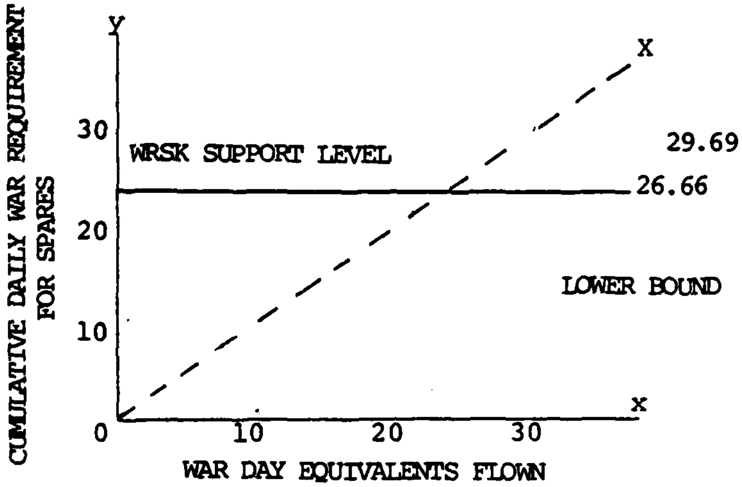


Fig. 9. 95 Percent Confidence Range for Number of Days of Spares Support from WRSK

CHAPTER IV

# PEACETIME FLYING PROGRAM SPARES SUPPORT ANALYSIS

## Introduction

### Background

In Chapter III it was determined that the lower bound for WRSK Percent Fill, with 95 percent confidence, was 89 percent. This translated to 89 percent of thirty or 26.66 days of spares support available (pessimistic, lower bound) or expected from a given WRSK. Further, it was determined that over the past three years the lower bound of Percent Fill has not experienced significant variance. The preliminary model for wartime spares support was consequently changed from

$$Y = \omega + FX(\varepsilon)$$

to

$$Y = 26.66 + FX(\varepsilon)$$

In this chapter an analysis similar to that employed in Chapter III was used to determine the percent of the Air Force's peacetime flying program which is not supported due to reparable spare parts shortage and, conversely, the percentage which is supported. This has been translated into the percent supported with 95 percent confidence (lower bound as in Chapter III). The factor derived will be used in lieu of "$\varepsilon$" in the model. It should be noted at this point, however, that the model represents a general case, hence the factors must be stable. Consequently, an analysis of variance for peacetime spares support was conducted using samples from the past four years. Further, of particular concern during deployment are the increased pipeline burden and maintenance workload competence at the deployed base, particularly when the base is an allied base and when overload conditions are prevalent. As previously indicated, analysis of pipeline support is beyond the scope and resources available to this research. However, the importance of these factors is significant and must be incorporated in the final equation. In the appendix an arbitrary figure for degradation due to pipeline and base repair overload is provided for the application model. These factors are critical to the model and are recommended for future studies. In this chapter a composite sample of foreign U.S. base peacetime spares support will be compared to continental support to determine if significant variance exists among U.S. bases, foreign versus domestic.

## Research Objectives

This chapter will:

1. Determine the lower bound of war days which can be supported (reparables) via the peacetime flying hour program with 95 percent confidence.

2. Determine the constancy of the lower bound (95 percent confidence level) over the past four years (1976-1979) for different deployable aircraft at different bases, both foreign and domestic.

3. Determine an appropriate ε factor (i.e., the percent of the peacetime flying hour program which is actually supported) for the spares analysis model; to include possible pipeline and foreign base maintenance degradation.

## Approach and Methodology

### Introduction

Primary emphasis in this chapter will be dedicated to those critical peacetime spares which can cause either a Not Mission Capable Supply (NMCS) or a partial mission Capable Supply (PMCS) situation (see Chapter II).

### Specific Research Objectives

1. Determine the upper bound (1 minus the upper bound of unsupported flying hours equals the lower bound of supported hours) of the percent of the peacetime flying hour program which is not accomplished due to NMCS or PCMS with 95 percent confidence.

2. Determine if the variance of NMCS plus PMCS has been significant over the past four years at different bases with different aircraft.

3. Determine if the variance of NMCS plus PMCS for continental U.S. bases versus NMCS plus PMCS for foreign U.S. bases has been significant over the past four years and, if so, to what extent (i.e., $H_0$: $\mu_1=\mu_2=\mu_3$ or $H_1$: not all $\mu_j$'s are equal).

General Statistical Methodology

1. Universe. All Air Force items (reparables and components) which caused either an NMCS or PMCS over the past four years.

2. Population

a. Percent (NMCS+PMCS) equals degradation due to supply (PDS).

b. Mean PDS per month (1976-1979) was determined for the C-130 and F-4 aircraft at the bases shown in Table 8.

TABLE 8

AIRCRAFT/BASE SAMPLE LIST (NMCS/PMCS)

| Aircraft | Bases |
|---|---|
| F-4 | George AFB, California |
| | Clark, Phillipines |
| | Ramstein, Germany |
| | Homestead, USA (Fla.) |
| C-130 | McClellan, USA (Cal.) |
| | Selfridge, USA (Mich.) |
| | Reinmain, Germany |
| | Kadera, Okinawa |

NOTE: 8 bases--4 USA, 4 foreign; 4 F-4, 4 C-130.

3. Units Measured (independent variable). The percent of hours not flown in the peacetime flying program due to either NMCS or PMCS (PDS) taken from the USAF semi-monthly and end-of-month status report [RCS:HAF LGY (CM)7503] Aerospace Vehicle Status/Utilization Report, A-G033B.

4. Sampling Plan

a. Resource limitations and data availability restricted both the number and types of aircraft which could be covered in this study. Prime consideration was devoted to finding two aerospace systems which were ubiquitous in a geographical sense, both in the United States and elsewhere, and systems for which data was available over the past four years. A secondary consideration was the likelihood of emergency foreign deployment of the aircraft. Hence, the aircraft desired were of a tactical as opposed to a strategic nature. Although it is recognized that strategic aircraft are deployed during contingency operations, it is assumed that in most cases they will return to a continental U.S. base prior to the end of thirty days. Examples are the B-52, C-5 and C-141. The aircraft selected for this study were the F-4 and C-130. Both of these aircraft meet the criteria in terms of manifold distribution, available data and expectancy of deployment to foreign bases for contingency operations.

b. Sampling technique: A G033B provides percent NMCS and PMCS per month per aircraft. A census of NMCS plus PMCS for the aircraft at the bases indicated above during the period indicated was derived, and mean monthly NMCS plus PMCS data is listed in Table 9. Mean NMCS + PMCS = percent of peacetime flying program not supported each month = percent degradation supply (PDS).

In Table 9 the figure designated for a particular month is the mean value for that month over the years indicated. Consequently, the value is smoothed and large deviations have been eliminated.

c. Statistical technology: A chi-square test (continuous probability distribution) was conducted on the ninety-six smoothed samples to determine if the distribution was normal (alpha risk controlled at .01). Variance and standard deviation were estimated from the analysis of variance data between aircraft and bases.

This technique indicated normality, hence it allowed for the determination of the upper bound of percent degraded supply (PDS) with 95 percent confidence via standard normal distribution tables/techniques. This factor (upper bound PDS) indicated the maximum percent degradation of the peacetime flying program (pessimistic estimate) with 95 percent confidence. By subtracting PDS from 100 percent the percent of the peacetime flying hour

TABLE 9

PEACETIME PERCENT NMCS + PMCS PER MONTH MEAN 1976, 77, 78, 79

| A/C | Base | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F-4 | Clark | 6.45 | 6.53 | 6.80 | 6.75 | 7.25 | 5.25 | 6.88 | 5.48 | 4.85 | 5.08 | 3.42 | 7.07 |
| | Ramstein | 6.69 | 5.97 | 6.43 | 4.72 | 4.58 | 5.87 | 4.98 | 6.85 | 4.98 | 5.95 | 6.65 | 6.82 |
| | George | 5.35 | 6.32 | 6.43 | 5.45 | 6.62 | 5.28 | 6.75 | 7.08 | 6.48 | 4.72 | 6.32 | 5.67 |
| | Homestead | 4.65 | 5.03 | 4.88 | 5.52 | 6.28 | 6.35 | 5.13 | 7.10 | 6.51 | 6.42 | 6.80 | 5.82 |
| C-130 | Kadena | 5.15 | 8.90 | 8.40 | 7.03 | 5.08 | 6.50 | 3.11 | 6.18 | 5.33 | 2.23 | 6.02 | 5.87 |
| | Rheinmain | 6.60 | 8.36 | 5.07 | 8.52 | 8.35 | 4.76 | 3.57 | 6.13 | 5.05 | 5.83 | 5.15 | 5.35 |
| | Selfridge | 3.43 | 5.65 | 7.23 | 5.50 | 5.65 | 5.97 | 6.47 | 6.88 | 4.70 | 5.57 | 8.43 | 6.42 |
| | McClellan | 8.00 | 8.02 | 8.30 | 4.31 | 6.78 | 5.17 | 3.90 | 3.62 | 4.65 | 4.88 | 5.13 | 6.08 |

program likely to be supported (lower bound) with 95 percent confidence was obtained.

## Normality of the Smoothed PDS Sample

From the data previously presented in Table 9 of this chapter it was determined that the smoothed PDS samples were normally distributed (alpha risk = .01).

Goodness of fit test employed was the chi-square test for continuous probability distribution:

Hypothesis

$H_0$: the population is normally distributed

$H_1$: the population is not normally distributed

Decision Rule

If $X^2_{calc} \leq X^2$ (1-α;k-m-1), conclude $H_0$

If $X^2_{calc} > X^2$ (1-α;k-m-1), conclude $H_1$

Estimated parameters from the data (see Table 9)

Mean = $\bar{X}$ = 5.93 (PDS)

Std. Deviation = s = 1.3068

Chi-square calculations

The chi-square calculations for goodness of fit are presented in Table 10.

Decision (two parameters, μ and σ, estimated)

$X^2$ (.99; 7-2-1) = (.99;4) = 13.3

$X^2_{calc}$ = 9.5863 < 13.3; hence $H_0$ (normal distribution)

$H_0$ is concluded (i.e., the population of smoothed samples is normally distributed).

TABLE 10

CHI-SQUARE CALCULATION TABLE

| Class $i$ | Percent PDS $x$ | Observed Frequency $f_i$ | Probability Under $H_0$ | Expected Frequency Under $H_0$ $F_i$ | $f_i - F_i$ | $(f_i - F_i)^2/F_i$ |
|---|---|---|---|---|---|---|
| 1 | Under 4.5317 | 8 | .1429 | 13.71 | -5.71 | 2.3781 |
| 2 | 4.5317 to 5.1851 | 20 | .1429 | 13.71 | +6.29 | 2.8858 |
| 3 | 5.1851 to 5.6948 | 14 | .1429 | 13.71 | + .29 | .0061 |
| 4 | 5.6948 to 6.1652 | 11 | .1429 | 13.71 | -2.71 | .5357 |
| 5 | 6.1652 to 6.6749 | 19 | .1429 | 13.71 | +5.29 | 2.0411 |
| 6 | 6.6749 to 7.3283 | 15 | .1429 | 13.71 | +1.29 | .1214 |
| 7 | Over 7.3283 | 9 | .1429 | 13.71 | -4.71 | 1.6181 |
| | | 96 | 1.0003 | 95.99 | 0.03 | $X^2_{calc} = 9.5863$ |

## Determination of Confidence Interval

### Analysis

Since the distribution of PDS is normal it follows that by employing the unbiased estimators for the mean and standard deviation ($\bar{X} = 5.93$, and $\alpha = 1.3068$) respectively, a 95 percent confidence interval for PDS can be constructed.

$z(.95) = 1.645$

$1.645(1.3068) = 2.1497$

Then with 95 percent confidence:

3.78 percent $\leq$ PDS $\leq$ 8.08 percent.

It can be concluded with 95 percent confidence that the percent of degradation due to supply will be less than or equal to 8.08 percent. Using the logic presented earlier, if the upper of PDS is determined the lower bound of peacetime spares support expected with 95 percent confidence

$$(PDS_{upper} - 1)\ (-1)$$

or

$$(.0808-1)(-1) = .9192$$

Thus, approximately 92 percent of the peacetime flying program is supported (with 95 percent confidence). If the variance of PDS (smoothed) is constant for different aircraft at different bases, i.e., if the variance is determined to be insignificant, it follows that 92 percent is a relatively good intermediate range planning factor for peacetime flying program spares support. In the next section the results of an analysis of variance will be presented demonstrating the constancy of $PDS_{upper}$.

## Analysis of Variance (Bases/Aircraft)

### Analysis

#### Objective

To determine if $PDS_{upper}$ is constant from aircraft to aircraft and base to base an analysis of variance was conducted.

#### Hypothesis

$H_0$: $\mu_1 = \mu_2 = \mu_3 \ldots = \mu_8$

$H_1$: not all $\mu_j$'s are equal

#### Decision Rule

$F^* = \frac{MSTR}{MSE}$ (from data)

If $F^* \leq F\ (1-\alpha; r-1, r_T-r)$, conclude $H_0$

If $F^* > F\ (1-\alpha; r-1, n_T-r)$, conclude $H_1$

#### Alpha Risk

Controlled of $\alpha = .01$, confidence level = .99

#### Calculations

$r$ = number of treatments = 8

$n_T = 12 + 12 + 12 + 12 + 12 + 12 + 12 + 12 = 96$

$F(.99;\ 7,88) = 2.85$

$$\frac{MSTR}{MSE} = \frac{.1389}{1.7077} = .0813 = F^*$$

### Decision

$F^* .0813 \leq 2.85 = F(.95; 7,88)$

Conclude $H_0: \mu_1=\mu_2 \ldots =\mu_8$ with 99 percent confidence

### Conclusions/Results

1. From the test results it is clear that the population means may be considered equal.

2. It follows that $PDS_{upper}$ will be fairly constant over a three- to ten-year range time. Thus the derived factor for peacetime spares support, i.e., 92 percent, may be used for mid- to long-range planning.

## Summary

### Background

The primary aim of this chapter was to determine what percent of the peacetime flying hour program is normally supported by available spares assets with 95 percent confidence. In order to determine peacetime spares supportability and develop and acceptable mid- to long-range planning factor, two research questions were answered.

1. What was the percent degradation due to supply with 95 percent confidence?

2. What was the variance of $PDS_{upper}$ from aircraft to aircraft and base to base?

Limitations

1. Due to the sensitive nature of precise NMCS and PMCS data, current A-G088B data was not presented.

2. A-G033B data was smoothed over a four-year period; hence, it reflects long-term trends rather than the support situation at any given point in time. Specific data points varied from the mean by as much as 30 percent; hence, use of the long-range planning factor developed herein is not advised for long-term contingency analysis, particularly if, as anticipated, current NMCS and PMCS for specific aircraft is readily available.

3. Only two aircraft have been treated in this analysis; hence, further investigation is required prior to manifold application to U.S. Air Force systems.

General Findings

1. The expected value of the mean PDS 95 percent confidence interval ranged from 3.78 percent to 8.08 percent.

2. The smoothed distribution of PDS was normal with a mean of 5.93 and a standard deviation of 1.3068. With 99 percent confidence it was determined that $PDS_{upper} = 8.08$ percent. And, consequently, peace spares support $PSS = \varepsilon \cong 92$ percent.

3. It was determined that over the past four years at selected bases the PSS for the F-4 and C-130 were the

same. Hence, in the mid- to long-range sense, PSS may be considered constant. It should be pointed out, however, that there is no guarantee against significant variation between specific aircraft at different bases. Hence, this planning factor is unsuitable for short-term planning and should be used only when more discrete data is not available.

4. Finally, the evolved aircraft spares support model presented at the end of Chapter III was further refined:

$$Y = 26.66 + F(X)(.92) \tag{4}$$

This chapter constituted the second and final major step in the analytical development of improved factors for the spares support model. In Chapter V the limitations, conclusions and recommendations pursuant to the overall analysis are presented.

# CHAPTER V

# RESULTS, RECOMMENDATIONS AND CONCLUSIONS

## Introduction

Previous chapters defined the objectives and analytical methodology of the proposed aircraft system spares readiness model. This chapter will briefly summarize the results obtained from the statistical analysis in previous chapters, discuss limitations, recommendations and potential study topics pursuant to the analysis; and finally, conclude with comments on the model's potential for application.

## Results

Briefly, the following equation was presented as a model for predicting the number of days of contingency operations which could be supported by available spares:

$$Y = \omega + FX(\varepsilon)$$

where,

$Y$ = total days of spares support available (war);

$\omega$ = days of spares support available from WRSK;

$F$ = ratio of peacetime flying program hours per aircraft per day to wartime flying hour requirement per aircraft per day;

X = number of days of wartime operations; and

ε = percent of the peacetime flying hour program not compromised due to lack of spares support.

In Chapter III it was found that the lower bound of expected number of days of spares support available from WRSK (with 95 percent confidence) was 26.66 vice the current Air Force assumption of thirty days. In Chapter IV it was determined that the lower bound of the daily peacetime flying hour program not compromised due to lack of spares support was 92 percent (with 95 percent confidence). Hence, the preliminary model was changed to:

$$Y = 26.66 + FX(.92)$$

(see equation (4), page 64).

## WRSK Factor Analysis

There were two significant weaknesses in the WRSK analysis. They were:

1. The assumption that percent fill of WRSK was a direct indicator of the number of days of support available.

2. The possibility that the allowances made for WRSK gaming are inaccurate.

For analytical purposes it was assumed that percent WRSK fill was a direct measure/indication of the percent of support capability. Unfortunately, there [illegible] the inherent possibility of inaccuracy of data reported in the D005 system. This is particularly true because of constant pressure on unit commanders to both maintain WRSK in a high state of readiness and high performance in peacetime flying operations (maintaining low Not Mission Capable (NMC) status). One of the characteristics of current Air Force supply procedures is that WRM/WRSK assets are used to augment and support daily peacetime flying operations (11). Hence, the most critical operational items are likely to be those taken from WRSK. Pressures to maintain high standards of readiness could cause commanders to overestimate the support capability of their unit's WRSK. Hence, there is not necessarily a direct relationship between percent fill and mission capability. Percent fill is, however, the best empirical indicator available to indicate readiness in a quantitative manner; however, if the items missing are high failure/hard to replace/short supply items, as is likely to be the case, it is possible that the percent missing would have greater adverse impact than otherwise indicated in determining WRSK readiness. In order to overcome this, each Air Force unit commander provides a subjective WRSK analysis of unit WRSK to determine an appropriate M readiness rating (as previously indicated)[1] but the relationship should not be construed to be exact. For this reason the binomial

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[1]See Table 3, page 34.

approach using M ratings was employed in Chapter III to reinforce the direct percent fill to percent mission capability analytical approach.

The binomial analysis yielded evidence which supported the use of the lower bound 95 percent confidence interval. Although the mean WRSK percent fill was almost 94 percent which indicated expected spares support to be twenty-eight war days, the lower bound was chosen as the baseline because it represented the at-least-quantity expected to be available. Hence, the baseline selected was a conservative estimate. It should be noted that twenty-seven is 90 percent of thirty which indicates possible degradation of 10 percent. This corresponds to the condescriptive degradation analysis conducted. Interestingly, the lower bound of the 95 percent confidence level, i.e., 88.85 percent is extremely close to the expected WRSK percent fill subsequent to 10 percent degradation due to gaming, high failure items, reporting inaccuracy, etc., i.e., 88.22 percent. Further investigation would be required to substantiate a direct relationship; however, it is possible that the lower bound of the confidence interval absorbs both inaccuracies inherent in WRSK readiness.

It is not anticipated that the factor (twenty-seven days of spares support) precisely depicts actual WRSK readiness. It is, however, a better indication of readiness than the assumed factor of thirty. It is anticipated that actual testing will substantiate this claim. Unfortunately, such testing is expensive and conducted infrequently. One method for testing actual WRSK degradation is actual deployment. Upon deployment, however, management options are usually limited. Further, during deployment control factors are usually obscured by the necessity for swift action. If would appear that the most feasible method of determining WRSK support is via computer simulation. Such a model was developed by Captain R. K. Rasmussen, USAF, and Captain W. D. Stover, USAF, in their thesis "A Simulation Model for Assessing WRSK Capability at Unit Level," LSSR 4-78A (18). Simulation runs indicated that for the RF-4C, significant shortages were encountered after day twenty-eight of deployment (18:53). This clearly supports the statistical analysis conducted herein.

## Recommendations

It is apparent that squadrons should be committed to combat based upon their percentile ratings as arranged within M groups, highest units being selected first. This would help to ensure that marginal units would not be deployed if better equipped units were available. It is recommended that:

1. Contingency plans/scenarios which require deployment be examined to determine if conditions exist

(ex.: geographical location) which would either necessitate or make it advantageous to designate specific units or a group of units as forces to be deployed. Where specific units are required M-1 status should be required because the option of selecting a unit with greater readiness may not be available.

2. That a study be conducted to determine the feasibility of either establishing an emergency WRSK "hot item" response system or establishing a centrally controlled WRSK "hot item" safety stock.

Summary

Several problems inherent in the present WRSK rating procedure increase the risk of developing support factors from D005 data. As shown, however, by anticipating gaming, i.e., during reported WRSK percent fill and by using conservative estimates, a fairly robust factor for expected days of WRSK support was developed for the spares support model.

## Peacetime Spares Support Factor Analysis

There were several weaknesses in this phase of the analysis. As shown by the ANOVA tests, all PDS distributions were normal with differences in means which were insignificant. From this it may be inferred that there is no mid- to long-range planning difference between the

PDS of either the F-4 or C-130 at the foreign or domestic bases. This does not, however, mean that pipeline effects are negligible. As shown in the raw data, PDS for foreign based systems had wider variance from year to year and month to month. This could have been caused by a dearth to sate relationship which could indicate high PDS due to delivery delays followed by overordering/stockpiling and oversupport. Also, despite the lack of significant difference in PDS, this does not necessarily infer that maintenance capability and backup facilities at foreign bases is comparable to U.S. bases in country. Nor is the condition of overcrowding at deployed bases considered. Overload at foreign U.S. bases is a particularly probable situation in the event of deplcyment. Lastly, the technical aspects of repair by host countries of varigated technological possibility are not addressed. This is a major weakness in the model which requires additional study.

Another critical caveat is the poor applicability of the peacetime support factor (PSS) to real time contingency situations. The PSS factor, i.e., 92 percent, was not constant from year to year or month to month. Variations for discrete aircraft ranged up to 35 percent (PMCS+NMCS); however, over the four-year period, these fluctuations cancelled each other out. Hence, short-term PSS prediction based upon the 92 percent factor could be drastically inaccurate. Real time application of the PSS factor is not recommended.

The severest weakness of the model is due, however, to the lack of knowledge concerning foreign host base support capability. No comprehensive attempt has been made to categorize and quantify foreign base repair capability for U.S. weapon systems. Granted, this may require a base-by-base analysis due to lack of foreign standardization. However, general analysis techniques could be used to geographically classify language, religious, technology, engineering, standardization, repair procedure, etc., factors which would affect host base repair support capability.

Finally, only two aircraft, the F-4 and C-130, were considered in this analysis. Albeit they were the best examples available, they should not be construed to be overly representative of all Air Force weapon systems without further confirmation.

## Summary

These problems degrade the validity of the "$\varepsilon$" developed for the model. This is particularly true with respect to real time model application. The "$\varepsilon$" factor is, however, deemed to be a best available estimate for mid- to long-range estimation of expected peacetime support not degraded due to NMCS or PMCS. Although repair capability is not directly a concern of this study, its impact cannot be disallowed. Future study in this area is suggested.

## Conclusions

This thesis presented an aircraft weapon system spares support model for determining the number of days of contingency operations which would have a high probability of not being compromised due to lack of required spares. It was postulated that contingency spares support is of paramount concern to Air Force readiness. Hence, the translation of current or predicted inventory conditions into meaningful measures of military capability is crucial to both operational and logistics planning. As pointed out, the Air Force has no management information system (MIS) which can accurately assess spares support for deployed weapon systems. The model herein developed will serve as an interim planning structure and preliminary decision support model which provides mid- to long-range (i.e., three to ten years) spares readiness assessment. In the appendix to this thesis it is further demonstrated how a more comprehensive system can be developed for real-time, short-range spares support assessments.

APPENDIX

MACRO AIRCRAFT SPARES ANALYSIS
MODEL APPLICATION (MIS)

## Introduction

This appendix includes a brief summary of the major findings of the thesis "Macro Aircraft Spares Readiness Analysis," and presents a potential management information system (MIS) using the spares readiness model developed earlier. To reiterate, the purpose of this research was to develop a basic equation to provide a quantitative approach to the evaluation of spares support capability in contingency operations. In particular, the factors developed for WRSK and peacetime spares supportability are incorporated into a final equation and are functionally applied to long-range contingency analysis. The development of the MIS is treated as a separate subject and, as such, incorporates the basic recommendations of the thesis. It provides enough background information to permit its review as a separate topic without undue recourse to the thesis itself. Note: Sources cited refer to the selected bibliography of the thesis.

The proposed management information system is entitled "Macro Aircraft Spares Readiness Analysis (Part A--Long Range, Hypothetical Case)" (MASRAA). It is suggested as an appropriate information system for use by the Directorate of Plans (XRX) of the Plans and Programs DCS (XR) of the Air Force Logistics Command.

The MIS presented is in no way to be construed as a finalized system, rather it is intended as a pilot effort to direct more formal pursuit of a more definitive system which can meet not only long-range but also mid- and short-range planning needs. Moreover, this MIS is presented in conjunction with and is the conclusion/application proposed for the master's thesis, "Macro Aircraft Spares Readiness Analysis" developed by Mr. Ronald C. Wilson, Lieutenant Colonel Nazar Muhammad and Lieutenant Charles Middleton. Consequently, the background information for the development of this MIS will rely heavily on the thesis already developed. Greater in-depth treatment of relevant historical information may be obtained therein; however, as indicated, this section of the thesis has been designed to stand by itself for those primarily interested in spares requirements computation, practical application and/or Management Information Systems.

## Origination of the Thesis (MIS) Requirement

This part of the MIS design study is devoted to investigating the need for developing a new information system, and defining the objectives to be accomplished by the study. As in this case, the need for an MIS is often the result of unfavorable or questionable performance (26:71). However, it should be pointed out in this case the problem has not so much been a lack of performance in the past as much as the realization that there could be greater problems in the future due to truncated war mobilization time and the almost certain realization that the subject of this MIS, aircraft spares, could be better managed, particularly in respect to combat application.

Although the Air Force has reliable management systems for maintaining cognizance of consumable material such as petroleum and ammunition, there remains an analysis vacuum in the area of spares or reparable items. The management of Air Force spares is the responsibility of Air Force Logistics Command (AFLC) which maintains the ability to replenish base stock levels throughout the world both for our forces and in some cases our allies (6:2). AFLC managed approximately 1.8 million line items worth over nine billion dollars (23:34). The Air Force problem in spares assessment became particularly apparent at the recent first Air Force Sortie Surge Conference when none of the participants including AFLC were able to project the impact of their war readiness material (WRM) spares asset posture on combat surge capability (22:1). Unfortunately, the adequacy of spare parts support, with respect to the demands of contingent military operations is a predominant factor in determining Air Force capability and readiness. Further, the exponential acceleration of spares costs (5:2) driven by inflation, combined with until recently a steadily declining (in constant dollars) defense budget makes reliable forecasts for spares support economically critical (3:22).

The inability to determine spares supportability has handicapped the Air Force in short (tactical), middle (programming and budgeting) and long (strategic) range planning efforts. In 1975 the Readiness Planning Division (XRXX) of the Plans and Programs DCS (XR of Hq AFLC conducted an ad hoc, pilot contingency logistics support analysis on a specified operations plan (title withheld due to security classification). All areas of logistics support were finitely assessed except spares supportability for specific aircraft. At that point in time no management information system was available whereby logistics could determine spares supportability (17). Consequently, the entire question of weapon systems availability was not satisfactorily treated.

General Mullins, then DCS of Plans (XR), noted on several occasions that the Air Force cannot indicate specifically how and to what degree weapon systems (and their combat mission) will be effected when funding for spare parts is curtailed. He further postulated that the inability to tie cuts in spares support directly to curtailment of specific missions has inherently diminished the credibility of logistics planners (6:12). In consequence, the importance of spares support has been historically overshadowed in the budgeting process. Lack of visibility has made spares support a prime target for often unwarranted and potentially dangerous underfunding when compared to high visibility mission-oriented weapon system acquisition programs.

Further, logistics which consumes over two-thirds of the defense dollars required to design, produce and maintain a weapon system over its life cycle, has finally come to be recognized as a potent factor in determining the cost of force readiness. In an effort to capitalize on the integration of reliability and maintainability concepts and innovations early in weapon system development (to lower life cycle costs), the Air Force created the Air Force Acquisition Logistics Division (AFALD) in mid 1976 (2). This manifold shift in acquisition management technique and philosophy not only points out the importance of the long-range effects of logistics in general, but also of spares and supply support in particular. In order to plan effectively for future spares support and impact present-day design, long-range spares support requirements must be considered.

Two other major areas in which spares availability impact are strategic and international (security assistance) logistics planning. Logistics is currently on the verge of becoming a major determinant in long-range strategic planning. Until recently it seemed that almost limitless

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resources were available. Hence, logistics was an afterthought to strategy--what was needed was acquired after the plan was developed. Now, we are painfully aware that resources such as oil, etc. may be seriously limited and prohibitively expensive. Consequently, logistics is steadily becoming a more important consideration prior to the development of strategic plans. General spares support levels could and probably will be critical in future strategic planning scenarios. Hence, extensive cost (and resource availability) benefit analysis will be required.

Security assistance logistics support, on the other hand. cannot only cause unpredictable support strains, but also has the potential to seriously disrupt and degrade the readiness of our own forces. This is particularly true for spares support. Low visibility items such as spares have been and may in the future be allocated to foreign consumption without prior notice via executive agreement. Currently there is no general formula or system to determine either the immediate or long-range support impact of security assistance on U.S. forces. In 1973 the U.S. provided massive support to Israel after the Yom Kipper War (8). In that instance the inability to credibly predict the efforts of short- and long-term spares shortages on U.S. force readiness made any argument to modify such wholesale support indefensible. Although spares support analysis might not alter international support decisions, it would at least make commanders and politicians more aware of the potential effects of their decisions.

## Definition of Information Needs and Uses

This part of the study is dedicated to the consideration of the specific management needs which have generated the requirement for a management information system (MIS) (26:74). Further, the specific role that the MIS will fulfill is developed in concert with organizational responsibilities. The specific objectives of the MIS, i.e., outputs, are clearly identified.

From the preceding section it follows that the critical requirements for spares support demands that a management information system (MIS) be developed to indicate spares support status, predict impact and determine contingency supportability. Several broad needs have been outlined:

1. Tactical Planning--determine force readiness with respect to an immediate real time tactical situation using specifically designated forces.

2. Strategic Planning--determine broad force long-range readiness with respect to general prevailing or projected conditions.

3. Programming and Budgeting--determine force readiness in the one- to five-year planning range to support PPBS, determine budgeting impacts and support AFLC Program Objective Memoranda (POM) inputs.

4. International Logistics Support (Security Assistance, etc.)--determine the impact of force readiness when DOD is required to provide massive logistics support to foreign nations.

5. Acquisition Logistics Planning--determine the effects of deployment of new or additional weapon systems on spares supportability and determine the effects of increased reliability and maintainability over the life cycle of a weapon system.

These needs can be broken down into three major categories:

a. The specific area: tactical

b. The budgeting and programming case: medium range

c. The hypothetical impact case: strategic

This paper will treat only "c" above; i.e., the hypothetical impact case. Although it is necessary to limit the scope of this study due to time and resource limitations, it should be noted that developing appropriate MISs for "a", tactical, and "b", programming and budgeting, should be possible. Tactical planning will require exact, last-minute input data to the system on spares support availability, specific weapon system readiness and specific mission requirements. The MIS developed for the hypothetical case will be applicable but input data will be much more precise, data processing will be more sophisticated and outputs will be more discretely oriented; i.e., to specific spares deficiencies, etc. The hypothetical case will also provide the foundation for mid-range planning and emphasis will be oriented more toward the specific as with the tactical MIS. However, a real time, discrete approach would be inappropriate because it would fail to provide cognizance of general trends. Hence, an exponential smoothing technique would be used to meet budgeting and programming needs. Again, output requirements would be more detailed than for the hypothetical case, but they would be smoothed to eliminate temporary aberrations.

## Specific MIS Requirements

The hypothetical case as both a pilot and basis for more discrete information systems application will, for the present, be limited to the needs of AFLC/XRX; i.e., strategic logistics planning and broad impact analysis. Within XRX the office of primary concern will be XRXS (Strategic Planning Division). Specifically, the hypothetical/strategic spares support MIS will provide answers to the following information:

1. Number of days of spares support available to an aircraft type (F-4, A-10, etc.) in a contingency operation.

2. Ratio of peacetime daily spares requirement to daily war requirement.

3. Impact of increasing spares support requirement (i.e., contingency operation, increased failure rate or repair time, support to another government agency, contractor or foreign country, etc.) in terms of decreased mission capability.

Having defined the requirements for the development of MASRAA let us consider some related systems and current attempts to deal with the spares support problem. The situation is not entirely bleak. In recent years, AFLC has made considerable progress in war readiness requirements computation. The most noteworthy achievement has been in the area of war readiness spares kits (WRSK) computation. The D029 system which relies on marginal analyses techniques can compute a WRSK for an aggregate thirty-day flying hour profile. The most recent AFLC spares assessment initiative is a "WRSK/BLSS Assessment Analysis" which can be used either in conjunction with the D029 WRSK computation system or with actual unit asset data from the AF Recoverable Assembly Management System (AFRAMS). In 1978 an impressive simulation model designed to test WRSK capability at unit level was developed as a master's thesis topic for the School of Systems and Logistics of the Air Force Institute of Technology (18:1). None of these systems, however, provides a total (peacetime spares plus WRM) spares assessment. All of these systems will contribute to this study and provide an excellent baseline for simulation studies which deal with total war surge capability.

Unfortunately, a concrete, finite determination of the limitations of spares support is presently beyond the capability of Air Force logistics planners and data systems. Such an effort would involve cognizance of hundreds of thousands of items, many of which would be used in several different aircraft with different failure rates. It is conceivable, however, that within the next five years current data processing systems will be altered or new ones will be created that will allow logisticians to definitize total war spares supportability (i.e., provide in-depth analysis for tactical operations to a finer degree of accuracy than proposed for MASRA-tactical). The effort will be monumental, time-consuming, and expensive; moreover, there is the ominous problem of dealing with the present. The Air Force is constrained by an austere procurement/ support environment which necessitates maximum benefit acuity in dollar allocation.

The present need is for a reasonably accurate management information system (MIS) for obtaining command/ planning indicators for spares supportability. The system should be simple, fast, and inexpensive. Further, it should accommodate, as outlined above, the basic needs of short-, mid- and long-range planning. However, as indicated, the present study is limited to the development of a long-range (hypothetical) planning technique. The system should provide not only current and projected spares readiness, but should also be applied to the general regulation of spares supportability by revealing trends (positive feedback) and allowing for the development of control parameters (negative feedback) which would provide for command awareness and corrective measures (14:69). The system's application would be virtually ubiquitous because spares support strikes at the very heart of military readiness. The system would effect not only logisticians but planners and commanders at all levels and in virtually all major commands. The system could have direct impact on: strategic and tactical planning, spares development acquisition and provisioning, war readiness material, peacetime spares support, foreign base support, POM input and the PPBS, contingency support analysis and international support impact analysis. This paper will, however, deal only with the needs of AFLC/XRXS which, in turn, would develop interface techniques with the rest of the Air Force, DOD, etc.

## MIS Design and Methodology (The Model)

This part of the study explains the techniques developed to gather data (inputs), process the data and provide meaningful output (information) which will assist strategic planners in decision making. Particular attention is devoted to the development of the model which portrays spares readiness.

Fortunately, much of the planning and data gathering required to develop such a system has already been accomplished. Standard requirements for combat operations and spares levels may be derived from war planning and Air Force program documents. From these documents a "best estimate" for total contintency spares supportability for discrete aircraft has been derived. The estimate is in the form of a simple linear equation:

$$Y = \omega + F(X)(\varepsilon)$$

where,

$Y$ = total days of spare support available;

$\omega$ = number of days of contingency operations support available from WRM (i.e., WRSK);

$F$ = proportion of flying hours in a peacetime day to the flying hours in a wartime day;

$X$ = number of days of contingency operations; and

$\varepsilon$ = (inherent percent degration - 1) due to variability in peacetime support, pipeline and base of deployment repair capabilities.

This equation or model is the foundation of MASRAA.

The spares considered in this MIS model are recoverable items--items that can be repaired by maintenance activities at base or depot when unserviceable, and reissued. These items are distinguished from end items which do not become part of a larger operating system when in use and lose their identity. Further, these items are distinguished from Economic Order Quantity (EOQ) items which are obtained on a consumption basis and thrown away when they become inoperable. From the management and budgetary standpoints respectively, reparables are the Air Force's most complex and expensive items (19:22).

Primary emphasis is placed upon WRSK reparables. The primary model is concerned with hypothetical contingency operations, hence deployment is a major consideration. War Readiness Spares Kits (WRSK) are one element of the War Readiness Material (WRM) program. WRM is defined as:

> . . . that quantity of stock required, in addition to normal peacetime operating assets, to assure logistics support of contingency or wartime missions until production can assure the continuity of resupply [25:4].

WRSK are defined as:

> . . . <u>air transportable</u> package(s) of WRM spares, repair parts and related maintenance supplies required to support planned wartime or contingency operations of a weapon or support system for a specified period of time (30 days) pending resupply [25:14-12].

Hence in the prime model $\omega$ = WRSK. Expansion of the application of the model for broader forecasting will be improved if the "$\omega$" factor incorporates consideration of all WRM.

The general application of the MIS model (equation) can be broken down into the three planning categories previously mentioned; i.e., short-, mid- and long-range. Our subject, long-range planning, by its very nature, is apt to be ambiguous and is best defined as a general case representing high probability in the present which can be applied to either the future or a hypothetical case with decreasing probability as the length of time between analysis and projected event increases (10:128). The optimum model for long-range forecasting is therefore one which has fairly constant factors (little variance over time) and high probability of accuracy within meaningful parameters (20:78). In-depth statistical analysis of WRSK supportability (in terms of WRSK percent fill and M readiness ratings--see Chapter III, has demonstrated that over a relatively broad period of time the constant $\omega$ equals twenty-seven days of wartime support can be anticipated with 95 percent confidence. Similar analysis conducted on the Not Mission Capable Supply (NMCS) and Partial Mission Capable Supply (PMCS) status of Air Force weapon systems over time revealed that the peacetime flying hour program is supported with 95 percent confidence 92 percent of the time.[1] Also, it is assumed that deployment to overseas bases with repair overloads degraded peacetime

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[1]The effects of increased pipeline requirements and maintenance support limitations at deployed bases was beyond the scope of this study due to time and resource constraints. However, these effects are recognized as potent factors which must be treated in order to make the equation and MIS developed more consistent with actual spares readiness. These topics are recommended for further study.

support by 20 percent. Hence, the $\varepsilon$ factor for the basic equation (with deployment) is:

$$\varepsilon = (.80)(.92) \cong .74 \text{ or } 74 \text{ percent}$$

Hence, the basic model for the general spares support case was:

$$Y = 27 + .74(F)X$$

The determination of long-range or unspecified-hypothetical impact is determined by entering the F factor for a particular weapon system into the equation and solving for Y, the number of days of spares support available, versus X, the number of days of spares support required. The F factor is determined as follows:

1. From USAF PA 79-1 (S) (Peacetime Flying Program) determine total number of flying hours per type of aircraft (F-4, A-10, A-7), etc.). Divide by the total number of aircraft which will equal the number of flying hours per aircraft per year or number of flying hours for which spares are provided per year. Divide by 365 to obtain the number of flying hours per day per aircraft for which spares are ostensibly available. Example: two hours per day per aircraft.

2. From USAF War Mobilization Plan-6 (WMP-6)(S) determine the general sortie (in terms of flying hours)

requirement per type of aircraft per day. Example: four hours per day per aircraft.

3. Determine the portion or percent of the war day flying requirement which the peace day flying hour represents by dividing flying hours per peace day by flying hour requirement per war day. Example:

$$\frac{2\ \text{hr}}{4\ \text{hr}} = .5 = F$$

Hence, each peace day will provide one-half the spares required to support each war day in this example.

The final equation for the particular aircraft (weapon system) chosen in our example is:

$$Y = 27 + .5(.74)X$$

This may be interpreted as follows: at day 10; i.e.,

$$X = 10$$

the number of war days of spare support are:

$$Y = 27 + .37(10) = 27 + 3.7 = 30.7$$

where

Y = Cumulative spares requirement, in war days.

Of particular interest is the day with Y equals X or when spares available equals the spares required. (Note: the spares requirement is both cumulative and constant; hence subsequent to the day that X equals Y the spares support requirement in days will be greater than the spares support available in days. Hence after Y a high probability of NMCS or PMCS exists. For example,

$$Y = 27 + .37X$$

or

$$1 = \frac{27}{X} + .37$$

or

$$.63 = \frac{27}{X} = .63X = 27$$

and

$$X \cong 42$$

After the forty-second day when spares requirements exceed spares available there exists a high probability of aircraft not mission capable due to lack of supply (spares availability). Using this model will provide strategic planners with information on how long a contingency force can be expected to operate at full mission capability using only spares allocated to the use of aircraft involved in the operation.

The F factor will indicate the ratio of the peacetime flying hour program to the wartime flying hour requirement and consequently also indicate the percent of wartime spares accumulated each day in the peacetime program. This factor is instrumental in determining the third strategic planning requirement (i.e., the impact of increasing the spares support requirement). In the previous example

F equal .5. It follows that if for every aircraft committed to this contingency spares support requirements can be met by grounding one aircraft (same type) after the forty-second day. This demonstrates the principal behind impact determination based upon this model. The impact of increasing the spares support requirement is expressed in terms of flying hours per day required additional (in the example, two hours per day). The increased support requirement is compared to the peacetime flying hour requirement per day (in the example, two hours).

2 hours/2 hours = 1

or one aircraft equivalent in flying time is required subsequent to the day when Y equal X. Whether or not to ground one aircraft or several is a command decision. To determine what percent of the daily peacetime program must be curtained for a known number of aircraft; 100 for example, merely divide the ratio of the increased requirement by the size of the force to be degraded. Hence, hypothetically, each aircraft degraded will fly 1.2 minutes less each day per aircraft in the contingency operation. Thus, each aircraft degraded will fly approximately twenty minutes less per day as long as the contingency lasts after Y equals X.[2]

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[2]Please note that it is not envisioned that aircraft flying hours will be reduced by any precise fraction. Rather, these figures are presented to depict hypothetical mission curtailments which will be applied in a gross manner to the entire or certain portions of the aircraft fleet.

This technique can also be applied to catastrophe support situations such as that faced by the Air Force subsequent to providing spares support to Israel in 1973-74. In such an instance, spares may be taken from WRM (WRSK) and the peacetime program. If only the peacetime program is depleted then the degradation rule above applies with the number of days support required and number of aircraft which require support determined by executive decision. Of particular interest in such catastrophe support operations are the "get well" date and combat degradation. Combat capability degradation can be expressed as mission time or sortie time lost (i.e., if one-half the sortie time is available, one-half the mission capability is lost). The "get well" date will be when the number of days of support required equals the number of days support accumulated can be determined by the equation:

$$Y = \frac{\mu}{X(\varepsilon - F)\lambda}$$

where,

Y = number of days to get well;

F = percent peacetime flying hour is degraded minus one times a negative one;

X = number of flying hours required per day in peacetime;

$\varepsilon$ = percent production capacity for peacetime program;

$\mu$ = amount lost (given away) in number of flying hours; and

$\lambda$ = number of aircraft (specific aircraft under consideration) in U.S. Air Force.

Hence, if the Air Force provides thirty days of war spares (sortie requirement per day equal three hours) for seventy aircraft to a foreign nation, the get well date is computed as follows if the Air Force peacetime flying hour program is degraded by 10 percent and production or accumulation of spares is increased by 10 percent and the normal peacetime flying requirement per day equals two hours:

$F = (.1-1)(-1) = .9;$

$X = 2$ hours per day per aircraft;

$\varepsilon = .1 + 1 = 1.1;$

$\mu = (30)(3)(70) = 6300;$

$\lambda = 120;$ and

$$Y = \frac{6300}{(2)(120)(1.1-9)} = \frac{6300}{48} = 131.25$$

or the Air Force will return to pre-catastrophe spares support capacity on the 132nd day after support is provided. If no increase in spares accumulation/acquisition or repair occured, the "get well" date would have been D+263.

<u>Note</u>: See attachments 1 and 2 (flow diagrams and symbol tables for MASRAA).

## Implementation of the MIS (Thesis) Process/Conclusion

It is intended that the general model presented and the MIS developed provide strategic planners in Hq AFLC with an heuristic, best estimate analysis capability for determining spares supportability in possible contingency operations and a capability to determine the impact of increased spares support requirements. The proposed MIS will fulfill this requirement.

The method is relatively simple and, although a FORTRAN program which uses the CREATE system has been developed, it can easily be programmed into a hand-held computer such as the Texas Instrument TI-55, 58 or 59. Data inputs are either readily available or they will be developed as planning estimates at command levels. Hence, neither cost nor technical ramifications presents problems to implementation.

Although much of the information used as input data would be classified, the data input to the program would identify neither specific aircraft nor operating locations, hence no security measures for MASRAA will be required. Further, reports may be obtained on an as-needed basis based upon command needs and estimates. Time required for program runs on hand-held computers would be less than five minutes.

The primary obstacles to MASRAA are: (1) the possibility of poorly defined command estimates for input data, and (2) possible lack of support from upper management levels. The program could be highly flexible but to a large extent will only be as useful and influential as the manager assigned to implement it. Consequently it is recommended that management of MASRAA be given to a senior manager with experience in both logistics and operational planning. Such an individual would have the experience, background and credibility necessary to develop planning factors and interpret them in such a manner that they would be meaningful to not only planners within AFLC but also in the operational commands and DOD at large.

As expressed earlier, however, the application of this model is limited by many caveats which have been indicated as prime potential candidates for further study/ investigation and verification. It is recommended that the responsibility for handling any future delineation in regards to aircraft spares analysis be given to the AFLC office responsible for interpreting this model. Verification of the model will require not only considerable research but also broad logistics and operational knowledge which can only be gained from extensive field experience and formal logistics education.

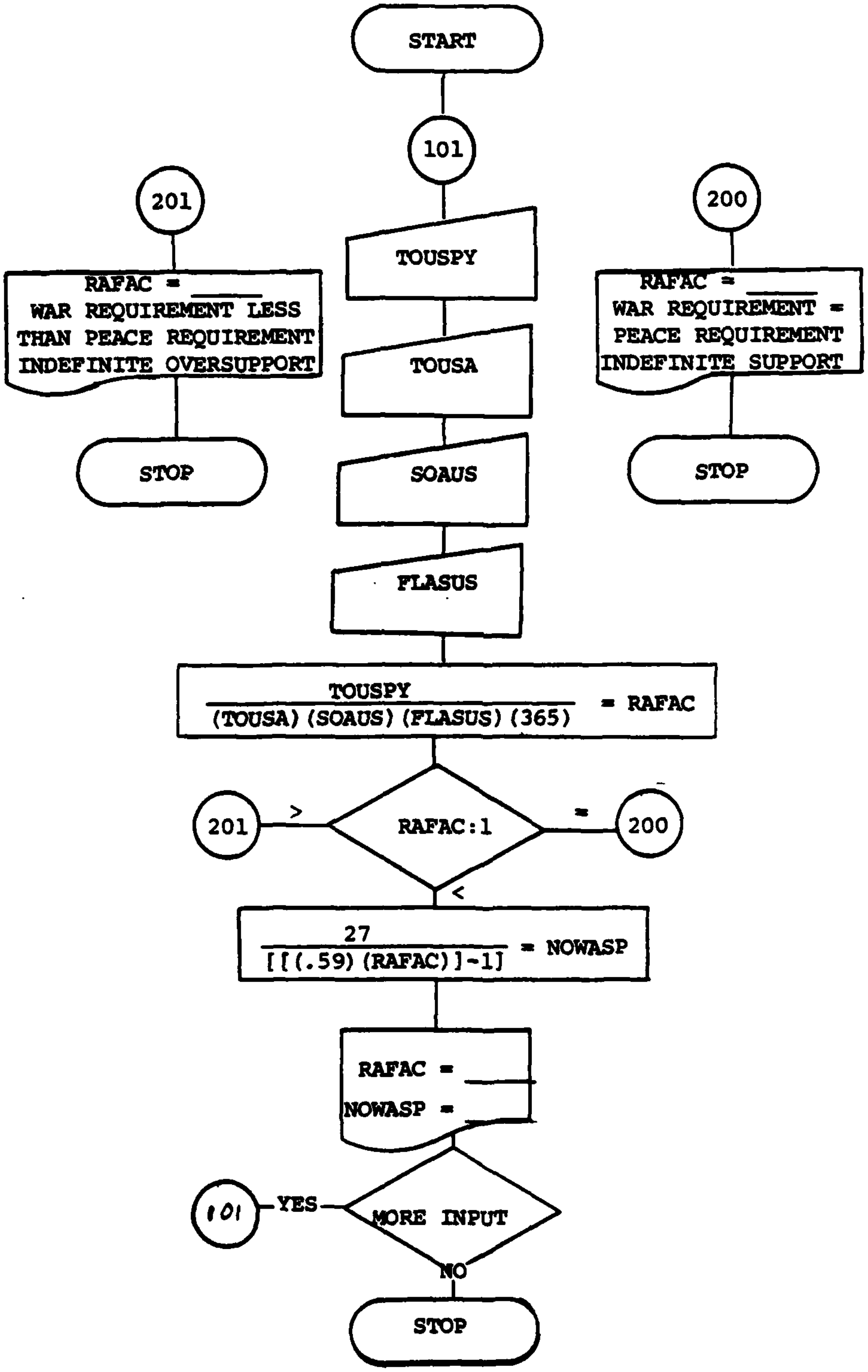
## Attachment 1

## Symbol Table--MASRAA1

This program determines the ratio of peacetime flying hours per day per aircraft to wartime flying hours per day per aircraft, and determines the number of days of spares support available during contingency operations (if no additional support is provided).

| Variable Name | Meaning |
|---|---|
| TOUSPY | Total number of flying hours per year aircraft type; |
| TOUSA | Total number of aircraft; |
| SOAUS | Sortie rate (in flying hours) per aircraft per day; |
| FLASUS | Flying hours per sortie per type of aircraft; |
| RAFAC | Ratio-peacetime flying hours per day to wartime flying hours per day (per aircraft); |
| NOWASP | Number of days of wartime spares support available. |

MASARA 1



START
101
TOUSPY
TOUSA
SOAUS
FLASUS
201
RAFAC = ____
WAR REQUIREMENT LESS
THAN PEACE REQUIREMENT
INDEFINITE OVERSUPPORT
STOP
200
RAFAC = ____
WAR REQUIREMENT =
PEACE REQUIREMENT
INDEFINITE SUPPORT
STOP
TOUSPY / (TOUSA) (SOAUS) (FLASUS) (365) = RAFAC
201
>
RAFAC:1
=
200
<
27 / [[(.59) (RAFAC)]-1] = NOWASP
RAFAC = ____
NOWASP = ____
101
YES
MORE INPUT
NO
STOP

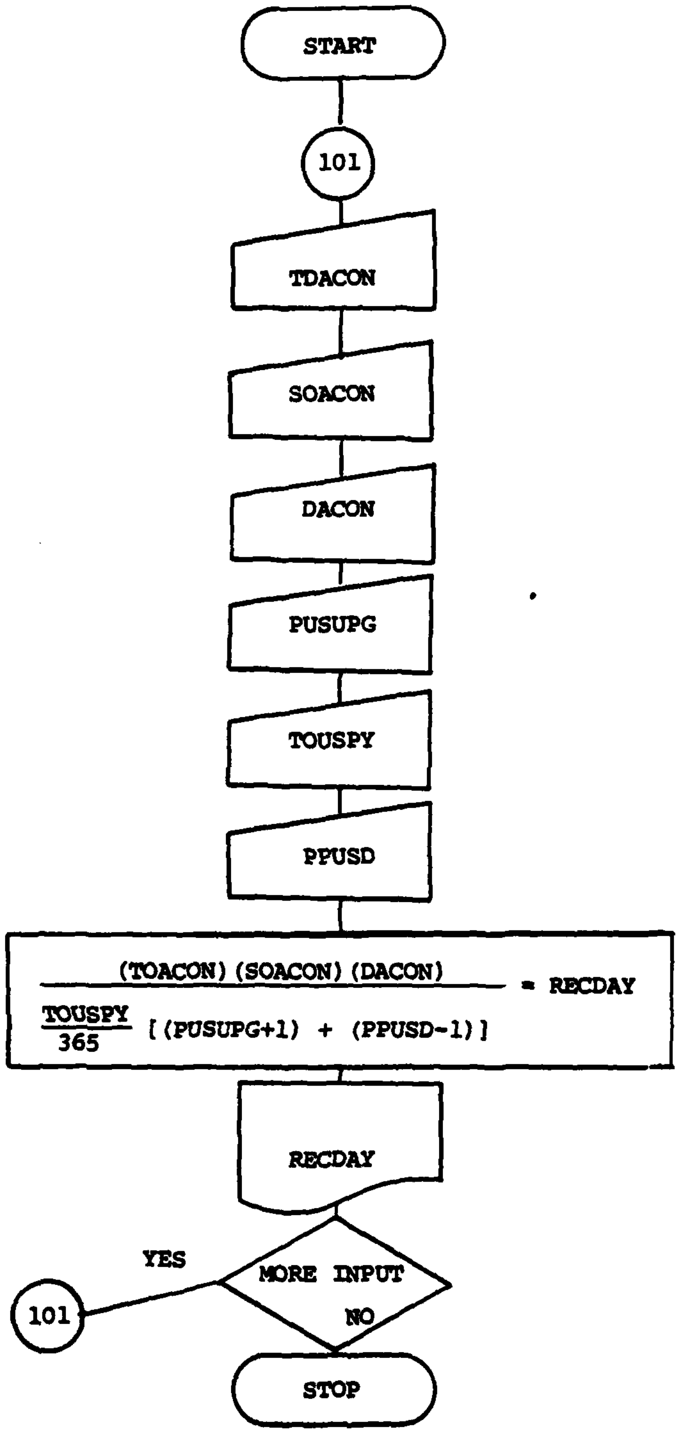
## Attachment 2

### Symbol Table--MASRAA2

This program indicates the number of days required for the U.S. Air Force to receover; i.e., regain, previous spares support posture when (contingency) spares support is provided which is in excess of normal spares support.

| Variable Name | Meaning |
|---|---|
| TOACON | Total excess number of aircraft given contingency support; |
| SOACON | Sortie rate per day in flying hours for contingency aircraft; |
| DACON | Number of days support provided for contingency aircraft; |
| PUSUPG | Percent production, repair, acquisition of spares upgraded; |
| TOUSPY | Total number of flying hours per year per aircraft type; |
| PPUSD | Percent U.S. peacetime flying hour program degraded; |
| RECDAY | Number of days for U.S. to recover from contingency. |

MASARA 2


START
101
TDACON
SOACON
DACON
PUSUPG
TOUSPY
PPUSD
(TOACON) (SOACON) (DACON) = RECDAY
TOUSPY / 365 [(PUSUPG+1) + (PPUSD-1)]
RECDAY
YES
MORE INPUT
NO
101
STOP

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