PERFORMANCE ASSESSMENT OF THE SPARE PARTS FOR THE ACTIVATION OF RELOCATED SYSTEMS (SPARES) FORECASTING MODEL

THESIS

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AFIT/GLM/LSM/91S-7

DEPARTMENT OF THE AIR FORCE
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Wright-Patterson Air Force Base, Ohio

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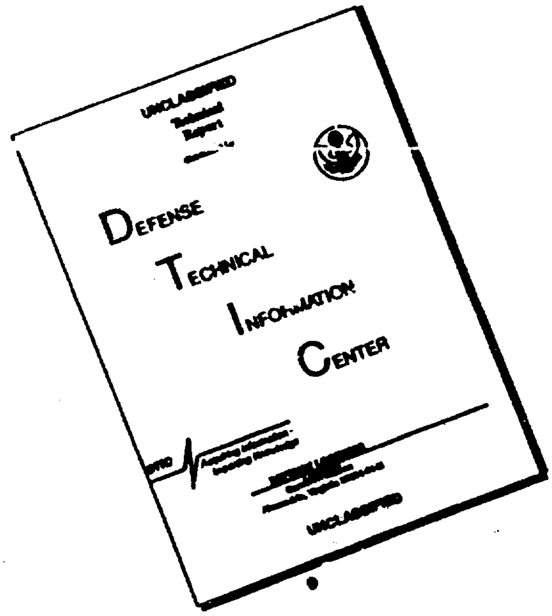

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THESIS

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Paul L. Bunker

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Abstract

This research assessed the performance of the Spare Parts for the Acivation of Relocated Systems (SPARES) forecast model used to develop the spares requirements forecast for the August 1988 activation of the 174TFW at Syracuse ANGB NY. SPARES was developed by the Air Force Logistics Management Center in August 1988 to replace existing Standard Base Supply System (SBSS) forecasting procedures. SPARES uses mission change data (MCD) from five similar-size source bases to determine the probability of future demand (PFD) for items at the gaining base. Before implementing SPARES in the SBSS, forecast performance must be measured and model weaknesses identified and corrected.

SPARES correctly forecasted 72 percent of the demanded items when a PFD of 20 percent was used; however, 58 percent of the items forecasted did not have subsequent demands. SPARES forecasted 692 items which had less than two customer demands at the five source bases combined. This indicates either the model's program coding is incorrect or deficiencies exist in theoretical program logic. Deficiencies in the MCD collection system also had an impact on SPARES performance. Based on these findings, SPARES program coding and logic as well as the MCD collection system must be reviewed before SPARES is implemented in the SBSS.

PERFORMANCE ASSESSMENT OF THE SPARE PARTS FOR THE ACTIVATION OF RELOCATED SYSTEMS (SPARES) FORECASTING MODEL

I. Introduction

General Issue

Through Fiscal Year 1996, the Air National Guard will support 40 aircraft and related weapon system activations at new locations (21). In addition, as the Air Force further develops and implements plans supporting the composite wing concept, additional weapon system activations at new locations will likely occur (30:8-9). To provide uninterrupted supply and maintenance support to these weapon systems, sufficient quantities of spares and repair parts must be on hand at each of these new locations. The Air Force Standard Base Supply System (SBSS) currently uses New Activation Spares Support Lists (NASSLs) to forecast the spare parts required to support the activation or relocation of an Air Force weapon system to a new operating base (18:12-39). In May 1988, the Air Force Logistics Management Center (AFLMC) analyzed the performance of the NASSL process and found the NASSL did not adequately forecast the spare parts requirements for activating systems (41:35). In some cases, the process forecasted only 50 percent of the required items and forecasted many items that did not have subsequent demands (41:17). Because of the poor performance and unreliability of NASSL procedures to accurately forecast requirements, "MAJCOMs frequently developed and used ad hoc, unscientific methods of compiling lists for new activations" (41:1).

To correct the forecasting errors in the NASSL process, the AFLMC created a microcomputer program, Spare Parts for the Activation of Relocated Weapon Systems (SPARES), for the MAJCOMs to determine the items needed to support an activation (40). Computer simulations by the AFLMC showed the SPARES program forecasted up to 64 percent of the right items and significantly reduced the amount of forecasted items having no demands placed against them (41:34). In August 1988, the Air National Guard (ANG) Bureau used SPARES to forecast the items needed to support the activation of F-16A/B aircraft at the 174th Tactical Fighter Wing (TFW), Hancock Field, Syracuse ANGB NY (40). An analysis of the SPARES forecast performance at Syracuse must be performed before implementing and coding the SPARES methodology in the SBSS.

Justification

General James P. Mullins, former commander of the Air Force Logistics Command (AFLC), highlighted the need for accurate spares forecasts by linking the "the availability of spares" to weapon system readiness and sustainability, "the backbone of today's national defense posture" (32:3). Underestimation of requirements lead to extraordinary actions by the logistics community to bring weapon system readiness and sustainability up to acceptable levels. On the other hand, overestimation of requirements creates numerous problems relating to managing excess inventories, such as transportation, storage and eventual disposal costs (50:18). During the past decade, the Air Force saw the pendulum swing drastically from having insufficient spares on hand to building alarming amounts of inapplicable inventory. Inapplicable inventory is defined as inventory in excess of current operational needs plus two years of anticipated requirements (6). Initially, the blame for the spares shortfall was placed on insufficient funding of spares requirements during the late 1970s and early 1980s; however, as funding became available, shortfalls in spares parts continued because of an inefficient and ineffective requirements determination process.

On March 17, 1980, the headlines of the Washington Post exclaimed "Shortages of Spare Parts Hamstring Warplanes" (51:1). The article cited Congressional sources as saying that "only 53 percent of the Air Force's F-15 Eagles were ready for combat at any one time" in 1979 (51:1). These findings were based upon the February 1980 testimony of Defense Secretary Harold Brown to the House Defense Appropriations Subcommittee. Congressional members were concerned that the Air Force was buying large quantities of new tactical aircraft without funding the spares required to keep existing airframes operational (51:1).

One year later, General W. L. Creech, Commander, Tactical Air Command, presented additional testimony to the Defense Appropriations Subcommittee that there were "serious shortages in both peacetime and wartime spare parts" (10:18). He revealed that "three and one-half wing equivalents" of Tactical Air Command aircraft were grounded due to lack of parts (10:18,. He argued that "spares support was the victim of the greatest funding neglect during the 1970s" (10:17-18). Figure 1 depicts

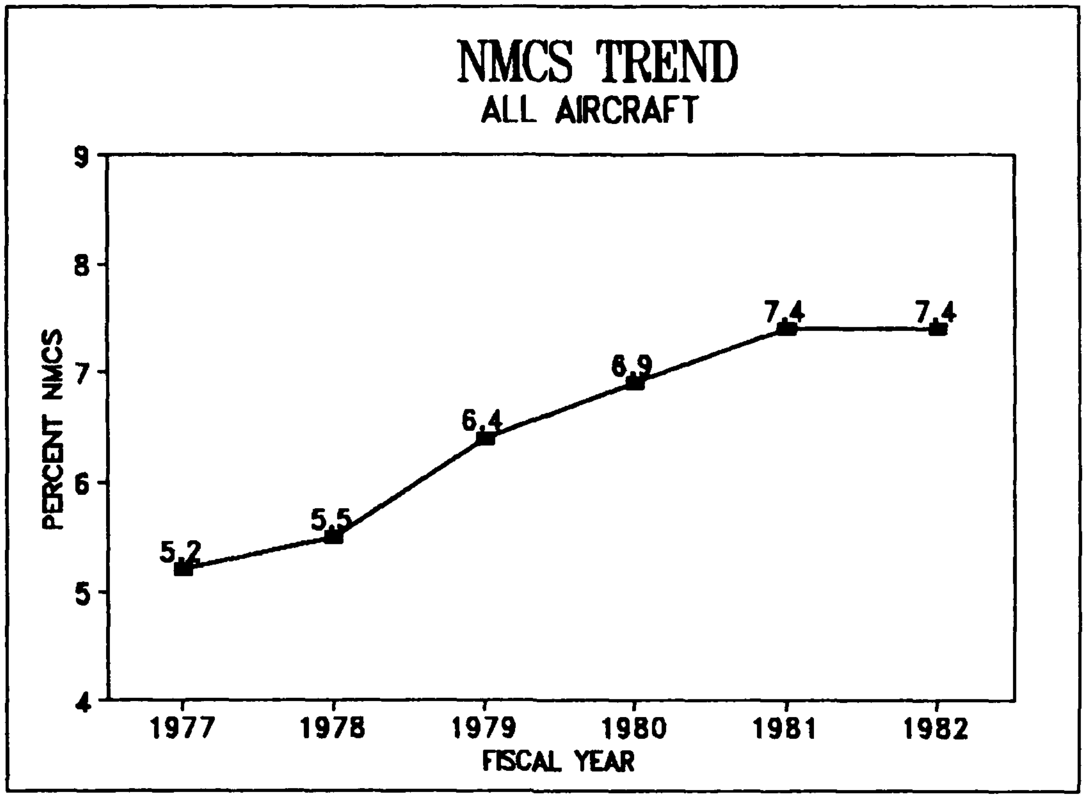

Figure 1. Non-Mission Capable Supply (NMCS) Trends (14:96)

the growth in percentage of aircraft inoperative due to a lack of parts (Non-Mission Capable Supply (NMCS)) and illustrates the impact of spare parts shortages. Although budgetary shortfalls were significant factors in the high NMCS rates, inaccurate requirements computations were also found at the core of the spares shortage problem.

Underestimation of requirements can severely impact budget allocations for the purchase of critical spare parts. "In FY 82, the Air Force made a concerted effort to fully fund replenishment spares in accordance with the emphasis being placed on readiness and sustainability" (14:1). However, the attempt to fully fund spares requirements fell short because the Air Force underestimated spare parts requirements for peacetime operating stocks (POS) by $873.5 million. "The growth in the requirement, coupled with Congressional funding cuts and internal Air Force reprogramming, resulted in a $1.1 billion POS deficit" (14:1).

After the causes of the shortfalls were identified and corrective actions outlined, the problem of insufficient spare parts was alleviated; however, it was soon replaced by a totally different problem, inapplicable inventory, caused in part by the other side of the forecasting dilemma - overestimation of requirements. In his March 1991 analysis of growth in Air Force inventory, Bailey reported that

> between 1980 and 1990, the value of Air Force secondary item inventories increased by 120 percent from $18.7 billion to $41.1 billion. During the same period, the value of inapplicable inventories increased by 165 percent from $4.3 billion to $11.4 billion. (6:i)

In a related study, the General Accounting Office (GAO) attributed the majority of this increase to inflation and force modernization , but felt "some of the inventory growth may also be attributable to such problems as inaccurate requirements computations that have been the subject of previous audit reports" (47:2).

With such a drastic change in the nature of the inventory problems over the past decade, supply managers must be aware of the fallibility of any computer generated product, with requirements forecasting being no exception (3:12-3). Computer generated forecasts are only as accurate and reliable as the information and forecasting logic provided by the manager. Failure on the part of the supply manager to become "knowledgeable of the capabilities and limitations" of the forecasting models will result in continued ineffective and inefficient stockage of spare parts (3:12-3).

Specific Problem

To prevent the implementation and coding of an inaccurate forecasting methodology into the SBSS, the forecast accuracy of the SPARES forecast at Syracuse must be analyzed using recorded demand data at Syracuse following the forecast upload. Failure to perform such an analysis could result in the expenditure of thousands of dollars for unneeded spares or degradation in the support of relocating weapon systems. This analysis must determine if the model's performance replicates AFLMC computer simulation results and exceeds the performance of the NASSL process (40). In addition, the procedures for SPARES program processing, at both MAJCOM and base level, must be validated to identify and correct any problems in data collection and program processing. With such a large number of activations planned during the next several years, a viable forecasting model must be available to adequately support the weapon systems involved.

Investigative Issues

This analysis focused on the following areas to determine the performance levels reached by SPARES and benefits derived from using the new forecasting program:

1. Analyze the mission change data (MCD) collection process used to develop the SPARES forecast at Syracuse and other available MCD used to support more recent unit activations.

2. Identify the items forecasted by SPARES for the Syracuse activation and determine their extended dollar value.

3. Identify the items forecasted by SPARES which were subsequently demanded at Syracuse and determine their extended dollar value.

4. Identify the items forecasted by SPARES which were not subsequently demanded at Syracuse and determine their extended dollar value.

5. Identify the items demanded at Syracuse which were not forecasted by SPARES.

6. Determine the SPARES forecast accuracy at Syracuse by dividing the number of items forecasted and demanded, as determined in issue 3, by the total number of items demanded.

7. Analyze the impact of Interchangeable and Substitute Group (I&SG) items on the SPARES forecast accuracy at Syracuse.

8. Using identical MCD, develop a NASSL forecast in accordance with AFM 67-1, Vol II, Part Two, procedures and SPARES forecasts with multiple probability of future demand factors and compare the accuracy of each forecast, based upon the demands generated at Syracuse.

9. Analyze the characteristics of items forecasted by SPARES and determine model tendencies.

10. Verify procedures provided by the SPARES User's Guide for the collection and processing of demand data to generate the SPARES forecast.

Scope and Limitations

This study analyzed the SPARES forecast and actual demand data of all expendable items related to the Syracuse activation during the period of August 1988 through June 1990. Expendable items are classified as those supply type items which "may be consumed in use or may lose their original identity during periods of use" (19:3-114). These items are coded in the supply system with Expendability, Recoverability, Reparability, Cost Designator (ERRCD) codes XB3, XF3, and XD2 (19:3-114). Items coded XB3 have no authorized repair levels higher than the user and have no accountable records established in the supply system once they are issued to the customer (19:3-114). Items coded XF3 and XD2 are authorized varying levels of repair, from field to depot level respectively, are maintained on accountable supply records upon issue, and have repair records established to record all repair actions (19:3-114).

This research focused only on the range issue as it relates to forecasting accuracy of the SPARES program. The range issue is defined as forecasting the right type of item to stock in comparison to forecasting the right quantity of the item to stock (8:62).

Summary and Overview

This chapter presented the problem of inaccurate forecasts for spare parts using NASSL procedures and the development of the SPARES program by the AFLMC to improve forecasting performance. The specific problem of SPARES performance validation was described and investigative issues were set forth as steps in validating performance. The scope and limitations of this study were also described. The next chapter addresses background information on forecasting methodologies used by the Air Force in supporting the activation of weapon systems. Chapter 3 delineates the methodology used in determining the performance of the SPARES forecast at Syracuse and its comparison against the NASSL program. Chapter 4 describes the analysis of the forecasting and demand data and the subsequent findings in regards to SPARES performance. Chapter 5 provides conclusions and recommendations for further study. Appendices A and B contain a list of acronyms and definitions of supply related terms used throughout this research paper.

II. Literature Review

Introduction

When Air Force programming action calls for the activation of a weapon system, the gaining MAJCOM, in coordination with the Air Force Logistics Command (AFLC) and the gaining base, must forecast requirements for spare parts needed to support initial weapon system operations (18:12-5). In his June 1981 address to the House Defense Appropriations Subcommittee, General W. L. Creech stated that "no matter how good the equipment, without adequate spare parts it simply cannot be maintained" (10:17). Before "adequate spare parts" can be on hand at any activating unit, accurate forecasts for the parts must first be made (3:12-5).

Current Air Force Forecasting Procedures.

The Air Force currently uses several different procedures to forecast requirements for spare parts to support the activation or relocation of a weapon system. The procedure used is determined by the life-cycle stage and type of weapon system supported.

Initial Spares Support Lists (ISSLs) are used "to provide the range and depth of items required for the initial supply support of new systems" (39:2). A system will be authorized an ISSL when the system is

> initially assigned to the Air Force inventory and having spares/ repair parts computed/allocated by the provisioning process . . . . ISSLs are also authorized for any activation occurring within 36 months after delivery of the last provisioned system. Additionally, systems modified so extensively that a change in series occurs will be authorized an ISSL (that is, F16A/B modified to F16C/D). (18:12-5)

Once the weapon system falls outside the initial provisioning guidelines, support for activations is provided through New Activation Spares Support List (NASSL) procedures (18:12-31). Whereas the ISSL is developed "using contractor provided reliability data, similar weapon system data, and expert judgement" (7:3), the NASSL uses demand data from bases operating the same weapon system (41:3). The NASSL is designed to support the "second year flying hour program after receipt of full complement of weapon systems" at the gaining base (18:12-31). The demand data used in the NASSL is compiled through the Mission Change Data (MCD) Collection System (28:1).

Another forecasting method, used specifically to support low density systems, is the Major Command Spares Support List (MSSL). A low density system is "any system for which the in-use quantity of the system is too small to generate sufficient consumption data to establish the range and depth of spares" (18:12-39). An example of a low density system would be an airfield's approach/landing radar system. The package of spare parts resulting from the MSSL process is based upon negotiations between the gaining MAJCOM and the inventory management specialists (IMS) managing the specific items (18:12-39).

In August 1988, the AFLMC developed SPARES to improve the forecasting accuracy of the NASSL process. The program uses MCD in a similar fashion as the NASSL, but uses different algorithms to determine the range of parts required to support the activating weapon system (44:1). The algorithms are based on the same mathematical techniques currently used in the Dyna-METRIC forecasting model developed by the Rand Corporation to predict wartime spares requirements (41:41).

Scope and Organization.

The ISSL and NASSL forecasting procedures have been used extensively in the past, and their failure to accurately forecast requirements has been well documented by the AFLMC and other sources (5; 7; 15; 39; 41; 47; 48; 49). The remainder of this review will document the historical development and performance of the forecasting procedures used to determine spare parts requirements for the activation of weapon systems already in the Air Force inventory.

Historical Development and Performance

Prior to the creation of NASSL procedures in 1983, forecasting for required levels of spare parts to support activating weapon systems was provided by modifying the appropriate ISSL to include actual demand data from a base or bases supporting the same weapon system. The modified list would then be given the designation of a Follow-on Spares Support List (FOSSL) (15:3). FOSSL procedures were "normally adopted 1 year after the production contract for a weapon system" was complete (15:3).

ISSL/FOSSL Performance Assessment.

Since the FOSSL was developed by updating the ISSL with actual demand data, accuracy in the ISSL update was crucial to ensure the FOSSL was providing good support to relocating systems (5:4). Several reports in the past twenty years by the GAO, AFIT researchers, the Air Force Audit Agency (AFAA), and the AFLMC documented errors in the ISSL update process which caused the expenditure of millions of dollars for spare parts that were not needed (5; 7; 15; 48; 49).

In their 1972 report on the initial support of the F-111 weapon system, the GAO cited instances where the failure to update the ISSL caused the Air Force to buy "substantial quantities of spare parts several times, even though data available to the Air Force showed there was no current need for these parts" (48:2). The GAO noted that "significant design problems" in the F-111 program caused delay in the actual delivery of the weapon system, yet the Air Force continued with purchases of spare parts. In April 1970, "spares valued at $45 million had been received although no operational aircraft . . . had been delivered and future deliveries were still uncertain" (48:8). The GAO projected that many of these parts would become obsolete due to the "numerous changes in design that invariably occur in the development and production" of the aircraft (48:2).

In their examination of the ISSL update system in place during this time period, the GAO claimed the system allowed for increases to quantities based upon higher than expected failures during the initial 2-year period of operation; however, "there is no provision . . . for adjusting estimated failure rates downward when failures have been less than anticipated during this 2-year period" (48:11-12). Since there was a "high degree of commonality" (48:12) between the first and subsequent models of the F-111, the GAO believed that

> had the Air Force used actual-experience data on the F-111A, it could have delayed, reduced, or eliminated procurement of a significant number of spare parts common to later models. If this low usage continues, it is possible that many of the parts procured for all three aircraft models eventually will be declared excess and will be scrapped. (48:13)

Six years later, the AFAA examined F-15 ISSLs and FOSSLs and found similar problems. They performed independent requirements computation of F-15 stockage levels at existing F-15 bases and found $28.8 million of assets were in excess of their computed requirements. Of this amount, $12 million had not shown any utilization (15:1). They also cited that FOSSLs were not being used

> even though at least 365 days of consumption data was available . . . . This was caused by Air Force policy which precluded the use of FOSSL procedures until 1 year after completion of the production contract. Following this policy will delay use of FOSSL procedures for the F-15 until October 1984, after all activations have taken place. (15:4)

Based on these findings, AFLC was directed by HQ USAF/LGY to utilize consumption data "as soon as a reasonable amount of usage data was available but, not later than 365 days after the activation of the first unit at each activation site" (15:6). AFLC was also directed to begin computing ISSL requirements based on consumption data "730 days after the activation of the first unit" (15:6).

The AFAA found that the F-15 system manager (SM) did not have visibility over the levels in the ISSL. No master F-15 ISSL was maintained nor was there a breakout of ISSLs located at the activation bases. "As a result, the SM did not detect the unauthorized lay-in of spares caused by configuration changes, stock number changes, and ISSL quantity fluctuations" (15:8). Based on these findings, AFLC developed procedures and necessary reports to allow visibility over ISSL levels from a system-wide perspective and at each activating base (15:9-10).

Discrepancies on how ISSL levels were established for activating sites were also cited. The AFAA reported

> the apportionment of initial spares support for the F-15 to each activation site was not based upon the same criteria used to determ e total worldwide requirements. Total Air Force ISSL requirements were based upon projected flying hours; however, the distribution of spares to activation sites was based upon the numbe of aircraft the site would receive. . . . When ISSLs are based on aircraft assigned instead of flying hours, aircraft at a base with an extensive flying hour schedule will be under-supported. Conversely, the base with a light flying hour schedule will be over-supported. (15:11)

The AFAA recommended and AFLC implemented procedures to include "flying hour programs (tempered by mission peculiarities) as a factor in determining the distribution of initial spares support" (15:11).

In their 1979 AFIT thesis modeling the ISSL process, Allen and Reiss found inaccurate ISSL levels were still a significant problem. Based on their interviews with AFLC personnel, they reported the worldwide fill rate for ISSL items was 17 percent as of March 1979 (5:2). For the F-15 during the same time period, the fill rate was only 10 percent (5:3). A F-4E squadron in Germany reported a fill rate of only 14 percent while a similar unit in Alaska had a 60 percent NMCS rate (5:11). Obviously, the ISSL update problems reported seven years earlier by the GAO and more recently by the AFAA still existed and pertained to a variety of weapon systems.

In January 1982, the GAO published another report critical of the ISSL update process. However in this report, the system was not the center of criticism, but rather, the focus was on management's misuse of available computational data. Based on their "review of 65 sample items in a buy position during the June 30, 1980 requirements computation cycle," the GAO found 30 of the sampled items to be overstated by about $2.5 million and understated by about $261,000 (49:5). Based on this sample, the GAO estimated that, for all items in a buy position during this cycle, $77 million of overstated and $8 million of understated requirement determinations were made (49:5). Four of the sampled items had erroneous levels on file because

> the ISSL or FOSSL lists had expired or were due to expire before completion of the support period for which the requirements were computed. In other words, the item managers were computing requirements beyond the point for which the stock would be needed. (49:10)

In his 1985 analysis of the ISSL/FOSSL update process, Blazer determined the core cause behind the inadequate forecasting capability was the lack of an "automated system to update and evaluate the performance of spare support lists" (7:1). The update process for the ISSL using MCD was found to be inadequate, causing forecast errors in the ISSL and subsequent FOSSL. Another major weakness of the ISSL/FOSSL update process was in the assumption that just one base could be used to accurately forecast requirements at another base. Blazer contended that "considering all demands" from several bases possessing the same weapon system would provide a more reliable forecast, "especially for low-density weapon systems or highly reliable component items" (7:4).

Blazer concluded the ISSL/FOSSL update system was mostly a manual process resulting in the inefficient and ineffective support of relocating systems. He concluded the Air Force must adopt a "centralized mission change data collection system" to ensure correct demand data is transferred from base-level supply to the MAJCOM and AFLC (7:15). At the time of Blazer's study, the Air Force had recently changed FOSSL procedures and had begun building forecasts for relocating systems based on demand data generated at bases supporting similar weapon systems (2). The new forecasts were titled New Activation Spares Support Lists, and the data used to construct them was provided through the Mission Change Data Collection System.

Mission Change Data Collection System.

As depicted in Figure 2, the MCD Collection System is a series of base-level supply computer programs and reports

> designed to collect base-level demand data for all primary weapon systems and are ultimately used to compute demand data for a variety of supply requirements including War Readiness Spares Kits (WRSK), Base-Level Sufficiency Spares (BLSS), Follow On Spares Kits (FOSK), Initial Spares Support Lists (ISSL), and New Activation Spares Support Lists (NASSL). (28:1)

At base level, the SBSS records each recurring demand against a specific end item, such as an aircraft series (F-16A), by using the end item's Standard Reporting Designator (SRD) (28:3). A recurring demand is defined as a request for an item "commonly required in day-to-day operations which probably will be needed again" as determined by the customer (19:7-54). The SRD is a three digit alpha/numeric code assigned to each weapon system and provides a unique identification of the end item in supply records (19:27-231). For example, the SRD for the single-seat F-16A aircraft at the time of the Syracuse activation was "A16"; the SRD for the two-seat F-16B model was "A3Z". Each SRD has an internal computer record, the SRD-Consumption Record (107), which accumulates by stock number the quantity demanded for each item coded with the applicable SRD. This record is also adjusted based on other transactions, such as cancellations and turn-ins (19:4-99).

Recording MCD Data at Base Level. When a recurring demand is placed for a weapon system part, supply technicians code the computer

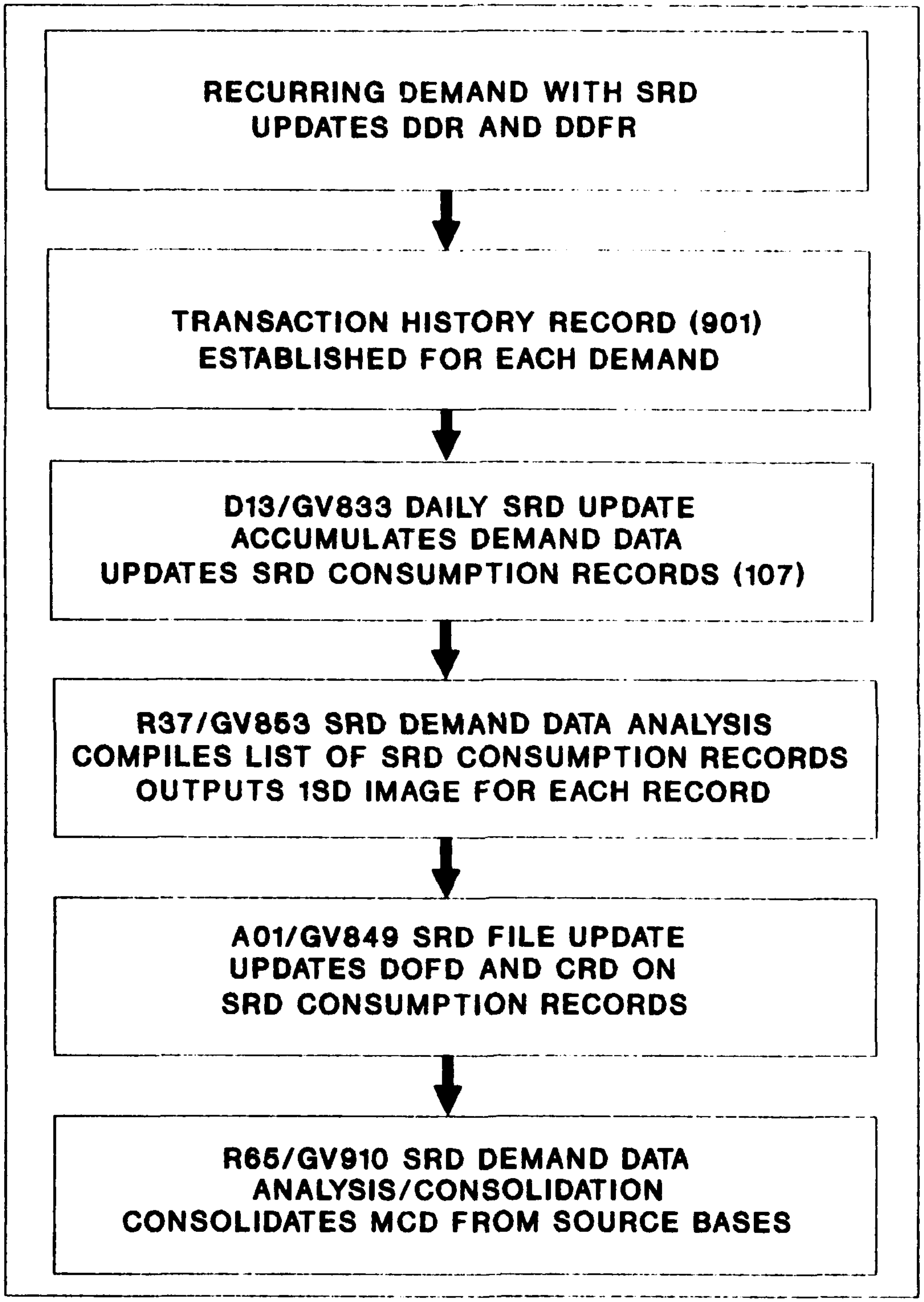

Figure 2. Base-Level MCD Collection System (28:4)

input with a recurring demand code of "R" and the weapon system's SRD (19:11-29). The demand code "R" updates the item record's date of first demand (DOFD) (if blank), number of demands (ND), and cumulative recurring demands (CRD) (19:11-54). The ND represents the number of customers or individual demands placed for an item. The CRD represents the quantity of the item demanded (19:19-47-48). For example, if a customer demanded 10 widgets on one recurring demand, the ND would be updated by one and the CRD would be updated by 10.

The DOFD, ND, and CRD are used in conjunction with the current Julian date to establish the Daily Demand Frequency Rate (DDFR) and the Daily Demand Rate (DDR). The DDFR represents the average daily frequency of demands (customers) and is computed by summing the total ND (computed in three separate six-month demand periods) then dividing by the SBSS Demand Days (current date (CD) - DOFD) during which the demands occurred. The SBSS constrains this time period to be between 365 and 540 days. If the time period (CD - DOFD) is less than 365 days, the SBSS defaults to using 365 days in the computation (19:19-49). If the period exceeds 540 days, the SBSS requirements computation (RECOMP) program adjusts the DOFD to reflect the current Julian date minus 365 days. In addition to updating the DOFD, the program drops the oldest six month demand period from the computer records and replaces it with a new current reporting period (19:19-47). Table 1 illustrates how the SBSS computes the DDFR. The data represents the demand history of an item between the time period 90001 and 91230 as expressed in Julian Dates. Demand 3 provides an example of how accumulated demands shift between six-month demand periods as the difference between the current date and DOFD becomes longer than 180 days. RECOMP is performed between demands 7 and 8 because the demand days reached 540 (91175 - 90001 = 540). In this example, the oldest six-month period demands (2P6MP) are dropped from the record, the CPD is blanked, and the DOFD is updated to 91175.

The DDR is the average number of units of an item demanded per day and is computed by summing the CRD and dividing by the current date

Table 1

Daily Demand Frequency Rate (DDFR) Computation

Demand	Current Date (CD)	Date of First Demand (DOFD)	SBSS Demand Days (n)	Current Period Demands (CPD)	First Past 6 Month Period Demands (1P6MP)	Second Past 6 Month Period Demands (2P6MP)	Total Number Demands (ND)	Daily Demand Frequency Rate (DDFR) ND/n
1	90001	90001	365	1	0	0	1	.0027
2	90112	90001	365	2	0	0	2	.0055
3	90189	90001	365	1	2	0	3	.0082
4	90240	90001	365	2	2	0	4	.0110
5	90334	90001	365	3	2	0	5	.0137
6	91023	90001	388	1	3	2	6	.0155
7	91117	90001	482	2	3	2	7	.0145
RECOMP	91175	90175	365	0	2	3	5	.0137
8	91176	90175	366	1	2	3	6	.0164
9	91202	90175	392	2	2	3	7	.0179
10	91333	90175	523	3	2	3	8	.0153

minus the DOFD. The SBSS also constrains the time frame in computing the DDR, but to a different degree. The minimum amount of time used in DDR computation is 180 days, and the maximum is 540 days (19:19-48). The CRD quantity is adjusted throughout the entire demand period (six month periods are not used) as recurring demands are input to the computer. Again, if the current date minus the DOFD exceeds 540 days, RECOMP adjusts the DOFD to reflect the current date minus 365 days. The CRD quantity is also adjusted at this time. The program multiplies the current DDR reflected on the item record by 365 days and stores this product as the current CRD. Table 2 illustrates how the SBSS computes the DDR using the same demand data presented in Table 1, except units demanded are also considered. As depicted, the RECOMP on the 91175 day adjusted the CRD to 12 by multiplying the DDR (19/540 = .035) as of the 91175 date by 365 (.035 x 365 = 12.842, rounded down to 12). The CRD quantity is then adjusted with any additional recurring demands until the 540 day threshold is exceeded again (19:19-48).

In addition to updating the item record's demand data, the recurring demand creates a Transaction History Record (901) (19:4-438). This record contains all pertinent information of the transaction, such as the item record's national stock number (NSN), the demand quantity, and the SRD. During daily reports processing, the transaction history area is scanned by the Daily SRD Update, (D13/GV833), which accumulates demand data by SRD for the item records demanded (19:5-109). This program then updates the SRD-Consumption Record with the quantity demanded and the DOFD, if the transaction was the first demand for this item record (19:4-99).

Table 2

Daily Demand Rate (DDR) Computation

Demand	Current Date (CD)	Date of First Demand (DOFD)	SBSS Demand Days (n)	Units Demanded	Cumulative Recurring Demands (CRD)	Daily Demand Rate (DDR) CRD/n	Daily Demand Frequency Rate (DDFR)
1	90001	90001	180	5	5	.027	.0027
2	90112	90001	180	2	7	.038	.0055
3	90189	90001	188	3	10	.053	.0082
4	90240	90001	239	3	13	.054	.0110
5	90334	90001	333	3	16	.048	.0137
6	91023	90001	388	2	18	.046	.0155
7	91117	90001	482	1	19	.039	.0145
RECOMP	91175	90175	365	-	12	.035	.0137
8	91176	90175	366	5	17	.046	.0164
9	91202	90175	392	5	22	.056	.0179
10	91333	90175	523	3	25	.047	.0153

When the base or MAJCOM needs to examine the demand data, the SRD Demand Data Analysis (R37/GV853) is processed. The R37/GV853 program reads each SRD Consumption Record for the selected SRD and accumulates demand data for each of the applicable item records. An option exists to compute the DDR for the item using the item's CRD, as described earlier. Normally, the DDR is computed based on the demands recorded on the SRD Consumption Record. The total item record CRD option "should be used only with the approval of the MAJCOM," since inflated demand rates for the intended SRD could result (19:6-416). An additional option is provided to accumulate demand data for item records which are members of an Interchangeable and Substitute Group (I&SG) (19:6-415). Before discussing this option, a brief explanation of the I&SG system is needed.

The I&SG system is used in the Air Force "to optimize the use of available spare parts . . . and is designed to group items with similar form, fit, and function" (23:i). If items within the group are fully interchangeable with one another, a master/interchangeable relationship is established and all demand data for the group is compiled against the group's master item record (23:6; 19:19-18). If an item in the I&SG is only "one-way interchangeable," requiring verification with the end user before actual issue, the item is still included in the same I&SG but is coded as a substitute and demand data is recorded against it separately (23:6; 19:19-18).

The first I&SG option accumulates the demand data from all the item records, including the substitute records, within the I&SG against the group's master item record. The second option accumulates the CRD quantities for only the master and interchangeable items. This accumulation is also posted against the I&SG master item record.

Before compiling a list of the SRD-Consumption Records, the R37/GV853 edits the SRD-Consumption Record (107) to determine if the DOFD is greater than 365 days. If the DOFD is greater than 365 days, R37/GV853 processing is stopped. Before the R37/GV853 scan be reprocessed, the SRD File Update (A01/GV849) must be processed to update the DOFD on the SRD-Consumption Record (19:6-415).

The A01/GV849 provides supply managers with a tool to change or delete SRD-Consumption Records. In reference to the DOFD update, the program changes the DOFD on each record that exceeds 365 days to reflect the current date minus 365 days (19:5-614). At a minimum, the base-level mission change manager must process the A01/GV849 at least once a year (19:19-194). Once the A01/GV849 is completed and the DOFD is updated on all records, the R37/GV853 can be processed.

Consolidation of Base-Level Mission Change Data. When the MAJCOM desires to consolidate the MCD from several bases, the MAJCOM can designate a base to process the SRD Demand Data Analysis/Consolidation (R65/GV910). This program has the capability of consolidating MCD from up to five source bases and "provides managers with the ability to analyze demand data from multiple sources to use in management forecasting of requirements" (19:6-563). Discussion of the program logic and required input parameters will be deferred to the review of the NASSL Procedures.

Performance of the Mission Change Data Collection System. In his 1986 analysis of the Air Force Combat Follow-On Supply Support System (CFOSS), Burleson reported the MCD collection system was not accurately recording all demands against the supported weapon system (9:14). At the time of his study, the CFOSS was designed to establish spares requirements following the initial 30 days of deployed operations until normal resupply operations resumed (9:1). Burleson noted the system was not collecting data on the "total number of demands for the weapon system" (9:14). As discussed previously, the number of demands or ND is used in the computation of the DDFR. The SBSS requirements computation program relies heavily on both the ND and DDFR to determine the range of stock (19:19-14, 55-56, 87-89). In addition to the problems with the ND and DDFR, Burleson also found the system understated the units demanded because of misuse of the SRD (9:14). He concluded "problems with the MCD collection system can seriously degrade mission performance" and recommended an automated system be developed to ensure MCD is recorded accurately (9:20).

In September 1988, Loden analyzed the accuracy of mission change data and estimated the error rate in the collection of MCD at base-level supply to be "5 to 28 percent for monthly transactions" (28:17). He found the majority of errors were caused by supply technicians entering the wrong SRD on the demand inputs and organizational bench stocks being coded with the inappropriate SRD (28:17). An organizational bench stock is a collection of consumable items coded with ERRCD XB3 which are stored in the organization's immediate work area because of frequent use. These items are maintained on Master Bench Stock Detail Records (217) and are replenished on a bulk issue basis (19:25-3).

As noted previously in this review, the SRD is the link in matching demand data to a specific weapon system. The customer provides the SRD to the supply technician when an item is requested. When organizational bench stocks are used for direct support of a weapon system, the bench stock detail records should be coded with the weapon system's SRD (19:19-194). For example, bench stocks supporting the F-16A should have the SRD "A16" assigned to each master bench stock record. When replenishment of bench stocks is accomplished, all replenishment demands are automatically recorded against the assigned SRD (28:3). There are some SRDs, in particular "ZZZ", which can be used in demand transactions to bypass normal SRD edits. This SRD is normally used to record demands for general and administrative supplies (19:11-39). Since the SRD-Consumption Record does not record transactions against "ZZZ", MCD is not collected when it is used and should rarely apply when requesting items for a weapon system (19:19-194).

Using the Air Force Stock Control Data Bank as a source, Loden sampled demand records covering a three month period from three Air Force base supply accounts. The Stock Control Data Bank is a database containing the supply records of 12 Air Force bases, representing a cross-section of the MAJCOMS and related AF missions, and is maintained at the AFLMC (19:19-98). Of the 9,124 transactions sampled, 1,115 or 12.2 percent contained some form of error relating to the assignment of the SRD. Loden found the majority of the errors in the recording of bench stock issues (28:13). He concluded "the causes of the error in MCD were lack of procedural guidance, lack of training, and computer software errors" (28:23). The errors he detected not only affect base-level MCD collection, but ripple through to the MAJCOM since the MCD collected at base level is used to support the activation of relocating systems as well the development of war readiness spares kits (WRSK).

Crimiel found similar problems with the MCD collection system in his April 1990 analysis of the consumable WRSK requirements computation process. A WRSK contains "selected spares and repair parts required to sustain operations (without resupply) at a base, a deployed location, or a dispersed location for the first month of conventional activity as projected in USAF war plans" (19:26-18). While reviewing the demand data generated from the Tactical Air Command's Coronet Warrior I exercise, Crimiel found that "775 different consumable line items were demanded during the exercise; however, 160 of them did not have a corresponding MCD detail" (11:3). He later discovered that 42 of the 160 line items actually had details created, but against the master item record in their I&SG as program logic dictates (11:3). The reason for the remaining 118 missing line items was undetermined. He concluded that computation of consumable WRSK requirements based solely on the MCD collection system would in some cases understate actual requirements and called for the inclusion of other sources of demand data, such as bench stock listings, to supplement the use of MCD (11:27). Currently, NASSL development procedures rely solely on the use of MCD.

New Activation Spares Support List Procedures.

When the MAJCOM receives notification of a weapon system relocation or mission change, one or more bases supporting the same weapon system are notified by the MAJCOM to process the R37/GV853 and forward the SRD Consumption Records for the weapon system involved in the programming action (19:19-191). Up to five bases can be selected to forward the MCD to the MAJCOM (19:6-147). Only those items having MCD are candidates for inclusion in the NASSL. "Extreme care must be taken to ensure only those items applicable to a given mission, design and series (MDS) are included" (18:12-31). In addition, several groups of items are excluded from NASSL consideration, such as clothing, medical, and "shelf life coded items" subject to deterioration beyond practical use after 18 months in storage (18:12-31). A complete listing and description of the excluded items are in Appendix C.

Source Base Notification. The MAJCOM mission change monitor will provide the selected MCD source bases with special instructions to process the R37/GV853. As mentioned previously, the MAJCOM will indic te which option to apply when collecting demand data on items in an I&SG. The MAJCOM will also provide the base factor to be applied to the MCD (19:19-192).

The base factor, in conjunction with the change factor at the gaining base, establishes the degree to which the MCD from the source base(s) will influence the final stock levels established at the base gaining the weapon system. The base factor is the number of units of the activating weapon system possessed by the base providing the MCD. If aircraft are involved, the base factor is further modified to consider the average length of sortie and the average number of sorties per day (19:19-199). For example, if a source base supports 24 F-16A aircraft with an average sortie rate of 1.5 per day and each sortie averages 2 hours, then the base factor is 72 (24 x 1.5 x 2 = 72). When the SRD Demand Data Analysis (R37/GV853) is processed, the base factor is stored on the 1SD image outputs (19:19-200A).

SRD Demand Data Analysis (R37/GV853) Processing. Once the MAJCOM provides all required input parameters, the source base processes the R37/GV853. The R37/GV853 produces 1SD images which are used to generate the final MCD for the gaining base. Appendix D contains the format and an example of an 1SD image. One 1SD image is produced for every item having SRD Consumption Data at the source base, with the exception of items within an I&SG (19:6-415). The image contains 21 data elements, including the bench stock flag indicator, the stockage priority code (SPC), the base factor, the mission change percent of base repair (PBR), the DDR, the DDFR, and the date the image was created (19:200-200a).

The bench stock flag indicates that the source base has a bench stock detail record established for this item. This flag is used by supply/maintenance managers to determine if the item should be placed on bench stock at the gaining base. The bench stock flag also indicates the item meets one of the four range criteria used to determine if an item coded with ERRCD XB3 will have a demand level established at a base (38:1). Discussion of the four range criteria follows later in this review.

The SPC is assigned to consumable item records when the item is first backordered and signifies the priority or mission impact of the backorder. A SPC of 1 indicates the item caused a weapon system to become MICAP (inoperable due to lack of a part) or an Awaiting Parts (AWP) requirement with an "AR" Urgency of Justification Code (UJC) was placed (19:19-39). The UJC identifies the part's degree of urgency in repairing an end item as well as the specific type of end item (engine, aircraft, etc.) being repaired (19:3-70A). The SPC is also used in the SBSS Hybrid EOQ Range Model to assess a penalty cost for backorders. This range model computes a cost to stock as well as a cost to not stock an item. If the cost to not stock an item exceeds the cost to stock an item, the SBSS computes a demand level for the item. The higher the SPC, the higher the penalty cost, and the greater likelihood the SBSS will establish a demand level for the item (38:1). Currently, demand levels are established automatically for all SPC 1 coded items; however, based on Reynold's 1990 "Analysis of the EOQ Range Criteria," the rules relating to automatic stockage of SPC 1 coded items are recommended for modification (38:36-37).

The mission change PBR is stated in tenths and is used by the requirements computation program to compute the demand levels for reparable items, ERRCD coded XF3 and XD<u>x</u>. When less than one quarter's repair cycle data exist at the gaining base, the mission change PBR is used. "If at least one quarter's repair cycle data exist," then the mission change PBR is not used (19:19-199).

Once the R37/GV853 is processed and 1SD images produced, the MAJCOM specifies the base which will consolidate the MCD from all source bases. All applicable MCD is then forwarded to the consolidating base and the SRD Demand Data Analysis/Consolidation (R65/GV910) is scheduled to be processed (19:19-192).

<u>SRD Demand Data Analysis/Consolidation (R65/GV910)</u>. The purpose of the R65/GV910 is to compile and consolidate the demand data from all source bases and output the necessary products to establish the NASSL forecast. The output includes a breakdown of the dollar value of the forecasted items, by SRD and budget code. The budget code breakdown allows supply managers to monitor the dollar value impact of the forecast at the gaining base. The output of the R65/GV910 program also includes the 1SD images containing the demand data which are used to load the forecast at the gaining base. The program contains several options on how the demand data is consolidated (19:6-563).

Ceilings and floors can be placed on the amount of DDR used to establish the 1SD images. For example, if items with no more than a DDR of two units are desired, then the parameters can be set to include only those items which meet the constraint. Likewise, if items with no less than a DDR of one unit are desired, a floor of one can be set. These two parameters can be used together to select items meeting both floor and ceiling constraints. Using the DDRs in the example just depicted, 1SD images would only be produced for items having a DDR between one and two units. In the case where multiple source bases are used, the 1SD image will contain the DDR from the source base having the largest DDR meeting the constraint. If no parameters are selected, the 1SD will contain the average of the DDR from all the source bases (19:6-564A).

One additional option will output BDFA images to the Air Force Stock Number User Directory (SNUD) (19:6-564A). The SNUD is an AFLC data system which serves as a registry of all users of a specific item and distributes indicative data changes (price, ERRCD, budget code, etc.) as they occur to all registered users of the affected item. The purpose of the BDFA image is to establish in the SNUD that the gaining base is now a user of the item record reflected on the BDFA image. The SNUD will review the BDFA image for accuracy and respond with a confirmation image. If there was incorrect indicative data on the original BDFA image, the SNUD confirmation image will correct the data established in the gaining base computer records (19:27-135).

Once the 1SD images are produced, the MAJCOM along with the consolidating base will review the output for errors. This review will include, but is not limited to, a check for inappropriate nomenclatures or Material Management Codes (MMC) for the weapon system being supported (19:19-195). Additional reviews are also required to be conducted by the responsible AFLC System Program Manager Office (SPM/PM) and IMS personnel. SPM/PM should notify the MAJCOM if there are discrepancies in matching the 1SD images to the specific Mission Design Series (MDS) supported. IMS personnel are responsible to ensure that 1SD images for AFLC managed items in a I&SG are recorded against the group's master item record. The supporting MAJCOM are responsible for I&SG items that are managed by Defense Logistics Agency (DLA) sources (18:12-31-32). Once all quality control checks are complete and corrections made, the 1SD images are uploaded at the gaining base and mission change adjusted level detail records are established.

Uploading 1SD Images. Once the 1SD images are received by the gaining base, a Mission Change Program Select Image (1XT434) is prepared to call the Mission Change (Data Load) (GV434) program to load constant data into the gaining base's computer records. Among the data elements to be loaded, the 1XT434 image contains the level detail effective date, the mission support effective date, and the PBR override (19:19-203). In conjunction with the 1XT434, the Mission Change Parameter Image (Constant Data Load) is also processed to load the change factor used, in conjunction with the base factor, to determine the mission change (MC) DDFR and DDR at the gaining base (19:19-208).

The level detail effective date establishes the date the MCDDFR and MCDDR "are considered by the requirements computation program in determining the item record's demand level" (19:19-198). This date is the first date when requisitions are submitted for the forecasted items (19:19-198). This date is restricted to be set at no more than 180 days before the receipt of the first weapon system at the gaining base and is termed the system activation date (18:12-32). The NASSL can be loaded prior to the level detail effective date for planning purposes, and, if this is done, a detail load date is established in internal supply records reflecting when the NASSL was uploaded into the SBSS (18:12-32). The mission support effective date "represents the date the last system is delivered and is considered the fully operational capability date" (18:12-32). On the mission support effective date, the impact of the MCDDFR and MCDDR on the demand level for the item begins to decline. The amount of impact is reduced by 25 percent each quarter following the mission support effective date. After one year, the MCDDR and MCDDFR will have no impact on the demand level at the gaining base (19:19-199). Figure 3 illustrates the time phasing of the NASSL process.

The PBR override "provides a planned percentage of repair in tenths" for reparable items (19:19-199). "When entered into the computer, this percentage overrides the current repair cycle records percent of base repair as well as the mission change percent of base repair" located on the 1SD (19:19-199). This override percentage is also sent to AFLC to be used in the worldwide requirements computation for selected XDx items (19:19-199).

The Mission Change Parameter Image (Constant Data Load) loads the "constant change factors to standard reporting designators . . . to be utilized during the in-line processing of the 1SD data inputs by program (GV433)" (19:19-208). The change factor represents the number of units to be supported at the gaining base. The change factor is computed in exactly the same way as the base factor was at the source base, but using the weapon system data applicable to the gaining base. If flying

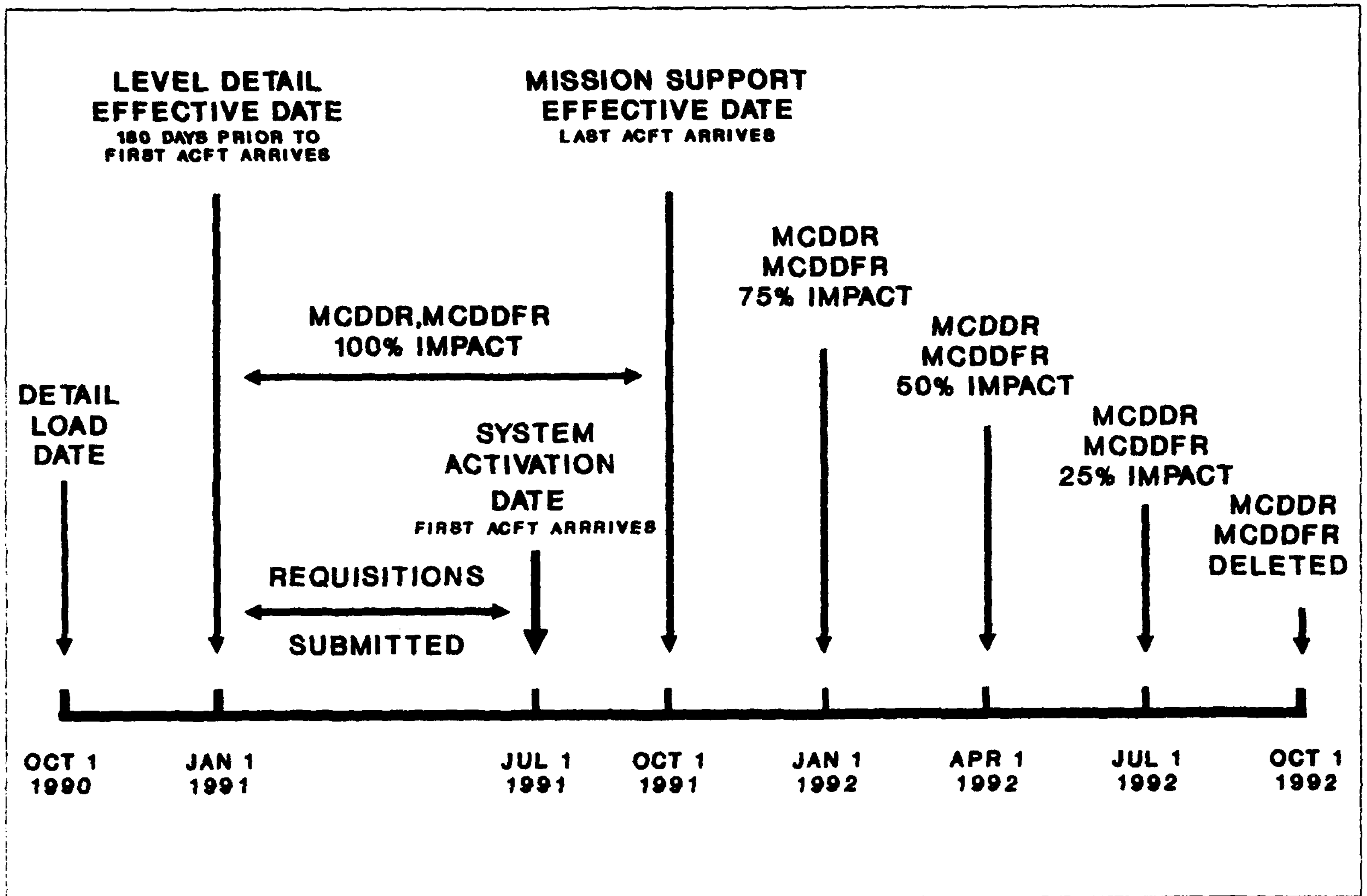

Figure 3. Time Phasing of the NASSL Process

units are involved, the number of aircraft and the expected number and length of sorties must be considered (19:19-198).

After all parameters and constant factors have been determined, the 1XT434 is processed and the 1SD images are uploaded into the gaining base's computer records. If the upload does not occur within nine days of the date the 1SD images were created at the source bases, the upload will reject. The demand data must then be recaptured from the source bases before the program will process correctly (19:19-195).

When the 1XT434 and 1SD images are successfully processed, new item records, as required, are established in the gaining base computer records. These new item records will contain the indicative data on the 1SD image. In addition, the NASSL, consisting of Mission Change Special Level Detail Records (216), is created and support of the activating system begins when the detail effective date is reached and the requirements computation program determines the stock levels based on the demand data on the 1SD images (19:19-196).

Mission Change Special Level Detail Records (216). A 216 record is established for each item record meeting the demand data selection parameters discussed earlier. Each record contains the mission support date, the level detail effective date, the mission change (MC) PBR, and the MCDDR and MCDDFR (19:4-146-147). Appendix E contains the format for this record.

The MCDDR and MCDDFR on the 216 record are computed by multiplying the DDR and DDFR on the 1SD image "by a ratio of the change factor over the base factor" (41:4). Table 3 provides an example of how the demand rates and base/change factors interact to determine the MCDDR and

Table 3

MCDDR and MCDDFR Computations

	Gaining Base	Source Base
Acft supported	36	24
Daily sorties per acft	1.7	.8
Average sortie length	2.2	1.4
Factor (change/base)	134.64 (change) (36 x 1.7 x 2.2)	26.8 (base) (24 x .8 x 1.4)
Base/Change Factor Ratio	$\frac{134.64}{26.8}$ = 5.024	
DDR on 1SD image - .0367		DDFR on 1SD image - .0054
MCDDR = .0367 x 5.024 = .1844		MCDDFR = .0054 x 5.024 = .0251

MCDDFR. When the level detail effective date is reached, the SBSS requirements computation program will use the MCDDFR and MCDDR to determine if a demand level should be established for the item, determine the depth of stock required, and submit a requisition to the source of supply for the item (19:19-198-199). If a demand level is already established on an existing item record, the MCDDR is added to the current DDR on the item record, effectively increasing the demand level to support the projected increase in demand (44:15). Currently, an XB3 item must meet one of four range criteria before the SBSS will compute a demand level. There is only one range criteria for an XF3 or XD2 item to meet before a demand level is created.

SBSS Range Criteria. For XB3 items, demand levels are established during requirements computation if an item meets one of the following criteria:

1. The cost to not stock the item is greater than the cost to stock the item (EOQ Hybrid Range Model).

2. The item has a SPC of 1 (MICAP or "AR" occurrence).

3. The item has a bench stock detail record established based on past demands.

4. The item has had 12 or more customer demands. (38:1)

In July 1990, Reynolds analyzed which of the four criteria items met before a demand level is established. Using the AF Stock Control Data Bank as the data source, Reynolds found that at three bases (England, Randolph, and Upper Heyford), a total of 3,033 new demand levels were established during March - September 1987. Of the levels established, the largest percentage resulted from items meeting the SPC 1 criteria (38:10). Table 4 summarizes the findings across each criteria and the applicable source base.

Reynolds also analyzed the subsequent demand rate for the items with the new demand levels. He found the EOQ Hybrid Range Model was the best predictor of future demands. Of the 1,063 items leveled based on the Range Model criteria, 66 percent actually had a subsequent demand. The worst predictor of future demands was for items stocked based on having a SPC of 1. As previously mentioned, the SPC 1 criteria was the most common reason for initial stockage of XB3 items. For this criteria, only 30 percent were demanded within a year (38:35). Based on his findings, he recommended the Air Force modify the criteria used to determine when demand levels are established (38:36-37).

Table 4

Newly Leveled EOQ Items (38:10)

Range Rule	England Nbr Items (%)	Randolph Nbr Items (%)	Upper Heyford Nbr Items (%)	Total Nbr Nbr Items (%)
Econ. Range Model	153 (21)	434 (49)	476 (34)	1063 (35)
Twelve Custom. Demands	1 (0)	14 (2)	6 (0)	21 (1)
Demand Driven Bench Stock	94 (13)	81 (9)	95 (7)	270 (9)
Stock. Pty. Code (SPC) 1	491 (66)	350 (40)	838 (59)	1679 (55)
Total	739 (100)	879 (100)	1415 (100)	3033 (100)

For XF3 and XDx items, there is only one range criteria an item must meet in order for a demand level to be established. A demand level is established "when the number of demands is two or more, and the DDFR is equal to or greater than 0.0054" (19:19-14). The DDFR of 0.0054 equates to having at least two demands placed within a 365 day time period.

Once the range of stock is determined, the requirements computation program calculates the depth of stock using the SBSS EOQ and reparable demand level formulas. Figure 4 provides a summary of the major steps and programs involved in the development of a NASSL.

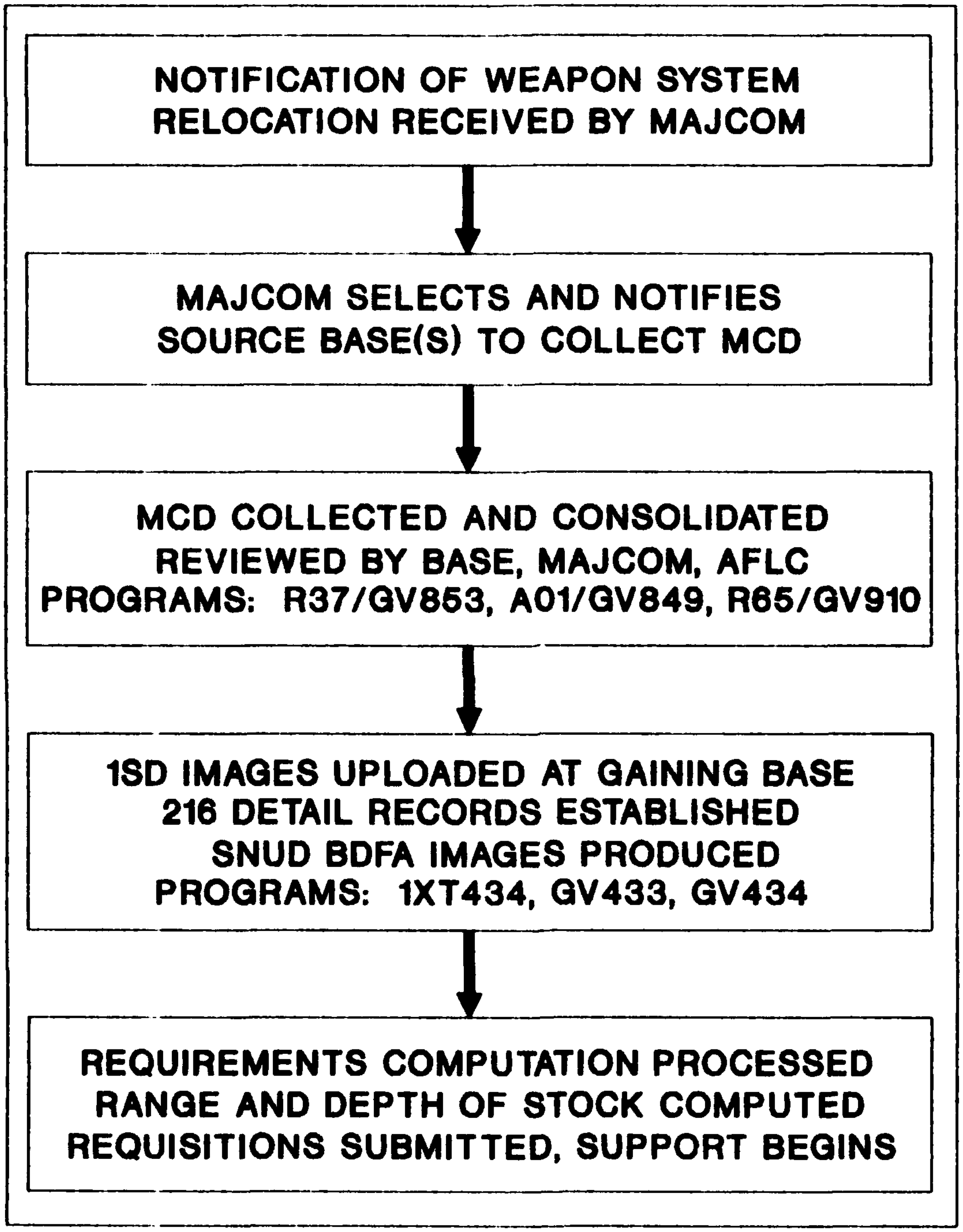

Figure 4. NASSL Development Process

Analysis of New Activation Spares Support List Performance.

In his May 1988 AFLMC analysis of the NASSL process, Reynolds reported the NASSL was not meeting the support requirements for activating weapon systems. He cited two examples involving the transfer of C-141 and C-5 aircraft where the NASSL process provided less than optimum support at the gaining units. When eight C-141s were transferred to Andrews AFB, the NASSL contained only 867 line items (item records), only ten of which were XDx items. The source base used to establish the NASSL supported 57 aircraft and had demand data for over 6700 line items. The C-5 transfer involved the relocation of eight aircraft to Westover AFS. The NASSL for this activation contained 1094 items, none of which were XDx. The source base for the C-5 transfer supported 32 aircraft and had demand data for 8355 items (41:1).

Reynolds attributed the NASSL's poor performance to the underlying assumption in the NASSL methodology that there is a strong linear relationship between the number of aircraft supported and item record demand rates (41:3). This assumption forms the basis and justification for the methodology used to compute the previously discussed MCDDR and MCDDFR (41:5). Also, he pointed out the NASSL process assumes a single source base can be used to accurately determine item requirements at a base gaining a similar weapon system (41:3). The NASSL process provides the option for using several bases as sources for demand data (41:4).

To test the NASSL performance and measure the applicability of the linear relationship and single source base assumptions, Reynolds used the AF Stock Control Data Bank to extract 12 months of demand data from the following C-130E and F-15A/B units.

C-130E (Acft Assigned)	F-15A/B (Acft Assigned)
Little Rock (LR) ANG (6)	McChord (16)
Niagara Falls AFRES (7)	Minot (18)
Willow Grove AFRES (9)	Langley (18)
Van Nuys ANG (12)	New Orleans ANG (21)
McChord (16)	Dobbins ANG (24)
Clark (16)	Tyndall (47)
Pope (48)	Holloman (69)
Little Rock (76)	

(41:15)

Assessment of Linear Relationship. Reynolds used a sample of 176 item records shared by four of the C-130E units with dissimilar numbers of aircraft possessed to determine "if Daily Demand Rates varied linearly with the number of possessed aircraft" (41:10). Reynolds performed similar correlational analyses on similar-size C-130E units to determine if stronger linear relationships existed when similar-size units are used. He found the coefficient of correlation showed inconsistencies in measuring the relationship between the number of possessed aircraft to Daily Demand Rates of spare parts.

> The Pearson product moment coefficient of correlation is a measure of the strength of the linear relationship between two variables x an y. . . . A value of r near or equal to 0 implies little or no linear relationship between the values of y and x that were observed in the sample. In contrast, the closer r is to 1 or -1, the stronger the linear relationship between y and x. . . . Positive values of r imply that y increases as x increases; negative values imply that y decreases as x increases. (29:514-515)

Table 5 depicts the coefficient of correlation matrices Reynolds developed to illustrate the relationship between DDR and the number of possessed aircraft. Even the best correlations (.523 and .580) for the four dissimilar-size units suggest the linear relationship between the dependent variable of DDR and the independent variable of number of possessed aircraft in this sample is "very weak" (41:10). The matrix depicting the similar size C-130 units indicates "that, with the

Table 5

DDR to Possessed Aircraft
Correlation Coefficient Matrices (41:10-11)

Dissimilar-Size C-130 Units (176 Items)

	76 Acft (Little Rock)	48 Acft (Pope)	16 Acft (Clark)	6 Acft (LR ANG)
76 Acft (Little Rock)	1.00			
48 Acft (Pope)	.334	1.00		
16 Acft (Clark)	.475	.135	1.00	
6 Acft (LR ANG)	.523	.178	.580	1.00

Similar-Sized C-130 Units (30 items)

	16 Acft (Clark)	16 Acft (McChord)	12 Acft (Van Nuys)	9 Acft (Wil. Grove)
16 Acft (Clark)	1.00			
16 Acft (McChord)	.017	1.00		
12 Acft (Van Nuys)	.058	.918	1.00	
9 Acft (Willow Grove)	-.001	.944	.983	1.00

$\alpha = .05$

exception of Clark, the linear relationship appears to be stronger when data is selected from similar sized units" (41:11).

Reynolds concluded that the above correlations "support the notion that some linear relationship does exist between number of aircraft and demand rates, however, the relationship is inconsistent and at best must be considered weak" (41:12). His findings are consistent with other research findings by Patterson, Hodges, Crimiel and Lockette on the strength of the linearity assumption of program factors to demand rates.

In his August 1980 analysis of alternative forecasting techniques for application in the SBSS, Patterson stated that "only a small portion of items in the SBSS are likely to be directly affected by program factors" (34:18). He sampled 200 item records from each of six federal stock groups (15, 16, 28, 29, 31, and 47) and ran correlational analysis on the items and three program factors - flying hours, sorties flown, and possessed aircraft. Table 6 shows his correlational analysis.

Table 6

Correlation Between Program Factors and Units Demanded by Federal Stock Group (FSG) (34:18)

FSG	Flying Hours	Sorties Flown	Possessed Acft
15	-.620*	-.479	.079
16	-.297	-.452	.315
28	-.155	.045	-.618*
29	-.633*	-.619*	.092
31	-.627*	-.238	-.372
47	-.427	-.283	.138

* - Significant at the .05 level

Patterson determined that no strong or consistent conclusion covering items in the SBSS was possible based on the results of this analysis and "it appears that the use of program activity in predicting demand for expendable items is still questionable" (34:19). Patterson theorized the negative correlation values were the result of a possible time lag or delay of maintenance action "during extensive program activity," thereby causing a delay in the demand for repair parts (34:19). The available data precluded Patterson from precisely determining the actual cause of the negative values (34:19).

Hodges pointed out that demands for some aircraft parts are not accurately modeled by just the number of flying hours a weapon system accrues. Demands for parts relating to landing gear systems would probably be better estimated by considering the number of landings, not the duration of the sortie. Electronic components are often turned on for many hours on the ground to conduct functional checks. For these type parts, actual hours in use can be understated if flying hours were the sole criteria for estimating demand (24:6). Crimiel later suggested the development of a "separate operational multiplier" that would adjust demand rates based on the program factors involved (11:24). For example, gunparts could be coded to reflect demands per 1,000 rounds fired (11:24).

In his 1984 AFIT thesis analyzing the recoverable asset requirements determination and obligation process, Lockette stated

> a linear relationship between obligation and flying hours may, in fact, only exist over the middle portion of a weapon systems life cycle. Early in a systems life cycle, relatively high failure rates can be expected which would decrease and then possibly remain linear over a number of years as reliability is improved through modifications. Later in a weapon systems life cycle, as components reach the end of their useful life, the rate of obligations per flying hour could again be expected to increase possibly in a nonlinear fashion. Therefore, the relationship may not be linear early and then late in a weapon systems life cycle. (27:66)

Assessment of Single Source Base Assumption. Using a computer model developed by the AFLMC to replicate the NASSL process, Reynolds measured the effectiveness of the current NASSL process using a single large source base. He used the demand data from the two largest bases (Little Rock and Holloman) for each weapon system (C-130E and F-15A/B respectively) to build a NASSL for three "activating" units. The "activating" units for the C-130E were Pope, Clark, and Willow Grove; the activating units for the F-15A/B were Tyndall, New Orleans, and McChord. Since actual demand data was already available from the "activating" units, an accurate assessment could be made as to the effectiveness of the NASSL. The performance measures used were "the number of items stocked but not demanded, the number of items stocked and demanded, and the number of items demanded but not stocked" (41:10-12). Figure 5 uses a Venn diagram to portray the performance measures. An effective NASSL results in a large intersection of both circles, with few items in the outlying areas.

Table 7 contains the data for the C-130E and F-15A/B aircraft using the current NASSL process to forecast requirements at the three "activating" bases using the single, largest base as the source. As the results show, the best fill rate achieved in the six "activations" was 58 percent for the F-15A/B "activation" at Tyndall. The fill rate is computed by dividing the total number of line items demanded and stocked by the total number of line items demanded (41:22). For example, the 58 percent fill rate at Tyndall was computed by dividing the total number of items stocked and demanded (2287) by the total number of items demanded (2287 + 1651 = 3938). The average fill rate was 51 percent for the C-130E and 55 percent for the F-15A/B; however, each "activation" had a large percentage, ranging from 57 to 87 percent, of items that were stocked but not demanded. The NASSL was especially inefficient as the number of aircraft at the gaining base decreased (41:14).

Reynolds then examined the range of items stocked at the 15 bases in his study and noted "that units with a similar number of aircraft

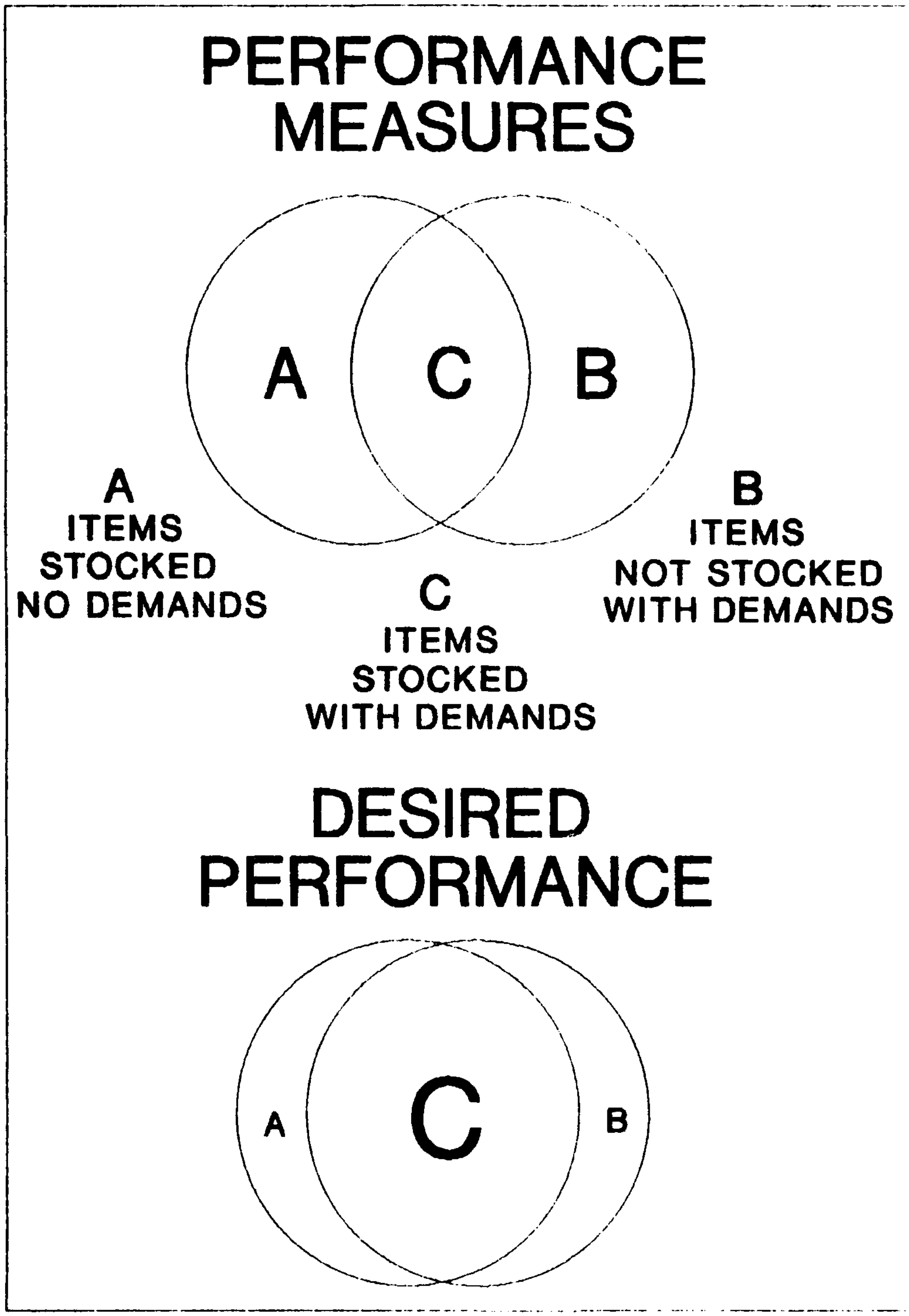

Figure 5. NASSL Performance Measures (41:22)

Table 7

C-130E and F-15A/B NASSL Replication
Using Large Source Base (41:13-14)

C-130E Data Source Base - Little Rock (76 Acft)

Activating Base (Acft)	Line Items Stocked Not Demanded Items (Pct)	Line Items Stocked And Demanded Items (Pct)	Line Items Demanded Not Stocked Items (Pct)	Fill Rate Pct
Pope (48)	4230 (57)	3233 (43)	3230 (50)	50
Clark (16)	4846 (71)	2026 (29)	1932 (49)	51
Wil. Grove (8)	5212 (87)	758 (13)	622 (45)	55
TOTALS	14288 (70)	6017 (30)	5784 (49)	51

F-15A/B Data Source Base - Holloman (69 Acft)

Activating Base (Acft)	Line Items Stocked Not Demanded Items (Pct)	Line Items Stocked And Demanded Items (Pct)	Line Items Demanded Not Stocked Items (Pct)	Fill Rate Pct
Tyndall (47)	3243 (59)	2287 (41)	1651 (42)	58
N. Orleans (21)	3485 (66)	1779 (34)	1631 (48)	52
McChord (16)	3973 (80)	980 (20)	844 (46)	54
TOTALS	10701 (68)	5046 (32)	4126 (45)	55

have consumption for a similar range of both consumable and recoverable items" (41:15). He then tested the NASSL process using three similar-sized bases to develop the requirements for the gaining unit.

Assessment of Multiple Sources. For the C-130E aircraft, Reynolds used Van Nuys, Clark, and Willow Grove as the source bases to support an "activation" at McChord and Little Rock ANG. Table 8 shows the results of the simulated "activations" and breaks the NASSL performance down by ERRCD categories. On the basis of this analysis, Reynolds concluded the NASSL multiple source base option provided

Table 8

NASSL Replications for Similar-Size C-130E Units (41:17)

<u>C-130E Data Source Bases (Acft)</u> - Van Nuys (12)
Clark (16)
Willow Grove (9)

Activating Base (Acft)		Line Items Stocked Not Demanded Items (Pct)	Line Items Stocked And Demanded Items (Pct)	Line Items Demanded Not Stocked Items (Pct)	Fill Rate Pct
McChord (16)	Overall	4019 (72)	1541 (28)	1459 (49)	51
	(XB3)	3829 (75)	1247 (25)	1235 (50)	50
	(XF3)	45 (49)	46 (51)	51 (53)	47
	(XD2)	145 (37)	248 (63)	173 (40)	60
Little Rock ANG (6)	Overall	3842 (72)	1465 (28)	1285 (47)	53
	(XB3)	3719 (73)	1357 (27)	1153 (46)	54
	(XF3)	17 (46)	20 (54)	23 (53)	47
	(XD2)	106 (55)	88 (45)	109 (55)	45

roughly the same performance as the single source option. Fill rates consistently fell within the 50 - 55 percent range and both options laid in a high percentage of items that were not demanded during the 12 month period. Examination of the breakdown between ERRCD revealed the reparable items, XF3 and XD2, outperformed XB3 items by a wide margin in the "Line Item Stocked Not Demanded" category. "In other words, the NASSL process seems to do a somewhat better job of stocking the right XF/XD parts than it does in selecting the subsequently demanded XB3 items" (41:17). To determine if errors in base-level coding of I&SG were responsible for part of the NASSL inefficiency, Reynolds replicated the C-130E "activation" at McChord with clean I&SG data.

Assessment of I&SG Impact on NASSL Performance. Recall from the previous discussion on collection of MCD for items in an I&SG that all demand data is compiled against the group's master item record. Reynolds used the C-130E multi-source "activation" at McChord to evaluate if there was a significant discrepancy in rolling the demand data to the group's master item record. He first obtained a copy of the D043, Master Item Identification Control System, from AFLC and then forced all MCD data from the three source bases to be rolled against the correct master item record (41:17). After the MCD was collected, the multi-source NASSL was processed for the gaining unit, McChord. Table 9 shows the results of this NASSL performance.

Based on this replication, Reynolds concluded there was no significant problem in the NASSL process due to errors in collecting MCD for items in an I&SG. His analysis shows that for almost all ERRCD categories of items, a slight decrease in the number of "Line Items

Table 9

C-130E NASSL Replication Using Master Item Records (41:18)

C-130E Data Source Bases (Acft) - Van Nuys (12), Clark (16), Willow Grove (9)

Activating Base (Acft)		Line Items Stocked Not Demanded Items (Pct)	Line Items Stocked And Demanded Items (Pct)	Line Items Demanded Not Stocked Items (Pct)	Fill Rate Pct
McChord (16)	Overall	3952 (72)	1554 (28)	1446 (48)	52
	(XB3)	3771 (75)	1259 (25)	1223 (49)	51
	(XF3)	44 (49)	46 (51)	51 (53)	47
	(XD2)	137 (35)	249 (65)	172 (41)	59

Stocked Not Demanded" and "Line Items Demanded Not Stocked" was realized as well a slight increase in the number of "Line Items Stocked And Demanded" (41:18). Although the errors were not significant, Reynolds stated the accuracy of the MCD Collection System relating to I&SG required further study (41:18). In Hancock's September 1989 study, "Analysis of Interchangeable and Substitute Groups (I&SG)," discrepancies were identified in the I&SG data transmission process between base-level and AFLC systems and recommendations were made for correction (23:19).

Alternatives to the New Activation Spares Support List Process.

Since the current NASSL process consistently achieved a fill rate slightly higher than 50 percent and stocked many items that were never demanded, Reynolds tested alternative stockage models to improve NASSL performance. He first established a performance target level for the NASSL.

NASSL Performance Target Level. "To determine a reasonable target" for NASSL performance, Reynolds used 10 months of demand data from a C-130E base and 12 months from a F-15A/B base to measure how well past demands match subsequent demands during a six-month period at the same source base (41:19). Table 10 shows the results of this test.

This test indicates that even when a base's own demand data is used to forecast subsequent demands at the same base, fill rates up to only 65 percent can be expected during the six month period following the forecast period. In addition, a majority of items (61 and 55 percent) will have no demands at all. Reynolds concluded that the rather low fill rates of 65 and 63 percent are "indicative of the high degree of

Table 10

Six Month NASSL Fill Rate Performance (41:20)

Aircraft	Line Items Stocked Not Demanded Items (Pct)	Line Items Stocked And Demanded Items (Pct)	Line Items Demanded Not Stocked Items (Pct)	Fill Rate Pct
C-130E	1677 (61)	1071 (39)	579 (35)	65
F-15A/B	1934 (55)	1607 (45)	963 (37)	63

demand uncertainty typical of weapon system support" (41:20). Using the 65 percent fill rate as a benchmark, Reynolds examined two alternative models to the current NASSL process - the Common-Use Range Criteria and the Demand Forecasting Range Model.

Common-Use Range Model. As noted earlier, Blazer recommended that several similar-size bases be used to forecast items at a new location instead of relying on one large source for demand data (3). In a related study, Moller and Blazer determined that MICAP demand data was predictive across bases supporting the same weapon system (31:15). Based on these recommendations and findings, Reynolds devised the Common-Use Range Model as an alternative to the current NASSL process.

The Common-Use Range Model stocks an item based upon the number of bases which have a recorded demand for the item. Five source bases are used to determine the specific policy. Table 11 contains the stockage criteria based on this approach.

Reynolds used the demand data from six C-130E units, with the number of supported aircraft ranging from 6 to 16. He developed a "best case"/"worst case" scenario to measure the performance of the Common-Use

Table 11

Common-Use Range Criteria (41:21)

Policy	Stockage Criteria
1	Stock an item if demanded at all five source bases.
2	Stock an item if demanded at four of the source bases.
3	Stock an item if demanded at three of the source bases.
4	Stock an item if demanded at two of the source bases.
5	Stock an item if demanded at any of the source bases.

Model. The "best case" scenario used the base with the least number of base-unique items as the gaining base while using the other five bases as the source bases. Base-unique items are items demanded at only one of the six test bases. The "worst case" scenario used the base with the most unique items as the gaining base while the others served as source bases. Using fill rate potential and line items stocked as the measures of performance, Reynolds compared the performance of the Common-Use Range Model against the current NASSL process (41:20-21). Table 12 shows the results of his comparison.

Under the "best case" scenario, policy 4 of the Common-Use Range Model was the first policy to outperform the current NASSL process. Policy 4 provided an overall fill rate of .69 in comparison to the NASSL fill rate of .66 and stocked only 3293 items versus 7640 using the NASSL. Under the "worst case" scenario, only policy 5 provided better fill rate results (.61 versus .53 percent), but also at the expense of stocking more items (7899 versus 7344). Reynolds noted that the point

Table 12

FRP = Fill Rate Potential   Common-Use Range Model Performance (41:23)

	Policy 1		Policy 2		Policy 3		Policy 4		Policy 5	
	FRP	Range	FRP	Range	FRP	Range	FRP	Range	FRP	Range
BEST CASE										
Overall	.07	188	.20	670	.37	1567	.69	3293	.74	8840
XB3	.06	153	.18	532	.35	1305	.53	2840	.72	7911
XF3	.08	6	.27	20	.54	48	.71	89	.77	191
XD2	.11	29	.36	118	.54	214	.73	364	.85	738

CURRENT NASSL	FRP	Range
Overall	.66	7640
XB3	.68	7340
XF3	.40	47
XD2	.52	253

	Policy 1		Policy 2		Policy 3		Policy 4		Policy 5	
	FRP	Range	FRP	Range	FRP	Range	FRP	Range	FRP	Range
WORST CASE										
Overall	.04	175	.11	578	.23	1315	.39	2801	.61	7899
XB3	.03	144	.10	467	.21	1102	.37	2425	.59	7059
XF3	.04	5	.14	15	.30	35	.50	68	.72	173
XD2	.06	26	.21	96	.36	178	.55	308	.75	667

CURRENT NASSL	FRP	Range
Overall	.53	7344
XB3	.52	6691
XF3	.60	173
XD2	.64	480

where the Common-Use Range Model outperformed the current NASSL process fell somewhere between Policy 3 and 4 for the "best case" scenario and Policy 4 and 5 for the "worst case" (41:40). Since the Common-Use Range Model "presents only discrete choices (no mid-point options)" and generalizations "about which discrete policy provided the best support" could not be made, Reynolds could not recommend the Common-Use Range Model replace the current NASSL process (41:22).

Reynolds analyzed the data of the six source bases used to test the Common-Use Range Model as well as the demand data from the six smallest F-15A/B units "to determine why the model was unsuccessful" (41:24). Table 13 reflects the results of his analysis. Reynolds reported a

> high incidence of base unique items. . . . 34 percent of all C-130E items were requested by only one of the six bases. Similarly, the rate of "uniqueness" for F-15A/B requests was 30 percent. Analysis of those items found to be unique to a single base indicated no trends in either demand rates or Federal Stock Groups (FSG). In other words, base unique items could not be discounted as "low demand" nor could they be easily identified by Federal Supply Group. Therefore, range selection criteria other than "common-use" were needed to discriminate among these unique items. (41:24)

Table 13

Common-Use Range Model Analysis (41:24)

	Base Unique	2 of 6 Users	3 of 6 Users	4 of 6 Users	5 of 6 Users	Common to All 6 Bases
C-130E						
Overall	.34	.20	.17	.14	.10	.05
XB3	.36	.20	.17	.13	.09	.05
XF3/XD2	.23	.16	.17	.17	.19	.08
F-15A/B						
Overall	.30	.20	.16	.14	.13	.07
XB3	.29	.20	.16	.14	.14	.07
XF3/XD2	.31	.21	.16	.18	.12	.02

Based on his analysis, Reynolds developed the Demand Forecasting Range Model which uses more sophisticated mathematical techniques to forecast demands.

Demand Forecasting Range Model. The Demand Forecasting Range Model uses demand data from five similar-size bases supporting the same weapon system to forecast the expected probability of demand for items at a sixth similar-size base. The demand data are then fitted to three mathematical models used to predict demands.

> These models--the Binomial Model, the Poisson Model, and the Negative Binomial Model--each make predictions given the mean and variance of demand over a time interval. The Binomial Model is appropriate when the ratio of the Variance to the Mean (the Variance-to-Mean Ratio or VMR) is less than 1. The Poisson Model applies when the VMR is equal to 1, and the Negative Binomial Model applies when the VMR is greater than 1. These models blend together at a VMR of 1 in the sense that the Binomial models with VMR slightly less than 1 predict the same distribution of numbers of demands as the Poisson Model or the Negative Binomial Model with VMR slightly greater than 1. This means that the combined use of these models provides a capability to smoothly model demand distributions for all possible VMR. (41:41)

The use of these mathematical models requires an "accurate estimation of expected mean demand and variance of demand" (41:42). The Demand Forecasting Model uses the demand data from five similar bases to estimate these parameters. For each item at the five bases, an average annual demand rate is computed considering demands at all five bases, regardless if a base had no demand data for the item. This average is then used as the "theoretical base mean demand" for the activating base (41:42). The same demand data is then used to estimate the "theoretical base demand variance" and the variance-to-mean ratio (VMR) (41:42). The following example illustrates how the model would determine the mean demand, the demand variance, and the VMR for an item using data from five source bases (n):

NSN at	Base 1	Base 2	Base 3	Base 4	Base 5	Total Demands
			Annual Demand in units (x) for			
1560013834256FL	4	1	0	3	2	10

$$\text{Base Mean Demand } (\lambda) = \sum_{i=1}^{n} (x_i) / n = 10 / 5 = 2$$

$$\text{Base Demand Variance (VAR)} = \sum_{i=1}^{n} (x_i)^2 / n - \lambda^2 = 6 - 4 = 2$$

$$\text{Variance-to-Mean (VMR) Ratio} = \text{VAR} / \lambda = 2 / 2 = 1 \qquad (33)$$

The VMR is then matched to the applicable mathematical model. Figure 6 depicts the distributions and formulas the three models use to determine the probability of future demand (PFD). In the Demand Forecasting Range Model, the three mathematical models only calculate "the probability that no demand for an item would occur over a year" (41:42). By taking the complement of this probability (1 - p), the model then determines the probability of at least one demand occurring during the next year.

Recall from the previous example using NSN 1560013834256FL that the VMR was 1. This indicates the Poisson Model is best suited for determining the PFD for this item. The Poisson Model would then determine this PFD by first computing the probability of no future demands as follows:

Given $p(x) = {}^{x} e^{-\lambda} / x!$

then $p(0) = 2^0 e^{-2} / 0! = .1353 / 1 = .1353$

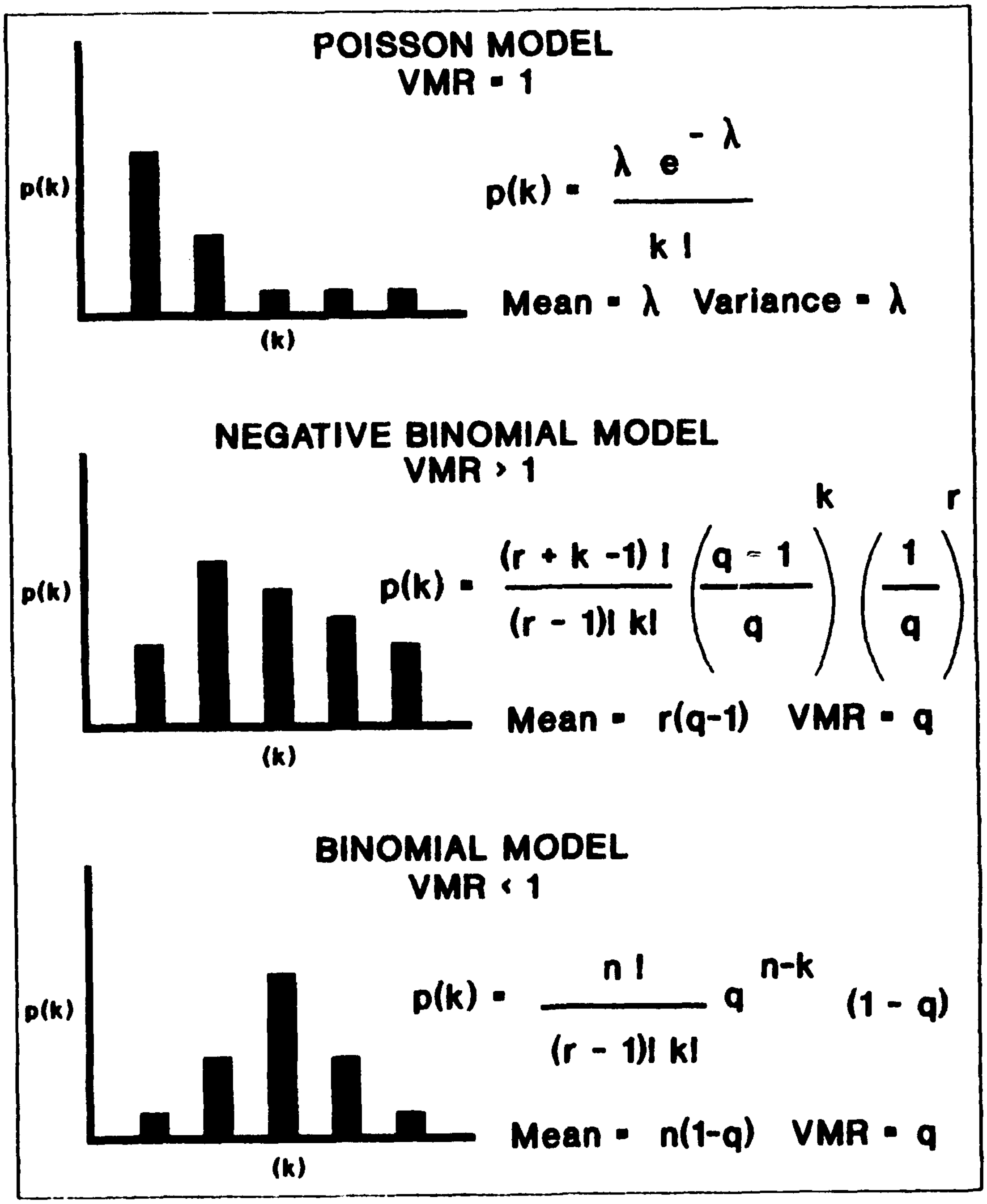

Figure 6. Mathematical Models Used in the Demand Forecasting Range Model (33)

For this particular item then, there is a 13.53 percent chance of no demands during the next year. Taking the complement or the PFD (1 - p(0)), there is an 86.47 percent chance that at least one demand for this NSN will occur during the next year.

Once all items are fitted to the mathematical model and the probabilities of no demands are determined, the user then sets a probability of future demand (PFD) threshold to select those items to be stocked at the activating base. For example, if a MAJCOM wanted to stock those items having a PFD of 80 percent, the model would select only those items having an 80 percent or higher PFD. In this case, the range of stock would be small in light of the high PFD threshold. In comparison, using a threshold of 20 percent would result in a much larger range of items since an item would only have to have a probability of 20 percent to be selected (41:25). For the example given for NSN 1560013834256FL, the PFD was high enough to meet the 80 percent probability threshold, so therefore, the Demand Forecasting Range Model would recommend this item be stocked.

Reynolds used the six smallest units for both weapon systems to measure the performance of the Demand Forecasting Model. Each unit was held out as the gaining base while the five other bases were used as sources for the demand data. As a result, six combinations of gaining/source bases were tested and each combination was further tested using six different "future demand probability thresholds" (41:25). Measurement criteria consisted of fill rate potential (FRP) and number of items stocked across ERRCD categories. The FRP is identical to the fill rate defined earlier in that it is computed by dividing the number of demands for items that are stocked by the total number of items demanded (41:22). Basically, the FRP answers the question of "how often did we stock what we needed?" (41:22).

Figures 7 and 8 show that as the desired PFD decreases, the fill rate potential increases, as well as the range of items stocked. Reynolds also noted that as the PFD exceeded 40 percent, the rate of increase in fill rate potential began to decline. The rate of increase in the number of line items stocked declined in a similar fashion. Based on these findings, Reynolds conducted a final range test using three PFD factors (20, 30, 40), the current NASSL process, and the range

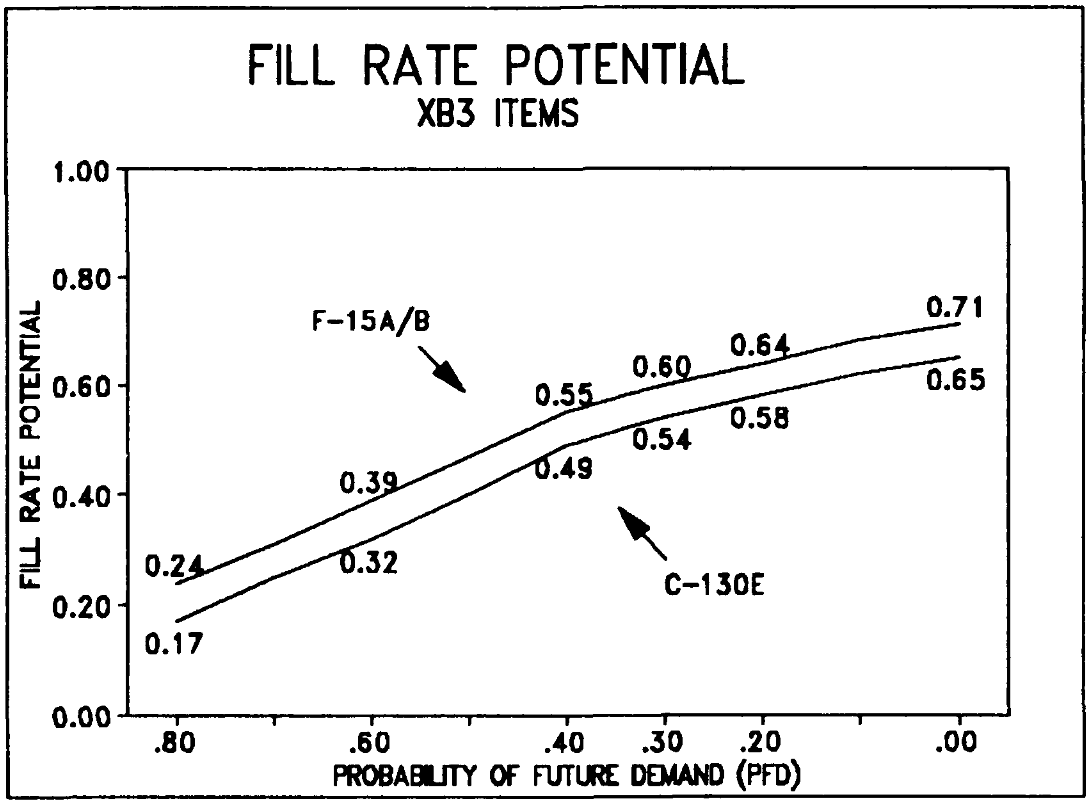

Figure 7. Fill Rate Potential - XB3 Items (41:29)

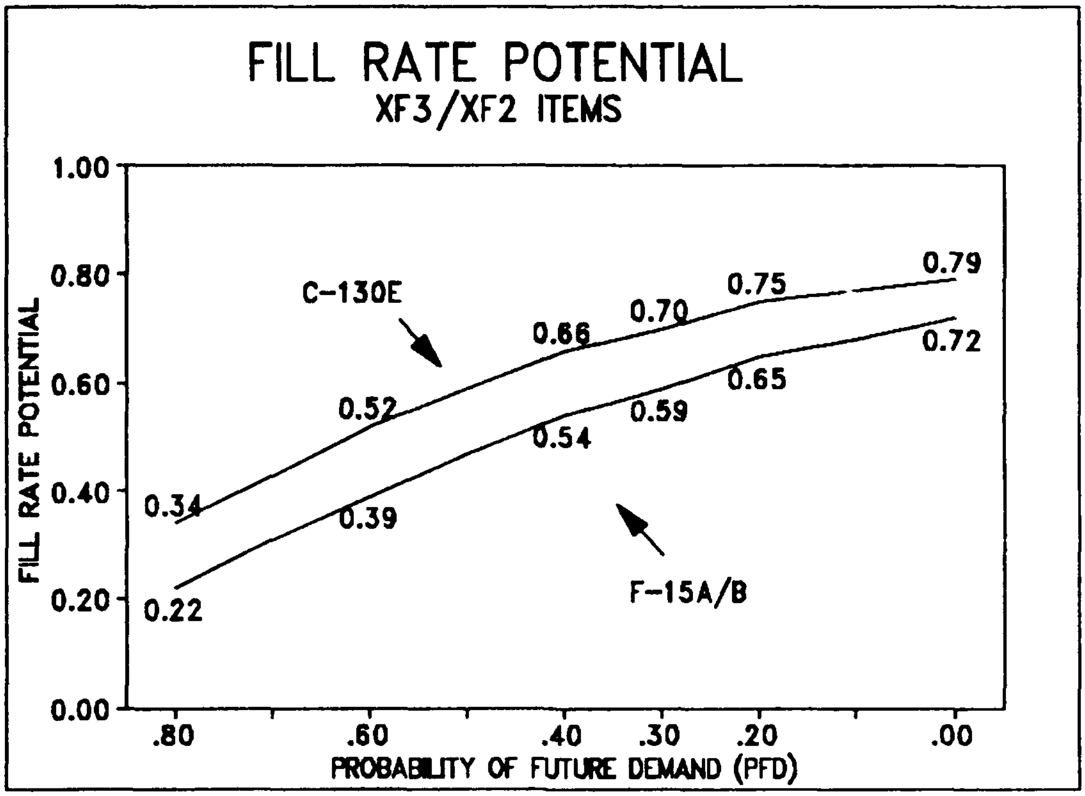

Figure 8. Fill Rate Potential - XF3/XD2 Items (41:30)

criteria of stocking all unique items. Table 14 shows the results of this test.

Measurement criteria used were the FRP as defined earlier, the range of stock, and extended dollar costs for each of the six possible base combinations of each weapon system The extended dollar costs where determined by applying the SBSS depth model formulas to the items included in the range forecast (41:31). Because the SBSS depth model for XF3/XD2 items requires the percent of base repair (PBR) to perform depth model calculations, an assumption had to be made as to the PBR at the gaining base. For this test, Reynolds assumed the PBR to be zero at the gaining base and provided two reasons for this assumption.

> First, base repair rates for XD2 assets are generally low; around 20 percent. Additionally, about half of all XF3 items have similarly low rates of repair. Secondly, the aim of the NASSL concept is to develop spares lists for new unit activations; these units normally have very limited experience supporting the newly assigned weapon systems. (41:32)

As noted earlier, Reynolds determined the performance target level (fill rate) for an alternative forecasting policy to be approximately 62-65 percent. The only policies approaching the target level were the PFD = 20, the stock all unique items, and the current NASSL process.

Table 14

C-130E / F-15A/B NASSL Policy Comparison (41:32)

POLICY	ERRCD	FILL RATE POTENTIAL C-130E / F-15A/B	RANGE C-130E / F-15A/B	COST IN THOUSANDS C-130E / F-15A/B
PFD = 40	XB3	.49 / .55	3353 / 3653	551 / 660
	XF3	.61 / .44	85 / 118	88 / 144
	XD2	.68 / .57	379 / 578	6417 / 23200
PFD = 30	XB3	.54 / .60	4471 / 4597	652 / 768
	XF3	.64 / .48	106 / 152	98 / 165
	XD2	.72 / .62	437 / 689	6933 / 25258
PFD = 20	XB3	.58 / .64	5422 / 5524	754 / 900
	XF3	.69 / .54	133 / 207	110 / 182
	XD2	.76 / .68	552 / 879	7883 / 27975
Stock All	XB3	.65 / .71	7591 / 7558	1042 / 1196
Unique	XF3	.74 / .63	184 / 301	124 / 209
Items	XD2	.80 / .70	709 / 1228	8209 / 31557
CURRENT	XB3	.62 / .69	7105 / 7498	1500 / 1835
NASSL	XF3	.50 / .40	92 / 138	230 / 273
	XD2	.61 / .58	366 / 753	5406 / 36562

The stock all unique items policy achieved the highest fill rate, exceeding the PFD - 20 policy by 5 to 10 percentage points across each ERRCD and easily outperforming the current NASSL in all areas. Although the margin of fill rate performance was slim (2 to 9 percent) between the PFD - 20 and the stock all unique item policies, the cost of inventory was much lower for the PFD - 20 (41:32-33).

Reynolds summarized his findings by stating

> that by incorporating the proposed demand forecasting model into the NASSL process, we can obtain equal or improved fill rate potential across the board; and for XB3 and XF3 items, cut initial inventory (stock fund) costs approximately in half. The model performs equally well regardless of item ERRC or weapon system. Even when our results were compared to a "stock everything" range policy, the demand forecasting model produced comparable fill rate potential at far lower stock fund costs. (41:34)

Based on his conclusions, the AFLMC developed the microcomputer program, SPARES, for use by the MAJCOMs to forecast requirements for activating weapon systems (44:1).

Spare Parts for the Activation of Relocated Systems.

The SPARES forecasting model has two distinct advantages over the current NASSL process. First, instead of using only one large source base to forecast requirements, the model uses data from five similar-size bases possessing the same weapon system (41:33). The other advantage is the ability for the MAJCOM to set limits on the inventory levels established by selecting a desired PFD threshold. The probability the MAJCOM uses would depend upon the availability of stock fund dollars and the desired level of support for the activating system (41:25).

The SPARES model is "designed for MAJCOM use and runs on a Zenith 248 microcomputer" (44:9). The program merges the MCD from the R37/GV853 files submitted by the five source bases. The merge process is similar in design and function as the R65/GV910 program discussed earlier. After the merge process is complete, the program asks the user for the desired PFD. After the PFD is entered, the program selects all item records meeting the probability threshold and determines the range of stock of the NASSL (44:12). The program then loops back and adjusts the demand data to ensure the items meeting the PFD threshold would also meet one of the applicable SBSS range criteria (43). The program is then ready to determine the depth of stock for each item using the SBSS EOQ and Reparable Demand Level formulas (44:12).

Before the depth of stock can be determined, the program requests the Order and Ship Time (O&ST) for each of the sources of supply which will support the activating base. The O&ST for the activating base is computed by the Routing Identifier Listing (Q05/GV871), and represents the average amount of time it takes for a routine stock replenishment requisition to be received at a base from the source of supply (19:5-530). Once the depth of stock is calculated, SPARES calculates the cost of the NASSL and provides a summary report of items leveled and the NASSL extended cost broken out over each ERRCD (44:12).

The program also provides an option for listing all items included in the NASSL. This listing should be reviewed by the MAJCOM and the "appropriate ALC NASSL monitor" for completeness and accuracy. The program also allows for corrections to be made for items on the list, as well as the ability to add or delete items as recommended by maintenance personnel. Different probability thresholds can be entered to quickly assess the impact in terms of the extended dollar value of inventory established (44:12-15).

When all changes are complete and the desired probability level established, the program asks for the base factor, indicating the number of aircraft at the gaining base, as well as the applicable SRD and the current date. The SPARES User's Guide emphasizes the need to use a base factor identical to the change factor to be entered in the Mission Change Parameter Image at the gaining base (44:19). The effect of using identical base and change factors is simply to cause the base/change factor ratio to become 1, thus preventing the MCDDR and MCDDFR on the 216 record to be factored up or down by the requirements computation program (43). This logic supports the principle of using five similar-size bases to forecast demands at a sixth similar-size base and negates the impact of the questionable linearity assumption (43). After all information is obtained, the program is processed and 1SD images are output. These output images are then uploaded at the gaining base, establishing the 216 records and commencing the support of the activating weapon system (44:19). Figure 9 depicts a flow chart of the SPARES process.

Conclusion

Attempts to accurately forecast spare parts requirements to support weapon systems have taken on a variety of names and acronyms during the past 20 years. The ISSL remains the key provisioning list in providing spare parts for weapon systems when they first enter the Air Force

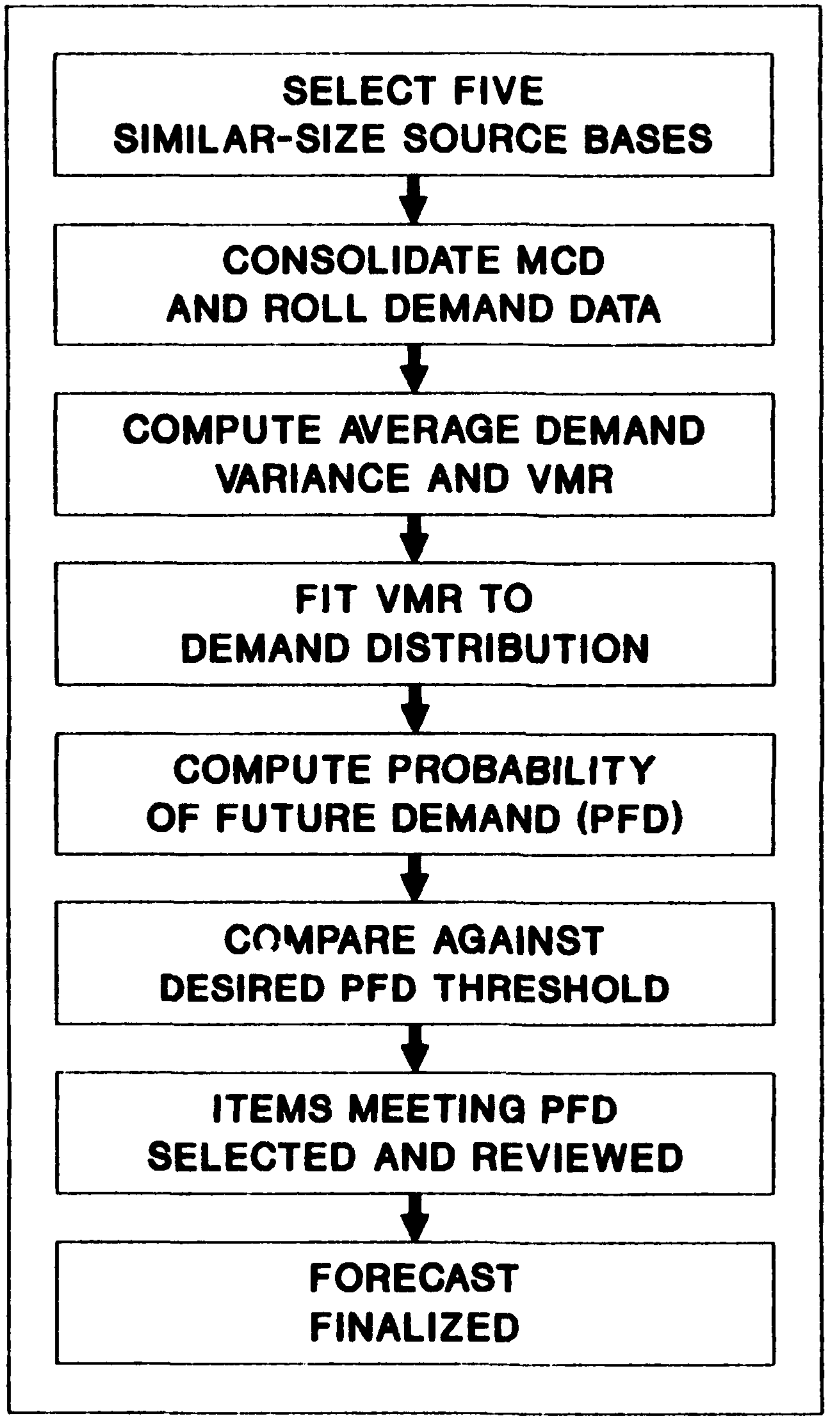

Figure 9. SPARES Forecast Methodology

inventory. As demand data is generated from weapon system operation, the ISSL is updated and should reflect actual usage rates. Following the initial provisioning period, the ISSL is replaced by the NASSL, which at one time was labeled a FOSSL. The NASSL is built primarily from the MCD generated at bases supporting similar weapon systems. If the weapon system does not operate in large numbers, it is given the designation as a low-density system and receives support from a MSSL. One common thread through the majority of these attempts to accurately forecast requirements has been their inability to do so accurately. The reasons for the poor performance are almost as numerous as the acronyms themselves. This literature review revealed two major areas of concern.

First, failure to quickly update provisioning lists with actual usage rates has resulted in the overstatement and understatement of requirements. Through the years, inaccurate forecasts have sent massive amounts of inventory directly from the "cradle to the grave" without ever being used. The AFAA, the GAO, and the AFLMC cite system and personnel issues as being the cause of these failures. In some instances, the system is not being fed the MCD as it is generated because system edits are bypassed, either by design flaws or inappropriate coding of input transactions. Even when the MCD did get through, inventory managers in some cases overlooked what the numbers added up to. With such a complex system to deal with, personal experience sometimes won out over system logic. Since system logic may be in error, as in the NASSL core assumption, perhaps personal experience would be the lesser of two evils.

The second area of major concern is the system logic behind the NASSL process. The literature does not support the assumption that demand data from one large source base, with adjustments based primarily on the number of weapon systems to support, can accurately forecast requirements. Replications of the NASSL process at the AFLMC and assessment of actual activations from the ANG and AFRES indicate the NASSL is not meeting the requirements to support the new weapon systems. With limited funds available for spare part purchases, an accurate and flexible forecasting methodology is needed immediately to support the upcoming ANG activations and the composite wing force structure moves.

Using the Demand Forecasting Range Model, the SPARES program represents the latest Air Force attempt to provide an accurate forecasting technique. The model uses the same mathematical techniques as the successful Dyna-METRIC Model developed by Rand and used by the Air Force to determine WRSK/BLSS requirements. Simulations by the AFLMC show SPARES has the potential to exceed current NASSL fill rate performance and at a much lower inventory cost. If the analysis of the activation at Syracuse replicates the simulation results, than the Air Force may have taken another step, this time in the right direction, to meet the Department of Defense's challenge "to provide our military forces the right item, at the right place at the right time, on an economical basis" (12:20).

The next chapter details the methodology used in assessing the performance of the mission change data collection system and the SPARES forecasting model in supporting the Syracuse activation. Core data files and data manipulation are described, and research limitations and assumptions are specified.

III. Methodology

Introduction

This chapter describes the methodology used in assessing the SPARES forecasting model's performance. Data used in this analysis are described along with related assumptions and limitations. Methods of data collection and manipulation are discussed. Finally, the research plan used to answer the investigative issues is set forth.

Data Collection

Population. The populations under study are:

1. The MCD files from the five source bases used to develop the SPARES forecast at Syracuse.

2. The supply items (ERRCD XB3, XF3, XD2) forecasted by SPARES.

3. The demands placed for all supply items in direct support of F-16A/B aircraft at Syracuse during August 1988 through June 1990.

4. Supply items included in the ALC F-16A/B NASSL.

5. Other MCD files provided by the AFLMC and the ANG Bureau and obtained from SBSS supply accounts.

Assumptions. The following assumptions relating to the data used in this research were made:

1. All data provided by the AFLMC, the ANGB, and the ALC NASSL monitor in the form of magnetic tapes, floppy disks, and reports were complete and accurate.

2. The SPARES forecast used to support the Syracuse activation followed documented SPARES procedures.

3. Supply personnel at Syracuse followed documented supply procedures in recording demands during the period under consideration.

Limitations. The SPARES model was developed to forecast requirements for Air Force weapon system activations using data from five bases with similar-size units already in operation (41:34). The activation under consideration in this research study consisted of 24 F-16A/B aircraft at Syracuse ANGB NY. The MCD files provided by the AFLMC were from the following bases possessing the number of aircraft ( ):

Great Falls ANGB MT	(19)
Burlington ANGB VT	(20)
Tucson ANGB AZ	(20)
McConnell ANGB KS	(44)
Jacksonville ANGB FL	(20)

(21)

The results of this study are applicable to those forecasts using input data from five, similar-size sources.

The actual 1SD images which were produced by the SPARES forecast for Syracuse and subsequently uploaded into the SBSS were not available. However, since the MCD from the five source bases was provided by the AFLMC, the original SPARES forecast at Syracuse could be replicated. Due to the time lapse and lack of official documentation, any external manipulation of the SPARES forecast prior to SBSS upload could not be ascertained, therefore, precluding explanation of discrepancies between the actual SPARES forecast and the 1SD images that were uploaded. Because of this limitation, the performance of the SPARES forecast is based on the 216 detail records provided by the AFLMC and cited as being the items loaded to support the Syracuse activation (42).

At the time of this analysis, the SPD Demand Data Analysis/Consolidation (R65/GV910) program had discrepancy reports (DIREPs) on file at the Standard Systems Center (SSC) (37). These DIREPs prevented the development of a NASSL forecast as described by AFM 67-1, Vol II, Part Two. However, the researcher wrote a program using SAS data set procedures to replicate R65/GV910 processing. This program also simulated the 1XT434 upload of 1SD images and the SBSS requirements computation program used to determine if a demand level is established based on the MCD contained in the 1SD images. The requirements computation program requires the use of the O&ST and variance of order and ship time (VOO) from each applicable source of supply. Since the 1988 O&ST and VOO values at Syracuse were unable to be reconstructed, the values listed on Syracuse's Q05/GV871 dated 28 June 1991 were substituted (45). This substitution does not affect the comparison of the SPARES and NASSL forecast methodologies since each forecast will be constructed using identical O&ST and VOO values. The SAS programs were based on procedures and formulas contained in AFM 67-1, Vol II, Part Two, and AFLMC reports; therefore, minimal limitation on the validity of the comparison between the SPARES and NASSL forecasting methodologies is expected, but must be addressed by the reader. Further discussion of the R65/GV910 DIREPs and the SAS programs written to simulate SBSS processing will be deferred to discussion of data analysis and findings in Chapter 4.

Data Collection. The majority of data used in this research was compiled by the AFLMC and provided on two magnetic tapes and seven floppy disks. The magnetic tapes contained "complete item, detail, and repair cycle records" for the Syracuse supply account as of June 1989 and June 1990 (42). The detail and repair cycle records were not used in this research. In addition, the tapes included 1SD images containing "mission change data indicating the demand rates for F-16 items at Syracuse as of June 1990" (42). The set of floppy disks contained the MCD from the five source bases supporting the F-16A/B activation at Syracuse and the 216 detail records established as a result of the SPARES forecast (42). Additional diskettes containing MCD other than that of the five source bases were also provided by the AFLMC.

The AFLC F-16A/B NASSL monitor provided a floppy diskette containing a list of the items included in the F-16A/B NASSL as of 16 May 1991. The ANG Bureau furnished floppy diskettes containing data generated in support of other SPARES forecasts developed to support the activations of weapon systems at different locations. In addition, the ANG Bureau provided, in listing format, the D165A-MICAP History of all cause code A and B MICAP incidents relating to the F-16A/B weapon system at Syracuse between October 1988 and October 1990. Cause codes indicate the reason why the MICAP incident occurred. Cause code A is assigned when the incident is the first demand ever placed for that specific item. Cause code B identifies items that were previously demanded but not in sufficient quantities to establish a demand level prior to the MICAP incident (19:17-51). Pertinent data from this listing was transcribed and recorded in a ASCII text file. The final data set included the MCD as of 16 July 1991 from the 2750ABW supply account supporting AFRES F-16A aircraft at Wright-Patterson AFB OH.

After the magnetic tape, floppy diskettes, and other files were received from the sources, the data were loaded onto the AFIT VAX mainframe computer. Once loaded, samples of the data were transferred to a personal MS-DOS computer and compared to supply item and detail record formats provided by the AFLMC to check for structure integrity. Appendices D through I contain samples of the data and the related record formats. After the compatibility of the data formats and the supply record formats was verified, various SAS programs were written to research the investigative issues. All SAS programs used in this research were written by the researcher.

The MCD on the floppy disks were used for two purposes. First, the MCD was used to develop a forecast using NASSL procedures as described in AFM 67-1, Vol II, Part Two. The MCD was also used to develop additional SPARES forecasts using different PFD thresholds to determine the impact of PFD on forecast performance.

Research Plan

The following investigative issues were examined and measured in the manner indicated based on the available data and the recommendations from the AFLMC:

1. Analyze the mission change data (MCD) collection process used to develop the SPARES forecast at Syracuse and other available MCD used to support more recent unit activations. SAS programs (Appendix J) were created to determine if MCD was collected on items prohibited from inclusion in a NASSL as prescribed by AFM 67-1, Vol I, Part One. Data file summaries were also reviewed to identify problems within the MCD

collection that could impact SPARES or NASSL performance. Telephone and personal interviews were conducted with AFLC, ANG Bureau, Syracuse ANGB, and the Standard Systems Center personnel to determine if any procedural or system problems impacted the MCD collection process for the Syracuse activation and other SPARES forecasts.

2. Identify the items forecasted by SPARES for the Syracuse activation and determine their extended dollar value. The floppy diskettes provided by the AFLMC contained the 216 detail records created by the SPARES program for Syracuse. Based on these records and the item record data file as of June 1989, a SAS program (see Appendix K) was created to determine the extended dollar value of the forecasted items. This program was also used to research investigative issues 2 - 6. The extended dollar value was determined by multiplying the demand level by the unit price on the item record data file for each item record having a 216 detail record on file. In the situation where a 216 detail record was recorded against an interchangeable item in an I&SG, the demand level of the group's master item was used to determine the extended dollar value. In addition, the program consolidated demand data and 216 detail records for all master or interchangeable against the group's master item. In effect, this treated multiple items in I&SG as a single item since a demand for a master or interchangeable item in a group would automatically be satisfied by any master or interchangeable asset on hand. For example, if an I&SG had five item records, one coded as the master and the others as interchangeable, and one 216 record was on file for the master item, then a demand placed against any of the group's items would be considered a demand against the 216 record. In

this case, the SPARES forecast, as indicated by the 216 record, would be considered to have accurately forecasted the demand.

To verify these figures, a SPARES forecast was developed using the probability of future demand factor .20, as used in the Syracuse activation (1), and the MCD from the five source bases.

3. Identify the items forecasted by SPARES which were subsequently demanded at Syracuse and determine their extended dollar value. The MCD from Syracuse was used to determine those items having demands that were recorded with a SRD related to the support of the F-16A/B aircraft. The extended dollar value and the forecasted items were determined in similar fashion as described above in issue 2. In addition, the five demand periods for each item in the master data set were summed to indicate the number of demands placed against the item during the entire demand period (August 1988 - June 1990). This demand summation was used to develop a separate forecast accuracy measurement to take into consideration all items demanded, regardless if MCD at Syracuse was established or not.

4. Identify the items forecasted by SPARES which were not subsequently demanded at Syracuse and determine their extended dollar value. The SAS program identified items having 216 detail records without a corresponding 1SD image or a recorded demand during any of the demand periods. The extended dollar value of items selected was determined as previously described.

5. Identify the items demanded at Syracuse which were not forecasted by SPARES. The SAS program identified those items having a 1SD image on file without a corresponding 216 record. Those items

selected represent the items that the SPARES program failed to forecast yet were needed to support the activation at Syracuse.

6. Determine the SPARES forecast accuracy at Syracuse by dividing the number of items forecasted and demanded, as determined in issue 3, by the total number of items demanded. The forecast accuracy was determined by dividing the number of forecasted and subsequently demanded items, as determined in issue 3, by the number of items having 1SD images, which is the sum of issues 3 and 5. An additional forecast accuracy measurement was calculated based on the presence of demands in any of the demand periods.

7. Analyze the impact of Interchangeable and Substitute Group (I&SG) items on the SPARES forecast accuracy at Syracuse. A SAS program (see Appendix L) was written to determine forecast accuracy without regard to I&SG assignment and followed similar logic as described in issues 2 - 6.

8. Using identical MCD, develop a NASSL forecast in accordance with AFM 67-1, Vol II, Part Two, procedures and SPARES forecasts with multiple probability of future demand factors and compare the accuracy of each forecast, based upon the demands generated at Syracuse. The MCD used to develop the SPARES forecast at Syracuse was used to develop a NASSL forecast in accordance with AFM 67-1, Vol II, Part Two, procedures. A SAS program (see Appendix M) was written to determine the same performance measures for the NASSL forecast as was accomplished for the SPARES forecast. Additional SPARES forecasts were generated using the MCD from the five source bases but with different PFD factors. These forecasts were uploaded to the VAX mainframe computer and a

comparison of each model's forecast accuracy was conducted to determine which model achieved the highest forecast accuracy and at what inventory investment cost.

9. Analyze the characteristics of items forecasted by SPARES and determine model tendencies. The MCD used in the SPARES forecast and the subsequent 216 detail records were analyzed to determine common characteristics between the items forecasted. SAS programs (see Appendix N) were written to determine the relationship between levels established by SPARES and the commonality of item usage and demand rates among the five source bases.

10. Verify procedures provided by the SPARES Users Guide for the collection and processing of demand data to generate the SPARES forecast. Interviews were conducted with ANG Bureau personnel to determine if the procedures in the SPARES User's Guide provided sufficient instructions and explanation for program operation.

Summary

This chapter discussed the availability and manipulation of data to answer the investigative issues. The limitations and assumptions of this research were specified, and steps in resolving research issues were depicted. The next chapter will focus on the analysis of the available data and the performance of the SPARES and NASSL models.

IV. Data Analysis and Findings

Introduction

This chapter provides the analysis of the MCD and other related data applicable to the activation at Syracuse, the SPARES forecast used to support the activation at Syracuse, and the SPARES forecast development process. Findings based on this analysis are also provided. Presentation of analysis and findings will follow the sequence of investigative issues as presented in Chapter 1. First, a summary of data contained in the core data files used in this research is provided.

Core Data File Summary

SAS programs (see Appendix O) were written to determine the number of records in the core data files used in this research.

Item Record Data Files.

Table 15 shows the distribution of item records (IR) across ERRCD categories from the Syracuse item record data files dated June 1989 and June 1990 and provides summary totals for each file.

Table 15

Syracuse Item Record Data

ERRCD	As of June 1989	As of June 1990
XB3	16372	15862
XF3	868	846
XD2	2286	2352
	-----	-----
Total IR	19526	19060

Table 16

Source Base MCD Files

	McConnell (8057)	Tucson (8064)	Jackson-ville (8050)	Great Falls (8057)	Burlington (8057)	Total Records
ERRCD						
XB3	1517	2477	3084	2300	2211	11589
XF3	79	110	77	0	83	349
XD2	274	393	366	0	274	1307
	-----	-----	-----	-----	-----	------
Total IR	1870	2980	3527	2300	2568	13245
(Dupe IR)	(320)	(480)	(333)	(110)	(272)	(1515)
	-----	-----	-----	-----	-----	------
Total 1SD Images	2190	3460	3860	2410	2840	14760

Mission Change Data (MCD) Files from the Five Source Bases.

Table 16 shows the number of item records with 1SD images in the MCD files from each of the five source bases. The number in parentheses below each base's name is the Julian Date on which the 1SD images were compiled. The number in parentheses below the Total IR figure represents the number of duplicate 1SD images. Duplicate 1SD images result from demands placed for the same item record but recorded against different SRDs. For example, parts common between aircraft models, such as the F-16A and F-16B, will have duplicate 1SD images if demands are placed for the part and recorded against each model's SRD.

The 14,760 1SD images were recorded against nine different SRDs. The SRDs and applicable weapon system were

A16 - F-16A Model Aircraft
A3Z - F-16B Model Aircraft
X16 - F100-PW-200 Engine
GSW - F-16 AIS RF Test Station
RY6 - PW100-200 Engine Module Augmentor
GSY - F-16 AIS DI Test Station
GZG - ALM 998 Test Set Programmer
GSV - F-16 Engine Test Stand
GSX - F-16 AIS PP Test Station (16)

Table 17

Distribution of 1SD Images by SRD

SRD	McConnell	Tucson	Jackson-ville	Great Falls	Burlington	Total Images
A16	1393	1906	3145	2270	2067	10781
A3Z	411	754	0	0	139	1304
X16	183	603	529	140	528	1983
GSV	7	35	24	0	27	93
GSW	76	0	39	0	23	138
GSX	38	60	66	0	18	182
GSY	19	32	0	0	22	73
GZG	0	70	57	0	16	143
RY6	63	0	0	0	0	63
-----	-----	-----	-----	-----	-----	------
Total 1SD Images	2190	3460	3860	2410	2840	14760

Table 17 depicts the distribution of 1SD images by SRD across the five source bases. Note in Tables 16 and 17 the wide disparity in the number of 1SD images at each base as recorded across ERRCD categories and individual SRDs. Jacksonville had the most 1SD images, 3,860, while McConnell, even though having the most aircraft, had only 2,190, a difference of 1,670. This issue relates to the use of MCD from five similar-size bases and the question of what constitutes a similar-size base. The 1SD images from some bases, most notably Great Falls, were lumped against a specific ERRCD or in some cases a specific SRD. Further discussion of these and related issues will be deferred to the analysis and findings of the specific investigative issues.

<u>Mission Change Special Level Detail (216) Record Data File</u>.

The data file of Mission Change Special Level Detail (216) records contained 4,805 images, with 26 being duplicated against the same item record. Of the 4,779 images against individual item records, 4,180 were for XB3 coded items, 121 for XF3, and 478 for XD2. An analysis of the images revealed the 1XT434 upload program was processed on the 8239 day, 175 days after the last data file of 1SD images was processed at a source base (Tucson). As discussed in Chapter 2, the MCD collection/consolidation process must be accomplished within 9 days or else the 1XT434 program will reject the upload attempt. Due to an existing DIREP on the 1XT434 program, validation of the nine day restriction could not be accomplished (37). The impact of the delay in processing the 1XT434 program will be discussed in the data analysis and findings section of this chapter.

The detail level effective was 8239; therefore, requisitioning action for the forecasted items occurred immediately following 1XT434 processing. The mission support effective date was 89212. Recall from earlier discussions that this date represents the date the last weapon system is scheduled to arrive at the activating unit and begins the gradual, lessening effect of the MCDDR and MCDDFR on computed stock levels. Telephone interviews with Syracuse personnel revealed the first F-16 was received in November 1988 and the last aircraft arrived in March 1989, approximately four months before the mission support effective date (22). Discussions with ANG Bureau personnel revealed that exact dates of aircraft arrival are difficult to project and are subject to change. Therefore, the mission support effective date is set far enough in advance to ensure adequate support for all arriving weapon systems (21).

Syracuse Mission Change Data (MCD) File.

The MCD file from Syracuse contained demand data against 2,828 item records, with 206 duplicate images present. Demands were recorded against 2,189 XB3, 93 XF3, and 340 XD2 coded items. The MCD file contained data against only three SRDs - A16, A3Z, and X16. Recall from Table 17 that nine SRDs were used to develop the SPARES forecast. To obtain a true performance level of the forecast, demand data from all SRDs involved in the initial forecast development should be reviewed. The time lapse gap between actual forecast implementation and this study precludes capturing demand data against the missing SRDs. However, to obtain a valid performance measurement, an additional SPARES forecast was developed using only the MCD for the A16, A3Z, and X16 SRDs from the original five source bases. This forecast was then compared against the available MCD from Syracuse.

ALC F-16A/B NASSL Data File.

The data file of the ALC F-16A/B NASSL contained 4,517 images. Of these, 4,446 were common to the other data files used in this research. The 4,446 images were recorded against 3,869 XB3, 117 XF3, and 460 XD2 coded items. The ALC NASSLs supporting the other SRDs involved in this research were unavailable.

D165A-MICAP History File.

The D165A-MICAP History file contained 642 observations against 398 separate item records. These cause code A and B MICAP incidents were recorded against 283 XB3, 68 XF3, and 47 XD2 coded items.

Analysis and Findings of Investigative Issues

Investigative Issue 1.

Analyze the mission change data (MCD) collection process used to develop the SPARES forecast at Syracuse and other available MCD used to support more recent unit activations.

The basic premise of the SPARES forecasting algorithm is MCD from five similar-size source bases can be used effectively to forecast the probability of future demand for items at a sixth base (41:i). As noted earlier, wide disparities in the number and type of MCD 1SD images used in the Syracuse activation indicate that simply using the number of aircraft as the sole criteria for determining similar-size units may not be the most accurate measure. Wide disparities such as these could severely impact the performance of any forecast methodology. Figure 10 depicts the 1SD images from the five source bases and the resulting 216 detail records established at Syracuse. Although the number of aircraft possessed at the six units were similar except for McConnell, the breakdown of 1SD images and 216 records reveals varying demand patterns which can be attributed to several factors.

First, although five bases may have similar numbers of aircraft, mission profiles may affect demand rates. Of the five source bases, Jacksonville, Burlington, and Great Falls had primarily an air defense role and Tucson and McConnell had extensive training missions (21). The mission of the 174TFW at Syracuse is primarily an air-to-ground role (21). Since the missions differ, the aircraft are also configured differently. Based on the mission, systems on board are subject to

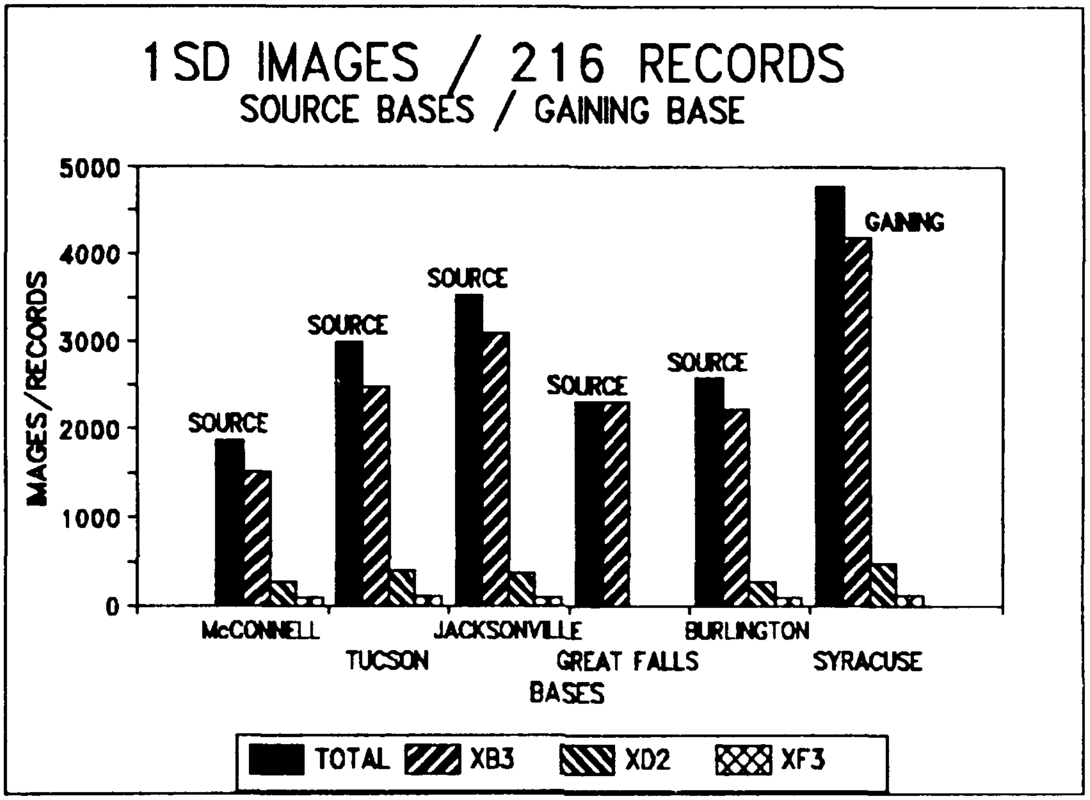

Figure 10. 1SD Images and 216 Detail Records

varying usage and subsequent failure rates, therefore causing different maintenance and demand patterns (26).

To support the different maintenance patterns, different maintenance concepts (either remove and replace (RR) or remove, repair and replace (RRR)) are developed to meet the requirements. In addition, test station equipment needed to support the maintenance concept must also be acquired and supported. These concepts and support equipment requirements cause demand patterns to vary since demands for repair parts at a RRR maintenance organization would not occur at bases operating on a RR basis (26). Table 17 showed that Great Falls did not have any 1SD images other than those directly related to the F-16A aircraft and engine SRD. Due to the time lapse involved in this study, a determination could not be made as to the actual cause of the "0" totals. Possible causes are that the related SRDs were left off the R37/GV910 program parameter image used to download the MCD or the maintenance concept in place did not require the related support equipment. Regardless of the reason, the absence of demand data would have the effect of underestimating requirements since the SPARES algorithm divides total demands by five, regardless if a source base reports usage or not. A recent activation of 6 KC-135R at Milwaukee ANGB highlights the impact of aircraft configuration and maintenance concepts on MCD.

Initially, over 1,000 line items were included in a SPARES generated forecast to support the activation (36). The forecast included both airframe and engine parts for the KC-135R. Since the unit was already supporting the KC-135A aircraft and the airframes of the two systems are almost identical, the forecast included many airframe parts that were already part of the Milwaukee inventory. In addition, two of the source bases providing the MCD had engine overhaul operations which would not be in place at Milwaukee. After screening the recommended SPARES forecast and removing unrequired items, less than 200 line items remained (36). Without this manual review, hundreds of spares and repair parts would have been procured to support the activation.

Unfortunately, manual review of the MCD is also required to detect system problems within the MCD collection process. As discussed in Chapter 2, Loden's analysis of MCD revealed two areas of concern in the recording of demand data at base level - system program problems and personnel error (28:17). Figure 10 graphically showed the distribution of the 1SD images between the source bases among ERRCD categories and potential problems in the recording of MCD. One obvious concern is the lack of 1SD images for XF3 and XD2 coded items at Great Falls. At the time of the Syracuse activation, a DIREP existed on the D13/GV833, Daily SRD Update Program. The program was by-passing "a majority of repair cycle turn-ins" (25) which is the triggering action for the SBSS to record demands for reparable items (19:19-69). Once again, regardless of the problem's cause, the effect of "0" data is to underestimate requirements and risk inoperable/grounded weapon systems.

Loden attributed the majority of errors for consumable items to erroneous processing of bench stock and the misuse of SRDs on recording demands (28:23). Again due to the time lapse, bench stock records from the five source bases were unavailable to determine if a problem in this area existed. However, Figure 10 raises concerns as to how bench stocks were aligned and coded at the source bases. Recall from earlier discussions that the mission at Jacksonville was a typical F-16A/B air defense role with typical maintenance requirements. However, as Figure 10 indicates, Jacksonville had the most XB3 coded items of any source base, almost 700 more than the next highest unit and almost 2,000 more than the unit having the least amount of XB3 items, McConnell. McConnell, as discussed earlier, had more aircraft and a different mission than the majority of other source bases. Although definitive findings cannot be reached without hard data, the wide disparity in the available figures indicate probable errors in the recording of bench stock demands which in turn would affect the SPARES forecast at Syracuse.

Loden also reported that errors in the MCD collection process also occurred because of improper use of SRDs by supply and maintenance technicians on demand transactions (28:23). A review of the data files revealed the existence of several 1SD images and 216 detail records against items, such as plastic bags, rubber bands, and common flashlight batteries, that in most likelihood are not part of the airframe structure, engines, or related support equipment. The question must arise as to how such items appear on MCD lists, which are used not only to develop NASSLs, but are also a critical decision tool in computing wartime requirements.

Simply stated, the system will record any issue transaction against any weapon system SRD as long as the SRD is loaded in the base constant records, even if the item is excluded from NASSL consideration. Currently, the SBSS has no automatic quality control checks to verify that the item demanded is actually a part of the weapon system represented by the SRD. MAJCOM reviews of recent MCD listings have revealed instances of items specific to one weapon system, for example the KC-135A, appearing on MCD lists for other systems, such as the A-10 (21). In other instances, items excluded by supply policy from NASSL consideration often appear in the MCD files and 216 records. Table 18 summarizes the distribution of items from the core data files requiring special requisitioning procedures or possessing an excluded FSG, FSC, shelf life code (SLC), or acquisition advice code (AAC). Appendix C contains a description for each of the exclusions.

Although the reasons for exclusion for some of these items are obvious (medical supplies, clothing, ammunition), others are less clear and, when consumption rates are considered, seem unwarranted. For example, of the 266 FSC/FSG excluded items in the core data files, 189 (71 percent) had 216 detail records established indicating the items were stocked at Syracuse. Each of the other core data files, except for the ALC F-16 NASSL file, had varying amounts of records (43 - 154) established for the excluded items. These numbers clearly indicate that some of the excluded items are common usage at base level accounts. In particular, FSG 80 (Sealers and Adhesives, Brushes, Paints) (20:41) had 182 records established, four of which included cause code A and B MICAP incidents for sealants used on the F-16A/B aircraft.

Table 18

Items Excluded from NASSL Consideration

Exclusion	Items	Exclusion	Items	Exclusion	Items	Exclusion	Items
FSC 5345	2	FSG 65	13	FSG 85	5	SLC F	1
FSC 5350	14	FSG 71	0	FSG 87	0	SLC G	1
FSC 9910	0	FSG 72	1	FSG 88	0	SLC H	2
FSC 9915	0	FSG 76	0	FSG 89	0	SLC J	0
FSC 9920	0	FSG 77	0	FSG 94	0	SLC K	1
FSC 9930	0	FSG 78	0	SLC 1	0	AAC M	1
FSG 13	1	FSG 79	34	SLC 2	13	AAC T	0
FSG 35	0	FSG 80	182	SLC 3	12	AAC V	180
FSG 37	0	FSG 83	13	SLC 4	58	AAC X	2
FSG 55	1	FSG 84	0	SLC 5	10	AAC Y	17
				SLC A-E	0	*AAC Z	83

* AAC Z is the only AAC excluded by supply policy from NASSL consideration; however, the others listed warrant the attention of supply managers due to requisitioning restrictions.

FSG 80 items are characteristic of common shop-use items already stocked at bases regardless of weapon system supported (35). In cases where these items are already stocked at an activating base, the 216 detail record would increase stock levels because of the effect of adding the MCDDR to existing demand rates (44:15). However, the increased stock levels generated as a result of the MCDDR are temporary because the 216 detail record remains in effect for only one year following the mission support effective date. In fact, the increased stock levels may remain unchanged even after one year passes because of increases in demands. Arbitrary exclusion of entire groups and classes of items simply based on FSC or FSG simply to avoid the possibility of temporary increased stock levels could impact weapon system operations and seems unwarranted. The exclusion of items with less than 18 months of shelf life also seems inappropriate.

The review of the core data files revealed that 98 items were assigned an excluded shelf life code. Of the 98 items, 90 had 216 detail records established. Since the SBSS requirements computation program considers the item's shelf life code when establishing the requisition objective (RO) and reorder quantities, exclusions to prevent possible expiration of shelf life is unwarranted. The RECOMP sets the RO to no more than one half the value of the expected demands during the shelf life period of the item (19:19-30-31). For example, if an item with a shelf life of 90 days had a demand rate of one unit per day, the RO would be set at 45 (90 x .5 x 1 = 45), ensuring a constant turnover of stock if demand rates remain the same.

The final category of excluded items was those possessing AAC Z, signifying the item was an insurance type item requiring special inventory management specialist (IMS) requisitioning procedures. A review of the core data files revealed 83 items with an AAC Z assigned. Most of these items were low cost, XB3 coded items and sourced at DLA depots which raised question to the validity of the code's assignment. Insurance items are typically thought of as high cost, low demand structural type items, "centrally managed, stocked, and issued" (17:1-292). By definition, they are required "occasionally or intermittently" with a "nominal quantity of material stocked due to the essentiality or the lead time of the items" (17:1-292). Discussions with the AFLC ISSL/NASSL Program Manager revealed that DLA uses a more "marketing perspective" to base AAC Z assignment (35). Because of the dissimilarities between definitions, the ability and overall purpose to restrict all AAC Z items is questionable and requires review.

Additional AACs were selected due to the special requisitioning procedures they entailed. Table 18 shows that 180 items were coded with an AAC V which indicates the item is presently "in stock; but future procurement is not authorized" (17:1-291). Normally, a replacement stock number is provided through the SNUD system and is identified in the nomenclature field with a message similar to "When Exhausted Use (NSN)" (17:1-291). Seventeen items were coded with AAC V indicating a "Terminal Item" with no future procurement authorized or existing stock available (17:1-291). Each of these AAC will eventually generate cancellations from the sources of supply creating additional workload on base supply stock control personnel. This workload will occur only after the 216 detail records are established at the activating base, because the 1SD images for the source bases or from the SPARES or NASSL forecast do not include the AAC.

A review of a more current MCD file revealed a significant program logic error in recording MCD for potentially inactive XB3 items. A SAS program (see Appendix P) was written to analyze the contents of a recent MCD file supporting F-16A aircraft. The file contained 3,318 images for XB3 items, 940 (28 percent) of which were assigned SPC 5. Based on current SBSS logic, SPC 5 coded items may have demand levels established, but no stock replenishment requisitioning will take place (19:19-40), since SPC 5 identifies potentially inactive items. Of those records with SPC 5, 266 had a DDFR of .0000, even though the DDR had a positive value. Since SPARES logic determines the probability of future demand based solely on the DDR, subsequent forecasts would in some cases recommend stocking potentially inactive items. The AFM 67-1 NASSL program would also be affected because a segment of the EOQ Hybrid Range Model is only sensitive to the DDR and not the DDFR (19:19-89). The following discussion of the SBSS requirements computation program logic demonstrates how SPC 5 are established and how a ".0000" DDFR condition could occur.

Recall from earlier discussions in Chapter 2 that the SPC is determined by the item's priority when a backorder is placed. As time goes by without further demand for the item, the SPC is decreased. For example, the SPC for a MICAP XB3 item would initially be 1. If no other demands for the item were recorded, the SPC would eventually migrate to 5 and would remain there until a demand was recorded or the item is deleted from the base supply account (19:19-39-40). The SPC migration process in this example would take 15 months to occur, and an additional 24 months would pass before the item would be subject to program deletion (19:19-39-40). During the first 18 months of period, the initial demand moves through the three demand periods (CPD, 1P6MPD, 2P6MPD) until finally the demand periods are zeroed and the DDFR becomes ".0000". However, due to program logic, the CRD is not zeroed out until the entire 39 month migration process is complete, thereby, allowing a DDR to be computed 21 months after the DDFR is blanked. The effect of the SPC 5 and ".0000" DDFR condition on the forecasting process, regardless of what program is used to actually develop the forecast, is the purchase and stocking of potentially inactive items at the gaining bases.

In summary, the MCD collection process in place during the Syracuse activation, as well as today, was and still is susceptible to error. The errors as well as the causes for the errors have been well documented in past research as well as the present study. Until some form of automated coding system as recommended by Blazer is developed to allow identification of specific items to specific weapon systems, the problem of faulty MCD will continue to exist. Not only will faulty MCD exist, but it will also potentially grow as more customers gain direct access to the SBSS to order supplies.

Fortunately, the problems presented affect only a relatively small portion of the entire MCD collection process. However, as manning documents shrink and the time available for manually scrubbing MCD becomes less and less, the need for a reliable and accurate MCD collection system will become more and more important (26). Without such a system, activations will continue to be supported with less than optimum demand data and subsequent shortfalls or excesses in the amount of spares and repair parts. These potential shortfalls and excesses are reflected in the fill rates achieved at the activating units - the topic of the next several investigative issues.

Investigative Issue 2.

Identify the items forecasted by SPARES for the Syracuse activation and determine their extended dollar value.

Table 19 shows the findings as provided by the SPARES forecast and the SAS programs. At quick glance, differences are apparent between ERRCD categories and total summaries of items actually forecasted by SPARES and those that were loaded in the Syracuse item and detail record files as of June 1989. The differences were previously cited as a limitation to this study. The SPARES forecast represents a forecast without any type of external manipulation to add, delete or change any

Table 19

Items Forecasted
(Cost in $1,000)

ERRCD	SPARES Forecasted		Initial 216 Detail Records		216 Records As of June 1989	
Category	Items	Cost	Items	Cost	Items	Cost
XB3	4260	301	4180	N/A	4114	335
XF3	119	160	121	N/A	114	154
XD2	504	7176	478	N/A	443	6650
Totals	4883	7637	4779	N/A	4671	$7139

of the forecasted items before actual upload into the SBSS. Items not relating to the weapon system being activated should be deleted before upload. In this case, 78 of the 4,883 items forecasted by SPARES were not part of the actual upload. The remaining 26 items were cited earlier as having duplicate 216 detail records established.

A discrepancy of 108 records also exists between the number of item records in the 216 detail record data file and the results provided by the SAS program. Sixty-six of the records were part of an I&SG and were rolled up against one item record in the I&SG. For example, an I&SG with six members, three of which had 216 detail records assigned, would be tabulated as one item record having one 216 detail record assigned. The stock numbers for the 42 remaining records were not loaded in the June 1989 item record data file at Syracuse, indicating some form of item record change or deletion occurred between the time of original forecast and the date the June file was created. Again, due to the time lapse, no definitive reasons can be reached as to why these records were deleted. However, as previously discussed in the analysis of AACs, 197 items were assigned an AAC of V or Y, indicating the item was in a "terminal" procurement condition. Many of these items were candidates for deletion at the time of initial lo d at Syracuse, and, most likely, were deleted as SNUD provided replacement item records.

The figures relating to the 216 detail records on file at Syracuse as of June 1989 will be used to answer this investigative issue and provide the basis for subsequent measurement of the SPARES forecast performance.

Investigative Issues 3, 4, and 5.

Identify the items forecasted by SPARES which were subsequently demanded at Syracuse and determine their extended dollar value.

Identify the items forecasted by SPARES which were not subsequently demanded at Syracuse and determine their extended dollar value.

Identify the items demanded at Syracuse which were not forecasted by SPARES.

Table 20 shows the results of the analysis and findings related to these three investigative issues.

As noted previously, the demand data from Syracuse only reflected the demands against three SRDs - A16, A3Z, and X16. Because of SPARES program logic, all 216 detail records were marked only against the A16, although they were established based on all SRD demand data. This prevented a precise assessment of the items forecasted and subsequently demanded and those items that were demanded but not forecasted. For example, subsequent demands for an item forecasted as a result of 1SD images against GSX would be unidentifiable because the demand data for this particular SRD was not provided. However, these demands would be recorded in the number of demand (ND) reporting periods so a limited form of measurement does exists. The limitation results from the inability to verify if the demand was in actuality marked for the correct SRD.

Because of these issues, two measurements were conducted providing both a conservative and liberal assessment of these investigative issues. The conservative approach measured demands as indicated by the available but limited demand data for the three SRDs. A more robust

Table 20

Items Forecasted and Demanded
(Cost in $1,000)

	ERRCD Category	Based on MCD: Line Items Forecasted And Demanded	Based on MCD: Cost	All Recorded Demands: Line Items Forecasted And Demanded	All Recorded Demands: Cost
Issue 3					
Forecasted Items With Subsequent Demands	XB3	1667	192	2840	277
	XF3	38	37	44	41
	XD2	193	4588	228	4977
	Total	1898	4817	3112	5295

	ERRCD Category	Based on MCD: Line Items Forecasted Not Demanded	Based on MCD: Cost	All Recorded Demands: Line Items Forecasted Not Demanded	All Recorded Demands: Cost
Issue 4					
Forecasted Items With No Subsequent Demands	XB3	2446	144	1273	58
	XF3	76	118	70	113
	XD2	246	2020	211	1632
	Total	2768	2282	1554	1803

	ERRCD Category	Based on MCD: Line Items Demanded Not Forecasted	Based on MCD: Cost	All Recorded Demands: Line Items Demanded Not Forecasted	All Recorded Demands: Cost
Issue 5					
Items Demanded But Not Forecasted	XB3	522	45	931	56
	XF3	53	14	62	16
	XD2	146	274	165	295
	Total	721	732	1158	367

measure took into account all recorded demands in the item record ND periods.

Investigative Issue 6.

Determine the SPARES forecast accuracy at Syracuse by dividing the number of items forecasted and demanded, as determined in issue 3, by the total number of items demanded.

Table 21 depicts the SPARES forecast performance using both the "MCD Only" and "All Recorded Demands" measurements. The fill rate percentage for both measurements are almost identical across ERRCD categories and overall totals. The SPARES model achieved an overall fill rate over 70 percent for both measurements. The overall fill rates

Table 21

SPARES Forecast Accuracy

Basis of Comparison	ERRCD Category	Line Items Forecasted Not Demanded Items (Pct)	Line Items Forecasted And Demanded Items (Pct)	Line Items Demanded Not Forecasted Items (Pct)	Fill Rate Pct
MCD Only	XB3	2446 (59)	1667 (41)	522 (24)	76
	XF3	76 (67)	38 (33)	53 (58)	42
	XD2	246 (56)	193 (44)	146 (43)	57
	Total	2768 (59)	1898 (41)	721 (28)	72
All Recorded Demands	XB3	1273 (31)	2840 (69)	931 (25)	75
	XF3	70 (61)	44 (39)	62 (58)	42
	XD2	211 (48)	228 (52)	165 (42)	58
	Total	1554 (33)	3112 (67)	1158 (27)	73

for both measurements were driven by a respective 76 and 75 percent fill rate in the XB3 item category, by far the category with the largest number of line items. In both measurements, the XF3 items achieved the lowest accuracy (42 percent). Items coded XD2 achieved fill rates of 57 and 58 percent. Based on these findings, the SPARES forecast did exceptionally well in predicting future demands for XB3 items, reasonably well for XD2 items, and fell short for XF3 items.

The only significant difference between the two measurements occurred in the percentage of "Line Items Forecasted Not Demanded" category. When "MCD Only" was considered, 59 percent of the overall forecasted items were not demanded. When "All Recorded Demands" was the measurement, this percentage dropped to 33 percent. Such a large drop was expected since the "MCD Only" criteria was based on MCD from only three SRDs. The "All Recorded Demands" measurement captured demands for all of the seven other SRDs (GSX, GSV, etc.) involved in the actual SPARES forecast. Figure 11 presents a graphical representation of how well the SPARES forecast performed.

An additional SPARES forecast using a PFD of 20 percent was developed substituting the MCD from McEntire ANGB for the data from Great Falls. This was done to analyze the impact of the "0" MCD from Great Falls for XF3 and XD2 items. Table 22 provides the forecast's performance.

The SPARES program forecasted 4,722 items, of which 4,032 were XB3, 135 XF3, and 555 XD2. Total cost for the forecast was $7.8 million. Because of this study's time differential, no external manipulation of the forecasted items was possible so, therefore, the items forecasted

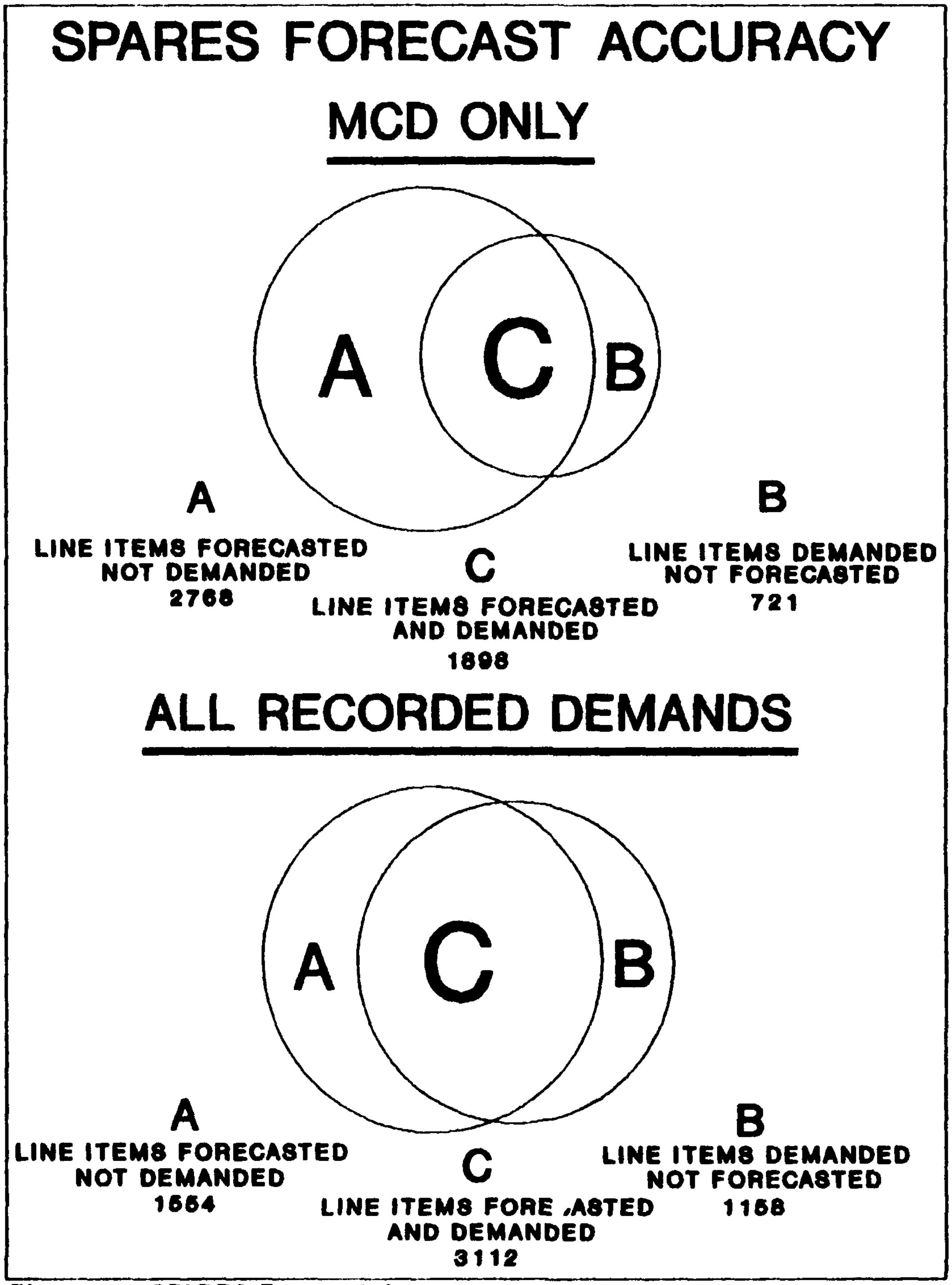

Figure 11. SPARES Forecast Accuracy

Table 22

SPARES Forecast Accuracy Using McEntire ANGB MCD

Basis of Comparison	ERRCD Category	Line Items Forecasted Not Demanded Items (Pct)	Line Items Forecasted And Demanded Items (Pct)	Line Items Demanded Not Forecasted Items (Pct)	Fill Rate Pct
MCD Only	XB3	2096 (56)	1625 (44)	564 (26)	74
	XF3	73 (65)	40 (35)	51 (56)	44
	XD2	249 (54)	210 (46)	129 (38)	62
	Total	2418 (56)	1875 (44)	744 (28)	72
All Recorded Demands	XB3	1012 (27)	2709 (73)	1062 (28)	72
	XF3	66 (58)	47 (42)	59 (56)	44
	XD2	209 (46)	250 (54)	143 (36)	64
	Total	1287 (30)	3006 (70)	1264 (30)	70

were assumed to be loaded at Syracuse. This assumption drove the "Line Items Forecasted Not Demanded" measurement to exceed the actual forecast using the original five source bases. However, in the other categories of primary concern (XF3 and XD2), the forecast using McEntire data performed slightly better then the original forecast in both MCD and demand comparisons. The fill rate percentage for XF3 items in both instances improved 2 percent and the XD2 rates improved 5 and 6 percent respectively. Although these improvements are slight and could possibly have occurred due to random chance, they do show that underestimation of requirements may occur if the forecast model is fed insufficient data.

Investigative Issue 7.

Analyze the impact of Interchangeable and Substitute Group (I&SG) items on the SPARES forecast accuracy at Syracuse.

Table 23 shows the results of measuring the forecast accuracy when demand data is not rolled for master and interchangeable coded items as was done for issues 2 - 6. The results should show similar fill rates for the "MCD Only" basis of comparison because program logic calls for both the 216 detail record and the MCD to be established against the master item. The "All Recorded Demands" comparison should reflect somewhat lower fill rates because demands are recorded against the actual item having the demand, not the group's master item. As it

Table 23

SPARES Forecast Accuracy Disregarding I&SG

Basis of Comparison	ERRCD Category	Line Items Forecasted Not Demanded Items (Pct)	Line Items Forecasted And Demanded Items (Pct)	Line Items Demanded Not Forecasted Items (Pct)	Fill Rate Pct
MCD Only	XB3	2509 (60)	1651 (40)	556 (25)	75
	XF3	78 (68)	37 (32)	71 (66)	34
	XD2	228 (56)	182 (44)	180 (50)	50
	Total	2815 (60)	1870 (40)	817 (30)	70
All Recorded Demands	XB3	1373 (33)	2787 (67)	1585 (36)	64
	XF3	70 (61)	45 (39)	110 (71)	29
	XD2	242 (51)	228 (49)	319 (58)	42
	Total	1685 (36)	3060 (64)	2014 (40)	60

turned out, the actual numbers agreed with the expected findings. The small increase in fill rate percentage (72 - 70) from issue 6 to issue 7 respectively is similar to the results reported by Reynolds in his assessment of the NASSL process (41:18). Because of system logic in recording demands, the fill rate for the "All Recorded Demands" comparison dropped 13 percent (73 - 60). Overall, these findings support Reynold's assessment that the I&SG system, although not perfect, has "negligible" impact on the performance of the SPARES forecast (41:18).

Investigative Issue 8.

Using identical MCD, develop a NASSL forecast in accordance with AFM 67-1, Vol II, Part Two, procedures and SPARES forecasts with multiple probability of future demand factors and compare the accuracy of each forecast, based upon the demands generated at Syracuse.

To develop a common ground of assessment for the two forecasting methodologies using actual demand data, the 1SD images for all SRDs except A16, A3Z, and X16 were removed from the MCD files from the five source bases before the forecasts were developed. Table 17 showed that 692 1SD images were recorded against SRDs that were not included in the Syracuse MCD core data file. By removing these 1SD images and then processing the remaining images through the forecasting programs, forecasts using common MCD data were generated and compared against common demand data.

An attempt was made to duplicate AFM 67-1, Vol II, Part Two, NASSL procedures using the Sperry 1100/60 computer at the Lowry Technical Training Center (LTTC). This system is identical to the system in use at operational supply accounts, and, under normal circumstances, would have produced the necessary products to accomplish comparison of forecasts. However, two problems in program processing prevented a NASSL forecast from being produced.

First, the R65/GV910 program which consolidates MCD from multiple sources had a DIREP which caused the program to truncate part of the 1SD image output (37). In February 1991, the 1SD image was expanded to 81 positions in length to accommodate the five position ordinal date (19:3-41; 19:19-201). However, the R65/GV910 program was not updated to incorporate the change. This DIREP is scheduled to be corrected in the 910901 program release from the Standard Systems Center (SSC) (37). In addition, documentation for program processing with multiple source bases was unclear, eventually forcing the Supply Systems Management Staff at Lowry to write a SURGE program (see Appendix Q) to replicate R65/GV910 processing. Once the SURGE program processed, the 1XT434 program was used to load the 1SD images and create the NASSL. A review of the output revealed additional problems relating to the database structure of the LTTC computer system. Since the system is used strictly for training supply system and inventory management apprentice airman, the core database records contained fictitious data elements (O&ST was zero for several common sources of supply) which are critical for accurate requirements computation processing. As a result of this, an actual NASSL forecast using standard supply programs and computer systems could not be obtained. However, a SAS program (see Appendix R) was developed to replicate R65/GV910 processing and requirements computation logic based on formulas and constraints contained in AFM 67-1, Vol II, Part Two, and AFLMC reports (19:19-51-59, 83-89; 38:39-40).

As the SAS program was being coded to include the four range criteria for XB3 items, a review of the 1SD images from the source bases revealed the image format did not contain a bench stock flag indicator. Recall from the literature review that items on bench stock meet one of the criteria to establish a demand level. Since the bench stock flag was unavailable on the 1SD as of August 1988, all XB3 items had to meet one of the three remaining EOQ stockage criteria in order to be forecasted by the NASSL process. In his study of the EOQ range criteria, Reynolds found that nine percent of the demand levels for EOQ items were established because of the bench stock criteria (19:10). This figure can be used as a conservative assessment of the underestimation in forecasting XB3 items by the NASSL process. A review of the 1SD images produced on 16 July 1991 at the 2750 ABW supply account revealed that 2787 of the 3326 (84 percent) of the XB3 items were coded with the bench stock flag. Since the bench stock records of the source bases during the time period in question were unavailable, a precise assessment of this issue was not possible. However, when looking at the percentages from the 2750ABW MCD, underestimation of XB3 requirements using NASSL procedures during this time period was likely to impact forecast performance.

Table 24 provides the results of the four separate forecasts. The SPARES forecast using a PFD of 20 percent achieved the highest total fill rate percentage (72) over all ERRCD categories but was also the

Table 24

SPARES and NASSL Forecast Comparison

Type of Forecast	ERRCD	Line Items Forecasted Not Demanded Items (Pct)	Line Items Forecasted And Demanded Items (Pct)	Line Items Demanded Not Forecasted Items (Pct)	Fill Rate Pct	Dollar Value (000)
20 PCT PFD	XB3	2384 (59)	1657 (41)	533 (24)	76	373
	XF3	68 (64)	38 (36)	53 (58)	42	160
	XD2	195 (51)	186 (49)	153 (45)	55	6561
	Total	2647 (58)	1881 (42)	739 (28)	72	7094
30 PCT PFD	XB3	1901 (55)	1574 (45)	616 (28)	72	349
	XF3	49 (60)	33 (40)	58 (64)	36	142
	XD2	138 (45)	169 (55)	170 (50)	50	6089
	Total	2088 (54)	1776 (46)	844 (32)	68	6580
40 PCT PFD	XB3	1412 (49)	1462 (51)	728 (33)	67	325
	XF3	40 (59)	28 (41)	63 (69)	31	137
	XD2	107 (40)	162 (60)	177 (52)	48	5937
	Total	1559 (49)	1652 (51)	968 (37)	63	6399
NASSL	XB3	1450 (54)	1252 (46)	937 (43)	57	311
	XF3	44 (66)	23 (34)	68 (75)	25	142
	XD2	138 (52)	129 (48)	210 (62)	38	6065
	Total	1632 (54)	1404 (46)	1215 (64)	54	6518

most expensive ($7094K). As the PFD drops, the overall fill rate drops as well as the inventory investment.

Figure 12 graphically shows the relationship between inventory investment, fill rates, and forecast methodology and the comparison of all four forecasts.

Fill rates for XB3 items were the driving factor in the overall fill rate of each model. The weakest performers were the XF3 and XD2 categories with fill rates consistent with those described in issue 6. These results also follow closely the findings reported by Reynolds and discussed in depth in Chapter 2 of this research. Based on his

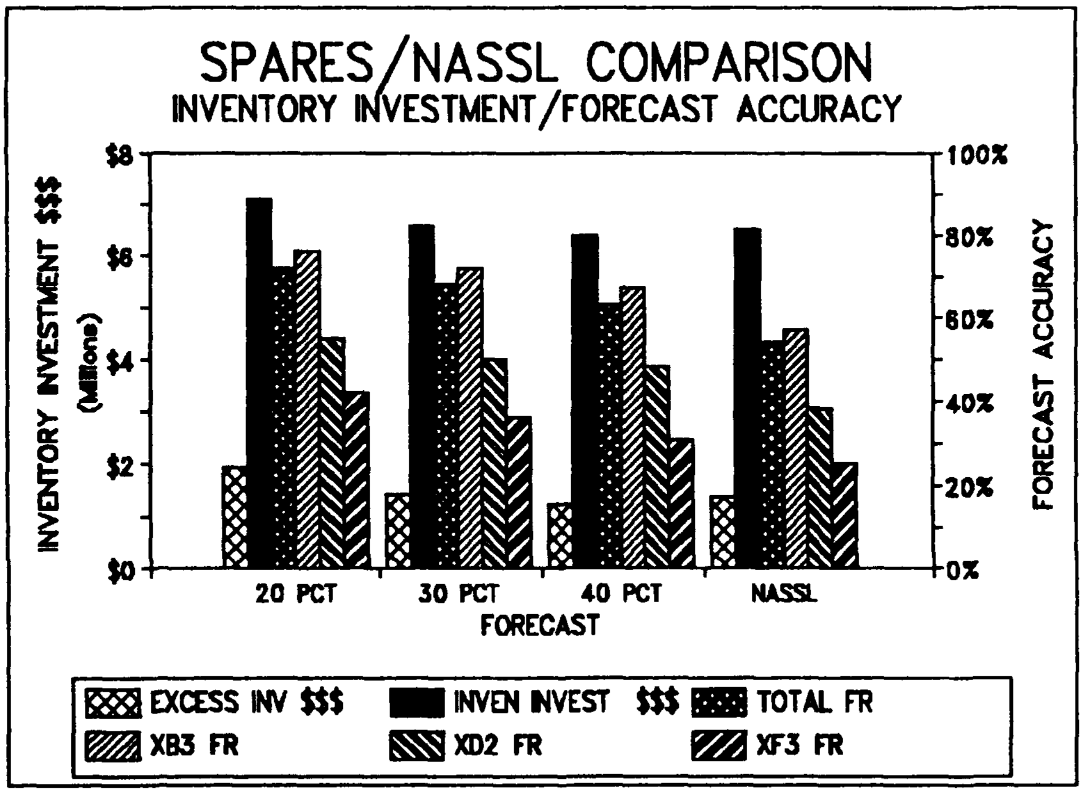

Figure 12. SPARES/NASSL Forecast Comparison

simulation results, Reynolds expected the SPARES model to attain fill rates of 61 to 65 percent over the course of a one year period. Figure 13 shows the actual SPARES forecast accuracy based on the present study of the activation at Syracuse and extends the demand period an additional 11 months. This extension explains the higher overall fill rate of 72 percent. A snapshot of SPARES performance at the one year point (3/89-9/89) shows the fill rate (.63) at Syracuse hit the expected performance exactly.

A 12 to 13 percent difference did occur between the two studies across each of the ERRCD categories. The Syracuse forecast performed better for XB3 items (76 to 64 percent) but did not meet the expected

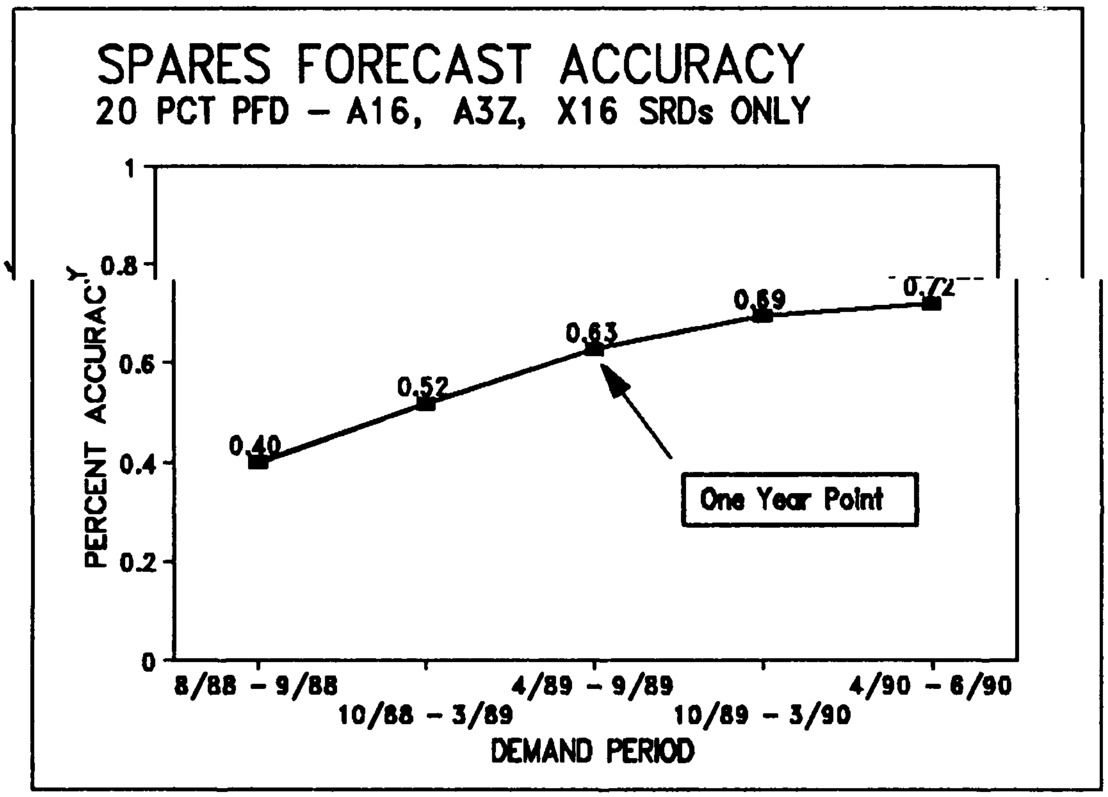

Figure 13. SPARES Forecast Accuracy Performance

fill rates for XF3 and XD2 items (42 to 54 and 55 to 68 percent respectively). One reason for the drop in XF3/XD2 performance can be attributed to the "0" MCD for these items in the Great Falls data file. Additional analysis of why these differences occurred was beyond the scope of the present study, but deserves attention in future research.

Almost all of the accuracy measurements from the NASSL forecast were below the SPARES forecasts, regardless of which PFD factor was used. The only measurement which the NASSL forecast outperformed SPARES was in the "Line Items Forecasted Not Demanded" category, but only when compared to the 20 percent PFD factor forecast. In this instance, the NASSL forecast did slightly better (54 to 58 percent) in stocking material that was not used. Overall, the NASSL forecast accuracy was at least 9 percentage points below the SPARES forecast when total fill rates were considered.

Based on these findings, SPARES provides the supply manager with options as to how to structure the inventory for the activating system. In the past, supply managers were primarily concerned with fill rates and the dollar value of XB3 and XF3 inventory since funding for these items came out of the Air Force stock fund and the customer bought these items out of their operational and maintenance (O&M) funds (41:33). Since stock funding of XD2 items is scheduled to commence on 1 October 1992, managers must focus attention on all categories of items, especially XD2, and look at inventory investment as well as fill rates (13:1-2). Of the 7 million dollar inventory established by SPARES for Syracuse, 6.5 million (92 percent) fell in the XD2 category. Therefore, when comparing forecast performance, managers must determine if generated fill rates are compatible with the amount of inventory investment necessary to attain those fill rates. The SPARES methodology allows the manager to use different PFD factors to examine available options to balance both mission requirements and inventory investment.

Investigative Issue 9.

Analyze the characteristics of items forecasted by SPARES and determine model tendencies.

The program coding was not available to assess how the SPARES program arrived at the probability of future demand for the items forecasted. Because of this, the analysis of this investigative issue was limited to the demand characteristics of the 1SD images from the five source bases and the items demanded at Syracuse as reflected in the Syracuse MCD file. Only the SRDs relating to the F-16A/B airframe and engines were part of this analysis.

As determined by the SAS programs, there were 14,068 individual 1SD images recorded against 6,366 item records among all five source bases. Table 25 shows a complete summary of the demand data relating to the Syracuse activation and depicts obvious trends in how the current SPARES program logic forecasts items.

Overall, only 267 item records had 1SD images common to all five bases. The 3,256 items common to only one base represented over half of the total 1SD images from all five source bases. By focusing attention on the "Items Forecasted by SPARES" categories, it becomes obvious the current SPARES logic follows a commonality approach in forecasting requirements. The SPARES program recommended to stock all items common to both four or five of the source bases, regardless of PFD. Items

Table 25

Summary of Demand Data for the Syracuse Activation

Bases With Common Images	Number of Source Base 1SD Images	Items Forecasted By SPARES			Items Demanded With Syracuse
		20 PCT PFD	30 PCT PFD	40 PCT PFD	
0	0	0	0	0	631
1	3256	1653	941	235	431
2	1179	1176	1176	1174	392
3	916	914	914	914	453
4	748	748	748	748	493
5	267	267	267	267	222
	----	----	----	----	----
Total Items	6366	4758	4046	3338	2622

common to two or three bases almost reached unanimity as well. The only category where the program showed some delineation between PFD factors was where the items were common to just one base. In this case, over half the items were recommended for stockage when a PFD of 20 was used. Lower percentages were realized when lower PFDs were used.

The SAS programs consolidated all demand data from the source bases and calculated an annual demand rate (ADR) in units ordered as well as the annual demand frequency rate (ADFR) depicting the annual customer requests. The program also sorted the data by both the ADR and ADFR. These sorts were used to determine the demands necessary to meet the SPARES PFD threshold.

Based upon the SPARES forecast using MCD from the source bases provided for this study, the minimum ADR for an item to be recommended for stockage was 1.825. Again, this represents demand for less than two units across five source bases. The corresponding ADFR for this item was 1.533. The minimum ADFR for an item to be stocked was 1.2775 with a corresponding ADR of 13.870. Al_nough these were the minimum standards, numerous forecasteu items with similar small demand rates were identified. Nearly 700 items had an ADFR equating to less than two demands per year. Over 900 items had ADRs of less than five units per year.

These findings indicate the SPARES program is either not following the logic established in the literature (33; 41; 44) or the algorithms allow the establishment of levels for low demand items. Without the actual programing code to review, further analysis of this issue is not possible in this research, but is highly recommended once the code becomes available.

Before addressing the next investigative issue, a new issue must be raised. Since the NASSL programs are currently DIREPed and the SPARES program stocks numerous, low demand items, the MAJCOMs are without a tool to forecast requirements for activations. Two suggestions are plausible.

First, until program logic becomes available and is analyzed, the MAJCOMs can still use SPARES to develop a basic forecast and then perform an external review or develop a local program to eliminate low demand items. As tables 24 and 25 indicate, a SPARES forecast using a 40 percent PFD eliminates many of the low demand, base unique items, but in doing so, reduces overall fill rates from 72 to 63. The other alternative is to use a commonality approach as reported by Reynolds and discussed in Chapter 2. A SAS program (see Appendix S) was written to measure this approach. The results indicated a fill rate of 62 percent

(1625/2622) would have been realized with a $60 thousand reduction in overall inventory investment as compared to the 40 percent PFD forecast. In order to use the commonality logic, the MAJCOMs would first need to develop a program to identify those items common to two bases or more.

Investigative Issue 10.

Verify procedures provided by the SPARES User's Guide for the collection and processing of demand data to generate the SPARES forecast.

Besides the possible faulty program logic problem described in the previous issue, the SPARES program works as described in the SPARES User's Guide. However, recent changes in 1SD image formats require modification of program processing to allow program interface with current SBSS procedures. Since these changes must be incorporated in a new SPARES program, an opportunity exists to enhance the program's user interface as well. This investigative issue will first address those required program changes and then identify areas where user interface and program efficiency can be improved.

As noted earlier, the 1SD image format was changed in February 1991 from 80 to 81 positions to incorporate the use of the five position ordinal date (19:19-200a). The current SPARES program still recognizes only the first 80 positions when computing requirements. This forces the user to first remove the extra position from all 1SD input images and then add it to the output images after the program has computed final requirements (21).

The SPARES program requires the input from five similar-size source bases to perform calculations. MAJCOMs have expressed concern with the difficulty of finding five similar-size source bases with identically configured weapon systems (26). Currently, the User's Guide suggests the user contact the AFLMC for additional guidance when such a condition arises (44:1). The only option if less then five sources are available is to reinput the data from one of the source bases until the required number of sources is reached. Obviously, such a step violates the principle of establishing realistic demand rates from five sources. An alternative is to modify the existing program to first ask the user how many sources are available, and then automatically compute the average demand based on the available sources. The requirement to have five sources was set because five was a "reasonable number" based upon the actual number of similar-size sources available to support any activation (4). Before the program is adjusted to incorporate this suggested alternative for using less than five sources, a study should be conducted using data from this research to determine the feasibility and validity of such a change.

The program does not automatically purge those items excluded from NASSL consideration. Recall from earlier discussions that these exclusions may in fact be unwarranted. The ANG Bureau has developed a program that removes those items which fall within the excluded FSC/FSG categories after the forecast is complete. Automated removal of other exclusions is impossible because the 1SD image does not have the codes which would identify the exclusions. A more reasonable approach is to design SPARES logic to identify the excluded items before they are forecasted. An edit of the 1SD images from the five source bases after they are input, but before actual forecast computations occur, would enhance program efficiency.

An additional issue related to the editing of excluded 1SD images is the required review of the NASSL by the ALC/SPM. This review is to "ensure items identified are applicable to the MDS for which it was developed" (18:12-31). In actuality, this review is seldom done for each NASSL development because of the delay caused in the transmission and review and subsequent retransmission from user to ALC/SPM (21; 46).

As noted in earlier discussions, the data collection process must be accomplished within nine days else the 1XT434 program will reject. The SPARES program gets around this constraint because it allows the user to change the date of image preparation to any date desired. Although this ensures program processing, it violates the intent of the nine day criteria - to ensure only current and accurate information is used to build the NASSL.

A suggestion would be to adapt the SPARES program to include a file of the items applicable to the activating weapon system to identify nonapplicable items. This file should be the same one the ALC/SPM uses to notify MAJCOMs of changes and deletes to the NASSL. The ALC F-16A/B NASSL Monitor currently maintains such a file which can be used for this purpose (46). One limitation of such files is that updates are currently done off-line on a quarterly basis and are contingent on the active involvement of all IMS and MAJCOM personnel. MAJCOMs in the past have expressed concern that such updates were seldom done and that weapon system configuration databases were not readily available from the SPMs (26). Additional study in this area is needed to ensure the

NASSL process is conducted in the most efficient and effective way, regardless of forecast methodology used.

As the above required changes and recommendations generate the need for a new user's guide, a section should be written which explains the theory behind program computations and explains the configuration of the output images. Currently, the program adjusts demand data to ensure the SBSS creates demand levels for the forecasted items; however, the guide does not explain which fields are affected and why. For XB3 items, the SPC on the output 1SD image is changed to 1 for each item that meets the PFD threshold regardless of what was on the input image. This logic forces the SBSS to create a demand level for the item since the item now meets one of the four EOQ range criteria. For XF3 and XD2 images, the DDFR field is changed to .0060 which meets the range criteria for reparable items and subsequently generates a demand level regardless of input demand data. Once again, the theory behind the SPARES model is that if an item meets the probability of demand threshold established by the user, demand data is adjusted to ensure the item is stocked by the SBSS. By tearing down the mystery of program logic and computations, the user can obtain the most benefit from the information the program provides.

By generating so many forecasts, several lessons were learned about the program and user interface which need to be addressed in a new guide. The most important issue is that after every forecast is made, all files relating to that forecast must be deleted. If not, subsequent forecasts using different input MCD will possibly cause excessive levels to be established. For example, one forecast was generated using all

MCD for all SRDs in the five source bases in this study. Another forecast was subsequently generated using MCD containing only the images directly related to the F-16A/B airframe or engines, without deleting the previous files. The resulting forecast, using smaller amounts of MCD, contained more items at a much higher inventory investment than the previous forecast.

Other problems encountered were the sensitivity to upper case responses to questions generated by the program and the print option. For example, if the user wants to see the net effect on the forecast by using a different PFD, the program will eventually ask the user if different O&ST days are to be input. The program provides a "Y/N" (yes/no) user response option. A "N" response results in the program completing the forecast, while a "n" response queries the user for O&ST once again. At one point the program will ask if the user wants a printed copy of the output file. If the response is yes, the file is printed as requested. If the response is no, only the page heading is printed for each page of the forecast. If 4,500 items are forecasted, the resulting output contains 90 pages with one line of header print. Situations such as these detract from the programs effectiveness and desirability as a forecasting tool for the user.

Summary

This chapter provided detailed analysis and findings related to the investigative issues set forth in the research plan. Specifically, all data used in the activation at Syracuse and used in this study were described and analyzed as well the SPARES and NASSL forecasting programs. Forecasts were developed and compared using both methodologies. The SPARES program tendencies were examined and possible program logic problems identified. The adequacy of documentation in the SPARES User's Guide was addressed and recommendations made for improvement. The next chapter list those conclusions and recommendations for further study based on this research.

V. Conclusions and Recommendations

Introduction

This chapter discusses the overall conclusions based on the analysis and findings of the investigative issues set forth in the research plan. Recommendations are made for implementation of the SPARES forecasting model into the SBSS. Areas requiring further research are also identified. In general, the SPARES model did an adequate job in forecasting spares and repair parts for the Syracuse activation. However, inconsistencies between theoretical program logic and actual program performance as well as continuing deficiencies in the MCD collection system must be resolved before the SPARES program is implemented in the SBSS.

Conclusions

The SPARES forecast model achieved an overall fill rate of 72 percent in support of the 174TFW activation at Syracuse. This fill rate met the expected performance levels established in a prior study introducing the forecast model. The SPARES model outperformed the simulated SBSS NASSL forecast in satisfying future demand when identical MCD was used, but in doing so, established numerous levels for low demand items. Fifty-eight percent of the items forecasted by SPARES did not have subsequent demands at Syracuse when a PFD threshold of .20 was used. Analysis of the investigative issues revealed weaknesses in program logic, the MCD collection system, and program user interface.

Program Logic.

The SPARES algorithms are designed to calculate a probability of future demand (PFD) for each item and recommend stocking the item based on the probability threshold established by the user. Analysis of the items forecasted by SPARES for the Syracuse activation indicates the program is forecasting future demand for numerous low demand items when a 20 percent PFD factor is used. Based on a 20 percent PFD factor, 692 items were forecasted that had less than two customer demands at all five source bases combined. When the number of units demanded are considered, 903 items had less than five units demanded. Overall, the SPARES forecasts showed a commonality approach to forecasting future demand. Of the 3,110 items common to at least two of the source bases, only seven items failed to meet the PFD thresholds used in this research.

Mission Change Data Collection System.

Problems in the MCD collection system impacted the SPARES forecast at Syracuse and continue to impact current activations. These deficiencies stem from system, procedural, and personnel weaknesses in the system's operation.

Although the SPARES program requires MCD from five similar-size bases, a review of the 1SD images from the five source bases indicated a wide disparity in the amount of data collected. The absence of MCD on reparable items at one source base impacted the model's forecast accuracy by 2 - 6 percent for that respective category of items. Wide discrepancies in the amounts of MCD collected for XB3 items between the five source bases indicate the recording of bench stock demands varied from base to base. Actual impact on the Syracuse activation could not be addressed because of the absence of source base bench stock records and absence of the bench stock indicator on the 1SD image.

Current MCD data files indicated the system is establishing 1SD images for potentially inactive items as indicated by the SPC 5 and .0000 DDFR. Since the SPARES algorithms are insensitive to the SPC and DDFR, the gaining base may in some instances be establishing levels for inactive items, resulting in needless expenditure of base stock funds.

Procedures are currently established to exclude categories of items from consideration in a NASSL, even though demand rates indicate valid requirements exist for several categories of these items. The MCD collection system records demands for these items regardless of type of exclusion. Because the 1SD images do not contain the data elements necessary to identify many of these excluded items, detection and editing is the responsibility of the user. Failure to remove items coded with acquisition advice codes (AAC) V and Y eventually results in the cancellation of requisitions and causes additional workload for base supply personnel. This study found 187 items falling into this category of excluded items.

This study also found instances where MCD was established for administrative and general office supplies not directly related to the support of the activating weapon system. In addition, telephone and personal interviews with system users indicate MCD in some instances is recorded for items not applicable to the intended weapon system (21). These problems stem from supply and maintenance technicians using the improper SRD on demand transaction inputs.

Problems such as these have impacted system performance since the inception of NASSL procedures. However today, with limited dollars to spend on spares and repair parts requirements, the impact is much more severe and will be seen in degraded support for activating weapon systems.

SPARES SBSS/User Interface.

A recent change in the 1SD image format prevents the SPARES model from directly interfacing with SBSS programs. As a result, program users must adjust source and output 1SD images to allow complete program processing.

The SPARES program can only be used if MCD is available from five source bases. This limitation impacts those MAJCOMs who support weapon systems at less than five locations or in multiple configurations. The only alternative is either to load MCD files repeatedly until the input requirement is met or use SBSS programs.

These shortcomings in program processing, in addition to minor user interface problems, detract from overall program use and effectiveness and must be corrected before the SPARES program is implemented in the SBSS.

Recommendations.

This study identified several areas where additional research is required to validate the SPARES model and resolve continuing problems in forecasting spares and repair parts requirements for relocating weapon systems.

1. Recommend the AFLMC/LGS continue the efforts and intent of the current study in addressing problems with the SPARES and NASSL programs. Specifically, there is a requirement to compare the theoretical basis for the SPARES model against actual SPARES program coding to determine why low demand items were forecasted for the Syracuse activation. The MCD and demand data used in the current study can be used to validate actual performance of the model once discrepancies are identified and corrected. In addition, when the current DIREPs are corrected on the SBSS NASSL programs, a comparison should be made between SPARES and NASSL forecasts to validate the results of the current study. Based on these findings, the feasibility of using the SPARES program when less than five source bases are available must also be addressed.

Once validated, the SPARES program needs to be adjusted for the 81 position 1SD image and allow direct interface with the SBSS. The program should also be adjusted to perform an on-line edit and compare the ALC/SPM NASSL against the forecasted items. This comparison can be used to identify and mark for removal those items not applicable to the activating system. Identified user interface problems must also be corrected before the program is released to the MAJCOMs. Finally, the SPARES User's Guide needs to be updated with flow diagrams of program processing and explanation of output images.

2. Recommend the AFLMC/LGS further analyze the demand characteristics of all categories of items to determine if forecast accuracy can be improved. Specifically, the impact of collecting MCD on XB3 items with SPC of 5 must be addressed, as well as the low fill rates reported for XF3 and XD2 items.

3. Recommend the AFLMC/LGS in coordination with the Standard Systems Center study the feasibility of establishing automated edits to the MCD collection system. These edits should have the capability of identifying items to specific weapon systems. Codes on the item record should be established for this purpose and be flexible enough to allow the processing of items common to several weapon systems. Also to be considered is the feasibility of establishing a MCD detail record which could be used by supply managers to selectively interrogate the MCD on desired items.

4. Recommend HQ AFLC/LGSI in coordination with AFLMC/LGS survey MAJCOMs to review the policy to exclude entire categories of items from consideration in a NASSL. Once categories are identified, the AFLMC/LGS should then coordinate with the SSC to modify SBSS programming logic to prevent the recording of demand data against the excluded categories.

5. Recommend HQ ATC/TTOA and all MAJCOMs continue to emphasize in all supply related training the need and importance of using correct SRD in supply transactions.

Summary

This study analyzed the performance of the SPARES model in forecasting the spares and repair parts requirements for the activation at Syracuse ANGB NY. The specific purpose was to determine if the model's performance warranted its implementation into the Standard Base Supply System. Although the model reached stated fill rate goals established by previous AFLMC studies, the model was also found to stock numerous items with low demands across the five source bases. Because of this finding, additional analysis of original program coding must be done before a recommendation for implementation can be made.

Regardless of the actual performance of this model, a larger issue was evident throughout the conduct of this study and has been addressed time and time again by numerous researchers and outside agencies. Even the most sophisticated model built to attain the highest possible fill rate at the lowest possible cost still depends upon the data fed to it. Without accurate data collection methods, further efforts to develop or modify forecast models to optimize the expenditure of limited funds will only result in disappointment, frustration, and more importantly, inefficient and ineffectual weapon system support.

Appendix A: Acronyms

1P6MPD - First Past Six Month Period Demands
2P6MPD - Second Past Six Month Period Demands
3P6MPD - Third Past Six Month Period Demands
4P6MPD - Fourth Past Six Month Period Demands
AAC - Acquisition Advice Code
ABW - Air Base Wing
ADFR - Annual Demand Frequency Rate
ADR - Annual Demand Rate
AFAA - Air Force Audit Agency
AFB - Air Force Base
AFIT - Air Force Institute of Technology
AFLC - Air Force Logistics Command
AFLMC - Air Force Logistics Management Center
AFRES - Air Force Reserve
AFS - Air Force Station
ALC - Air Logistics Center
ALS - Advanced Logistics System
ANG - Air National Guard
ANGB - Air National Guard Base
AWP - Awaiting Parts
BLSS - Base Level Sufficiency Spares
CFOSS - Combat Follow-On Supply System
CPD - Current Period Demands
CRD - Cumulative Recurring Demands
DDFR - Daily Demand Frequency Rate
DDR - Daily Demand Rate
DIREP - Discrepancy Report
DLA - Defense Logistics Agency
DOFD - Date of First Demand
EOQ - Economic Order Quantity
ERRC - Expendability, Recoverability, Reparability Code
ERRCD - Expendability, Recoverability, Reparability, Cost Designator
FOSK - Follow-on Spares Kit
FOSSL - Follow-on Spares Support List
FRP - Fill Rate Potential
FSC - Federal Stock Class
FSG - Federal Stock Group
FR - Fill Rates
FRP - Fill Rate Potential
FY - Fiscal Year
GAO - General Accounting Office
I&SG - Interchangeable and Substitute Group
IMS - Inventory Management Specialists
IR - Item Record
ISSL - Initial Spares Support List
MAJCOM - Major Command
MC - Mission Change
MCD - Mission Change Data
MCDDFR - Mission Change Daily Demand Frequency Rate
MCDDR - Mission Change Daily Demand Rate

MDS - Mission Design Series
MICAP - Mission Capable
MMC - Materiel Management Code
MSSL - Major Command Spares Support List
NASSL - New Activation Spares Support List
ND - Number of Demands
NMCS - Non-Mission Capable Supply
NSN - National Stock Number
O&M - Operational and Maintenance
O&ST - Order and Ship Time
O&STQ - Order and Ship Time Quantity
PBR - Percent of Base Repair
PFD - Probability of Future Demand
POS - Peacetime Operating Stock
RECOMP - Requirements Computation
RR - Remove and Replace
RRR - Remove, Repair, and Replace
SBSS - Standard Base Supply System
SLC - Shelf Life Code
SLQ - Safety Level Quantity
SM - System Manager
SNUD - Stock Number User Directory
SPARES - Spare Parts for the Activation of Relocated Systems
SPC - Stockage Priority Code
SPM/PM - System Program Manager/Program Manager
SRD - Standard Reporting Designator
SSC - Standard Systems Center
TFW - Tactical Fighter Wing
USAF - United States Air Force
VMR - Variable-to-Mean Ratio
WRSK - War Readiness Spares Kit

Appendix B: Definitions

Acquisition Advice Code (AAC) - Codes "used primarily to determine the stocked versus the nonstocked breakouts of various management products produced by the logistics systems. The codes are used to identify disposal, condemned, semi-active, and local-purchase/local manufacture items during the supply decision process" (17:1-289).

Air Force Stock Control Data Bank - A repository of internal supply records from 12 Air Force computer support bases including the records of assigned satellite accounts (19:19-98).

Awaiting Parts (AWP) - "A system used to secure materiel needed to repair equipment that is high priority (although not the highest priority of MICAP equipment)." The term identifies a reparable item which is inoperable due to the lack of a repair part. In such an instance, the reparable item is described as "awaiting parts" or simply "AWP" (19:17-7).

Base Factor - The number of supported weapon systems at the base where mission change data is collected. If aircraft are involved, the base factor can be modified to consider the average number of sorties per day and the average length of sortie for each aircraft. The base factor interacts with the change factor to derive the mission change daily demand rates and the mission change daily demand frequency rates (19:19-198).

Base Level Sufficiency Spares (BLSS) - "War Readiness Materiel (WRM) spares and repair parts required as base support for units which plan to operate in place during wartime, considering the available maintenance capability" (19:26-17).

BDFA image - An output image as a result of a new item record load at a base supply activity. This image is sent to the SNUD and registers the supply activity as a user of the applicable item record (19:27-134).

Bench stock - Consumable supply items coded with ERRCD "XB3" which are stored near the using organization because of frequent use. These items are maintained on Master Bench Stock Detail Records and are replenished on a bulk issue basis (19:25-3).

Bench stock flag - A one position data element on the item record which indicates the item has a Master Bench Stock Detail Record established (19:3-14).

Binomial Model - A mathematical model used by SPARES to determine the probability of a future demand when the variance-to-mean ratio of the applicable mission change data is less then 1 (41:41).

Budget Code - A one-position alpha/numeric code which "determines whether items are centrally procured, investment, or stock funded" (19:3-14).

Change Factor - The number of weapon systems that are being supported at the gaining base. If aircraft are involved, the change factor can be modified to consider the second year flying program in terms of the expected average number of sorties per day and the expected average length of sortie for each aircraft. The change factor interacts with the base factor to derive the mission change daily demand rate and mission change daily demand frequency rate (19:19-199).

Combat Follow-On Supply Support System (CFOSS) - The Air Force system used "to identify, compute, assemble, and ship the necessary supplies and demand data to convert from remove and replace (RR) to remove, repair and replace (RRR) maintenance for deployed units" after the first 30 days of combat operations (9:i-iii).

Cumulative recurring demands (CRD) - "The total quantity of an item requested on a recurring basis (R or C demand code). When the difference between the date of first demand and the current date exceeds one year, the CRD quantity is adjusted to equal one's year demand. The CRD is updated by the issue, due-out cancellation, and turn-in programs" (19:19-47).

Daily Demand Frequency Rate (DDFR) - Indicates the average number of demands placed on supply each day. The DDFR is computed by dividing the total number of customer demands by the "difference between the current date and the date of first demand. If the available demand experience is less than 365 day, then" 365 days are used (19:19-47).

Daily Demand Rate (DDR) - "The average quantity of an item that is used daily." The DDR is computed by dividing the cumulative recurring demands by the difference between the current date and the date of first demand. If the difference is less than 180 days, 180 days is used to "minimize the inflationary effect of limited demand experience" (19:19-48).

Date of first demand (DOFD) - "Indicates the Julian date of the first request for issue, regardless of demand code or transaction exception (TEX) code" (19:3-19). This field is periodically reviewed and updated as required by SBSS reports processing (19:19-19).

Demand - A request submitted by a customer to base supply to support management requirements for supplies and/or equipment (19:3-151). "Demands are categorized as initial, nonrecurring, recurring, or initial" (19:19-48).

Demand code - A one-digit alpha character entered on supply demand transactions which triggers demand data updates and establishes internal records controlling the accountability for the item (19:3-21).

Demand level - The amount of stock that is needed to meet customer requirements based upon the past customer demands (19:19-48).

Depth - The determination of how much of item to stock (8:62).

Detail effective date - The date the mission change daily demand rate and the mission change daily demand frequency rate are used by the requirements computation program to determine and establish demand levels and to generate requisitions for required assets (19:19-198).

Detail load date - The date indicating when the 216 Mission Change Adjusted Level Detail record was loaded into the SBSS (19:19-198).

Expendable item - A supply item that is "consumed in use or becomes a part of a next higher assembly during periods of use. All expendable items are accounted for on supply records until they are issued for use" (17:1-217).

Expendability/Recoverability/Reparability/Cost Designator (ERRCD) - A three digit alpha/numeric code that "designates the expendability status, level of repair, and cost category of an item" (19:3-27).

Factor computations flag - Allows the user to selectively apply the program factor to the forecasted items. The program factor "is the percent of effect the mission change detail(s) has on the item's or group's daily demand rate" (19:19-199).

Federal Stock Groups (FSG) - Contained in the first two positions of the item record stock number and identifies the commodity group of the item (19:3-27).

Federal Stock Class (FSC) - Contained in the first four positions of the item record stock number and identifies the commodity class of the item (19:3-27).

Fill rate potential - A measurement indicating the percentage of time an item was forecasted using the SPARES methodology and was subsequently demanded (41:22).

Follow-on Spares Kit (FOSK) - "An air transportable package of selected peacetime operating stocks, repair parts, and supplies . . . . FOSKs are built from residual peacetime operating stocks that were left when the unit left the base" (19:26-18).

Follow-on Spares Support List (FOSSL) - The modified Initial Spares Support List (ISSL) of spares and repair parts required to support the activation of a weapon system a new location. Modifications were based on actual demand occurrences for items required to support the weapon system. Replaced by the New Activation Spares Support List (NASSL) in 1983 (15:3).

Initial Spares Support List - The process and document used to determine the spares and repair parts required to support the initial operations of a weapon system as it enters the Air Force inventory through the provisioning process (39:2).

Interchangeable and Substitute Group (I&SG) - A group of items linked together by internal supply codes because of "similar, form, fit, and function." Depending on the coding and relationship of these items, automatic issue of these items occurs and results in the efficient use of related assets (23:1).

Low-density system - "Any system for which the in-use quantity of the system operating at a location is too small to generate sufficient consumption data to establish the range and depth of spares required to support the operational and maintenance concepts" (18:12-29).

Materiel Management Code (MMC) - A two digit alpha code on the item record which identifies the item manager specialist responsible for the overall support of the item (19:3-36).

Major Command Spares Support List (MSSL) - A list of required spares and repair parts developed by the MAJCOM following the expiration of the Initial Spares Support List (ISSL) for a low density system (18:12-29).

Mission Capability (MICAP) - "The term used to classify items of highest priority" and identifies a "unique system used to secure materiel needed to repair mission essential equipment" (19:17-7).

Mission Change Daily Demand Frequency Rate (MCDDFR) - The demand frequency rate located on the 216 Mission Change Adjusted Level Detail record that is used to determine if a demand level is established for the applicable item (19:19-198).

Mission Change Daily Demand Rate (MCDDR) - The demand rate located on the 216 Mission Change Adjusted Level Detail record that is used to determine the demand level or depth of stock for the applicable item (19:19-199).

Mission change data (MCD) - Demand data recorded by the SBSS each time a recurring demand is placed for an item in support of a weapon system with a valid Standard Reporting Designator (SRD) (19:19-191).

Mission support effective date - The date the last relocating weapon system arrives at the new base and the date the effect of the mission change daily demand rate and mission change daily demand frequency rate on the demand level begins to decline (19:19-199).

Negative Binomial Model - A mathematical model used by SPARES to determine the probability of a future demand when the variance-to-mean ratio of the applicable mission change data is more than 1 (41:41).

New Activation Spares Support List (NASSL) - "An established list of spares and repair parts required to support the maintenance efforts at the system operating site" (18:12-31).

Number of demands (ND) - "Indicates the number of times an item has been requested during a given period of time" (19:3-40).

Order and Ship Time (O&ST) - "The average number of days between the initiation and receipt of a stock replenishment requisition" (19:19-49).

Peacetime operating stocks (POS) - Stock levels of spares and repair parts needed to support normal peacetime operations (19:26-17).

Percent of Base Repair (PBR) - The average repair rate for a "XF" or "XD" item during the current and past four quarters (19:19-47).

Percent of Base Repair (PBR) Override - Overrides the existing PBR on the item record and uses a pre-established PBR to reflect a more realistic PBR in the early stages of weapon system support (19:19-199).

Poisson Model - A mathematical model used by SPARES to determine the probability of a future demand when the variance-to-mean ratio of the applicable mission change data equals 1 (41:41).

Program factor - "The percent of effect the mission change detail(s) has on the item's or group's daily demand rate" (19:19-199).

Range - The determination as to what items to stock and when to stock them (8:62).

Requirements Computation (RECOMP) - An internal SBSS program which compares "total assets to total requirements, updates demand data fields, submits stock replenishment requisitions and requests for requisition cancellations, and performs other internal stock control functions (19:19-31-33).

SBSS EOQ Hybrid Range Model - A model within the SBSS which determines if a demand level will be established by using existing demand data to compute and compare the cost to stock and the cost to not stock an item. If an item's cost to not stock is greater than its cost to stock, than a demand level is established (38:1).

Shelf Life Code (SLC) - A code on the item record which informs supply managers as to long an item may be stored without being used. Once the shelf life of an item is reached, the item may either be recertified for continued use by supply inspectors or disposed of (19:3-54)

Spare Parts for the Activation of Relocated Systems (SPARES) - A microcomputer program which uses mission change consumption data to "compute the range and depth of items needed to support" a weapon system at a new operating location (44).

Standard Base Supply System (SBSS) - "The unified management system that accomplishes all Base Supply and service workloads. The Standard Base Supply System operates through the collective interactions of supply procedures, service procedures, processing routines, and the Sperry S1100/60 computer" (19:3-154).

Standard Reporting Designator (SRD) - A three digit alpha/numeric code which "identifies the type of aircraft, major end item, or system" (19:3-58).

Stock Number User Directory (SNUD) - "An Air Force Logistics Command (AFLC) - operated data system. SNUD distributes stock control data such as stocklists to the recorded users of the stock numbers." The stock control data includes indicative data changes to existing item records such as the price, ERRCD, and budget code (19:27-133-134).

Stockage Priority Code (SPC) - A one position alpha/numeric code used by the requirements computation program to determine if a demand level is to be established for a given item record. The SPC is assigned based on the urgency justification code (UJC) of the item request (19:3-58). For example, a SPC of 1 represents a request for a MICAP item and would cause the requirements computation program to establish a demand level for the item (19:19-39).

Urgency of Justification Code (UJC) - A two digit alpha/numeric code entered on issue transactions by supply technicians which identifies the importance of the issue transaction and the type of equipment the transaction is for (19:3-70A).

War Readiness Spares Kit (WRSK) - "A kit consisting of selected spares and repair parts required to sustain operations (without resupply) at a base, a deployed location, or a dispersed location for the first month of conventional activity as projected in USAF war plans" (19:26-18).

Appendix C: Items Excluded from NASSL Consideration

a. The following types of items will not be included in a NASSL:
   (1). Common housekeeping items and soft consumable items normally obtained through the General Services Administration.
   (2). Insurance coded items, subject to waiver authority by IMS.
   (3). Federal supply codes "5345," "5350," "9910," "9915," "9920," and "9930."
   (4). Federal supply groups 13, 35, 37, 55, 65, 71, 72, 76, 77, 78, 79, 80, 83, 84, 85, 87, 88, 89, and 94.
   (5). Shelf life coded items with less than 18 months expiration date. (18:12-31)

The description of these excluded items is as follows:

1. Items such as mops, brooms, and administrative supplies normally carried in the Base Service Store.

2. These are items are coded in the SBSS with Acquisition Advice Codes (AAC) which indicate exceptions apply to normal requisitioning of supplies. The following AAC codes were selected as those items requiring IMS waiver authority or requiring special requisitioning action:

AAC	Description
M -	Restricted Requisition-Major Overhaul (Stocked)
V -	Terminal Item (Stocked). Identifies items in stock; but future procurement is not authorized.
X -	Semiactive Item - No Replacement (Non-stocked)
Y -	Terminal Item (Non-Stocked). Future procurement is not authorized. No wholesale stock is available for issue.
Z -	Insurance/Numeric Stockage Objective Item (Stocked) (17:289-292)

3. Descriptions of the excluded FSC are as follows:

FSC	Description
5345	Disks and Stones, Abrasive Belts and Belting, Hones, Abrasive Wheels.
5350	Abrasive Materials, Cloth, Papers, Powders, and Industrial Diamonds.
9910	Jewelry
9915	Collectors and/or Historical Items
9920	Smokers' Articles and Matches
9930	Memorials, Cemeterial and Mortuary Equipment and Supplies (20)

4. Descriptions of the excluded FSG are as follows:

FSG	Description
13	Ammunition and Explosives
35	Service and Trade Equipment
37	Agricultural Machinery and Equipment
55	Lumber, Millwork, Plywood, Veneer
65	Medical, Dental, and Veterinary Equipment
71	Furniture
72	Household and Commercial Furnishings and Appliances
76	Books, Maps, and Other Publications
77	Musical Instruments, Phonographs, and Home-Type Radios
78	Recreational and Athletic Equipment
79	Cleaning Equipment and Supplies
80	Brushes, Paints, Sealers, and Adhesives
83	Textile, Leather, Furs, Apparel and Shoe Findings, Tents and Flags
84	Clothing, Individual Equipment, and Insignia
85	Toiletries
87	Agricultural Supplies
88	Live Animals
89	Subsistence
94	Nonmetallic Crude Materials (20)

5. Shelf life coded items with less than 18 months expiration date. Shelf life codes indicate the number of months a new item may remain unused in storage before it must be condemned. There are two types of shelf life code, Type I (alpha) and Type II (numeric). Type I codes apply to items having a nonextendable period of life. Type II codes apply to items which may be extended after completion of inspection, test , or restorative action. The following shelf life codes apply to this study (19:3-54):

Shelf Life	Type I	Type II
1 month	A	
2 months	B	
3 months	C	1
4 months	D	
5 months	E	
6 months	F	2
9 months	G	3
12 months	H	4
15 months	J	
18 months	K	5

(19:3-54)

Appendix D: Example and Format of the 1SD Image

1SD Example:

Position Number:

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

1SDFLZB5841012224877EWEAT99S703750000RADAR,TFR 32-547   10004500824623823702 3A16
```

1SD Format:

Positions	Length	Field Description
1 - 3	3	TRIC "1SD"
4 - 6	3	Routing Identifier Code
7 - 7	1	Type Stock Record Account
8 - 22	15	Stock Number
23 - 24	2	Unit of Issue
25 - 25	1	ERRC
26 - 27	2	Mission Change Percent of Base Repair
28 - 28	1	Budget Code
29 - 29	1	AFRAMS/WRM Report Code
30 - 37	8	Unit Price
38 - 56	19	Nomenclature
57 - 57	1	Stockage Priority Code
58 - 62	5	SRD Daily Demand Rate
63 - 66	4	SRD Daily Demand Frequency Rate
67 - 70	4	Stock Record Account Number Where Data Collected
71 - 74	4	Date Prepared
75 - 77	3	Base Factor
78 - 80	3	Standard Reporting Designator

Note: The above example and format was accurate at the time of the Syracuse activation in August 1988. Since that time the 1SD image has been modified. The modified positions are as follows:

Positions	Length	Field Description
38 - 53	16	Nomenclature
54 - 54	1	Combat Supplies Management System (CSMS) Reportable Flag
55 - 55	1	Mission Impact Code
56 - 56	1	Bench Stock Flag
71 - 75	5	Date Prepared
76 - 78	3	Base Factor
79 - 81	3	Standard Reporting Designator (19:19-200-200a)

Appendix E: Example and Format of a Mission Change Special Level Detail (216) Record (42)

216 Example:

Position Number:

```
                                                                                                   1
         1         2         3         4         5         6         7         8         9         0
1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
123

2161005000228443  A200001LA007SC823900021234N164Z0001 A16   000060GC CC 4Z089212B088239A2
090213
```

216 Format:

Positions	Length	Field Description
1 - 3		Detail Type (216)
4 - 18		Stock Number
19 - 20		System Designator
21 - 25		Authorized Quantity
26 - 26		Detail Type (L)
27 - 40		Document Number
41 - 54		Application SRAN Tasking
55 - 57		Standard Reporting Designator (SRD)
58 - 60		MILSTRAP Project
61 - 61		PBR Override
62 - 66		Daily Demand Frequency Rate (DDFR)
67 - 67		Type Level Flag
68 - 68		Level Directed By Code
69 - 69		Duplicate Detail Flag
70 - 70		Level Justification Code
71 - 71		Approval Flag
72 - 72		Shop Repair Capability
73 - 74		Major Command ID
75 - 80		Mission Support Date
81 - 81		Type SRAN
82 - 87		Detail Effective Date
88 - 89		System Designator
90 - 97		Filler
98 - 103		Expiration Date

Appendix F: Item Record (101) Format (42)

Length	Positions	Field Description
3	1 - 3	Record Type (101)
15	4 - 18	Stock Number
2	19 - 20	System Designator
2	21 - 22	Unit of Issue
12	23 - 34	Unit Price
1	35 - 35	Stockage Priority Code
2	36 - 37	Application Code
3	38 - 40	Routing Identifier
3	41 - 43	ERRCD
1	44 - 44	Quantity Unit Pack Code
1	45 - 45	ISG Source
1	46 - 46	Parts Preference Code
1	47 - 47	Type Stock Record Account
1	48 - 48	File Status Quarter Code
1	49 - 49	Controlled Item Code
1	50 - 50	Freeze Code
1	51 - 51	Shelf Life Code
1	52 - 52	ADPE Code
1	53 - 53	Excess Exception Flag
1	54 - 54	Issue Exception Code
1	55 - 55	Requisition Exception Flag
1	56 - 56	Shipment Exception Flag
19	57 - 75	Nomenclature
4	76 - 79	MFGS ID Code
1	80 - 80	Foam In Place
3	81 - 83	OST Override Code
6	84 - 89	Date of Last Transaction
11	90 - 100	Warehouse Location
9	101 - 109	Serviceable Balance
1	110 - 110	AFRAM WRM Report Code
1	111 - 111	Demilitarization Code
1	112 - 112	Type Procurement Code
1	113 - 113	Excess Cause Flag
6	114 - 119	Date of First Demand
9	120 - 128	National Motor Freight Class
9	129 - 137	Cumulative Recurring Demands
3	138 - 140	Current Demands
3	141 - 143	Demands Past 6 Months
3	144 - 146	Demands Past 7 - 12 Months
6	147 - 152	Date of Last Demand/Adjustment
1	153 - 153	Precious Metal Indicator
1	154 - 154	AFTO Form 95 Code
3	155 - 157	Standard Deviation (C-Factor)
1	158 - 158	Acquisition Advice Code
1	159 - 159	Requirements Computation Flag
6	160 - 165	Date of Last Releveling
9	166 - 174	Demand Level
4	175 - 178	Date of Last Inventory

3	179 - 181	CSS Flag
2	182 - 183	Cargo Type
1	184 - 184	Filler-5 ???
1	185 - 185	Budget Code
4	186 - 189	Interchangeable Substitute Group
1	190 - 190	Relationship Code
6	191 - 196	SNUD Update
1	197 - 197	Price Validation Code
1	198 - 198	Bench Stock Flag
1	199 - 199	MSK Item Flag
1	200 - 200	Overflow Adjunct Flag
1	201 - 201	Supply Point Flag
1	202 - 202	Supply Adjunct Flag
1	203 - 203	Mission Change ISSL Flag
1	204 - 204	Minimum Level A,B,C Flag
1	205 - 205	Maximum Level D Flag
1	206 - 206	Fixed Level E Flag
1	207 - 207	D028 F Flag
1	208 - 208	Mission Change Gain G Flag
1	209 - 209	Mission Change Loss H Flag
1	210 - 210	TCTO Flag
1	211 - 211	Base Closure Flag
1	212 - 212	EOQ Consumption Flag
1	213 - 213	Health Hazard Flag
1	214 - 214	Suspect Material Flag
1	215 - 215	Problem Item Flag
1	216 - 216	SSD Stock Fund Credit Flag
1	217 - 217	Multiple DIFM Flag
1	218 - 218	Functional Check Flag
1	219 - 219	Local Purchase Flag
1	220 - 220	RIW Program Flag
1	221 - 221	Currency Record Flag
1	222 - 222	Inventory Flag
1	223 - 223	Mission Impact Code
1	224 - 224	Lot Size Flag
9	225 - 233	Cumulative Demand Quantity
18	234 - 251	Cumulative Demand Quantity Squared
6	252 - 257	Number Demands - 007SC
6	258 - 263	Date SPC-5 Assigned
11	264 - 274	Reserve Warehouse Location
16	275 - 290	Filler 3?
1	291 - 291	One Way Interchange Flag
1	292 - 292	Hazardous Material Code
1	293 - 293	BLSS
1	294 - 294	WCDO
1	295 - 295	WPSK
1	296 - 296	SPI Indicator
9	297 - 305	SPI Number
5	306 - 310	SPI Effective Date
5	311 - 315	Date of Last Transp Date
1	316 - 316	Foam In Place-1
1	317 - 317	CSMS Reportable

1	318 - 318	AFRAMS Report Code
12	319 - 330	New Serviceable Balance

Appendix G: Data Samples

Note: The following data is a sample of item record (101) data as of June 1989 from the Syracuse item record file labeled F1 on SAS programs. Appendix F contains the item record format.

```
1017110009314468  A2EA0000000136004  JBHNF30  ECU 0 A   CHAIR ROTA
AAC00400          008217             000000000 A
00000000008064000000000000000000000008174  001I908923600000000092290002  9
087091N000000000000000000000000 4
000000000000000000000000000000000000000
0000000000  000000000000
1015620PSADDLE    A2EA0000000015305  JBBXB31  B U 0     SADDLE 4 X 36"
ZZZZZ   009248              000000000 X
000000000000000000000000000000000000000  001  000000000000009248000  9
000000 0000000000000000000000100
000000000000000000000000000000000000000
0000000000  000000000000
1015365003678866PTA2EA000000000002315  FPZXB31  BCU 0     SPACER ST2108-26
00828651A083B006E000000001 A  000000000194120000000000000000000000082853
001D9089236000000019242000Z  1     089091N00000000001000000000000
000000000000000000000000000000000009236
0000000000  000000000000
1016145004031567  A2FT0000000000205  S9IXB3WBZBCU 00    WIRE ELECTRICAL
009131            000000000 A  00000000003092000000000000000000000008305A
001D9089236000000008263000Z  95417I089060V00000000000000000000000
000000000000000000000000000000000008263
0000000000  000000000000
1012835010656536  A2EA0000000129014  FPZXF31  BCU 0     COVER TURBINE
START             009026             000000000 A
00827000013339000000000100000000010090263 001D9089236000000009229000Z  1
088275N000000000000000000100000 1
000000001000000000000000000000000005312
00000   004303372320
1017510002012624  A2EA0000000005315  JBHXB30  BCU 6  K  RIBBON KEYPUNCH
00902451B001B002 000000042 A Z00809000000000000000000070000000000007151A
001I90892360000000079086000   9     085274N00000000000000000000000 4
00000000C0000000000000000000000006007334
0000000000  000000000000
1015961010486924  A2EA0000000014814  S9EXB30  BCU 0     TRANSISTOR
009072            000000000 A  00902000006302500000000100000100000009072A
001J9089236000000009019000Z  9     088275N00000000000000000000000 4
000000001000000000000000001000001000000
0000000000  000000000000
1018115004284185  A2BD0000000030074  GSAXB30  BCU 0     BOX S/W
18LX18WX18D         009248               000000000 A
00919500000000000000000200100000000009212A 001H908921200000000009195000   9
000000N000000000000000000000000 4
000000002000000000000000004000001000000
0000000000  000000000000
```

Note: The following data is a sample of item record (101) data as of June 1990 from the Syracuse item record file labeled F4 on SAS programs. Appendix F contains the item record format.

```
1012840012543054PTA2EA0000000358334  FPZXD21BZBBU 0     SEAL AUGEMNTOR
NOZZ     A  000134                000000000 B
0000000001333900000000000000000000000000A 001C00901340000000000025000Z
S6400I090091N000000000010000001010000 2
000000000000000000000000000000000008196
T000002E188827100000 Y6000000000000
1015920005032885  A2EA0000000000045  S9EXB35AABBU 0     FUSE 8AMP 32V
AGS8        008188                000000000 A
000000000620600000000000000000000000000  001V00901260000000009229000Z
94231M000000N0000000000000000000000000
000000000000000000000000000000000008202
0000000000 N 000000000000
1017530010730320  A2HD0000000017414  JBHXB30  BBU 0  K  TRANS NO LINE
00011551B001B007 000000014 A Y000000000000000000000000000000000000000A
001I009011500000000000073000   9     090032N000000000000000000000100 3
000000014000000000000000013000011000000
00000 N 004303372320
1018405010116423  A2EA0000000010604  S9TXB3NAABBU 0  E4 USE 012127443
000137              000000000 A  00908900004988000000000300000000000009128A
001V009010600000000000068000Z  94244M090032N000000000000000000000000 3
000000003000000000000000003000002000106
00000 N 004303372320
1015306011294437  A2EA0000000002565  FPZXB31  BBU 0     STUD
009274              000000000 A  009202000104520000000005000000001009219A
001D00901320000000009202000Z  1     089274V000000000000000001100000 1
000000005000000000000000025000001000134
0000000000 N 000000000000
1015315010467953  A2EA0000000002305  S9IXB30  BBU 0     PIN STRAIGHT
00927451A001K033B000000005 A Y0090890000951900000000010000000000006317
001D0090132000000001010600Z  9     089274N000000000000000000000000
000000000000000000000000000000002008207
0000000000 N 000000000000
1012935012377995  A2EA0000005613424  FHZXD21  BBU 0     COOLER,LUBRICA
16VP         009291               000000000 A
0000000001182400000000000000000000000000A 001C00901320000000009291000Z  S
089335E000000000000000000000000
000000000000000000000000000000000009086
T000001XE38711200000 N6000000000000
1014510002248549  A2EA0000000009955  GSAXB36  BBU 0     DISPENCER PAPER
TOW          009274               000000000 A
009097000039480000000001000000001009120A 001G00901320000000000120000Z  9
090032N000000000000000000000000 4
000000001000000000000000001000001009331
0000000000 N 000000000000
```

Appendix H: MCD from the Five Source Bases

Note: This sample is from Burlington ANGB as determined by the stock record account of "4678" in positions 67-70. Refer to Appendix D for the complete 1SD format.

```
1SDFLZB1005003357318  EAN  1+00001864CAM LOCK 7790681    500023007746788057021A16
1SDS9CB1005007225087  EAN  9 00000179BRUSH CLEANING SMAL400008001946788057021A16
1SDFLZB1005007852605  EAN  1 00000305PIN ASSY,7790768    400016005846788057021A16
1SDFLZB1005010534216  EAN  1 00010499SWITCH AND CONNECTO500008001946788057021A16
1SDFLZB1005010552159  EAN  1 00000667CONVEYOR ELEMENT,AM500091001946788057021A16
```

Note: This sample is from Jacksonville ANGB as determined by the stock record account of "4483" in positions 67-70. Refer to Appendix D for the 1SD format.

```
1SDFLZB1005000566753  EAT00S602982468GUN,20 MILLIMETER A400023010948308050021A16
1SDFLZB1005001482324  EAN  1 00000032LOCK BOLT           500029003948308050021A16
1SDFLZB1005003357318  EAN  1 00001864LOCK,CAM            500016003948308050021A16
1SDFLZB1005006999882  EAN  1 00001134TRACK ROTAR REMOVAB400029001948308050021A16
1SDFLZB1005006999913  EAN  1 00004454GEAR ROTOR  7268664500006002448308050021A16
```

Note: This sample is from McConnell ANGB as determined by the stock record account of "4621" in positions 67-70. Refer to Appendix D for the 1SD format.

```
1SDFLZB1005000228443  EAP141 00025565LIMITER 79F907051-3400006005546218057021A16
1SDFLZB1005000566753  EAT  S602982468GUN 20MM 7791641    400023016446218057021A16
1SDFLZB1005001048275  EAN  1 00003632GEAR ASSY 13586233 300005002746218057021A16
1SDFLZB1005001482324  EAN  1 00000032LOCK 11698279       500018011646218057021A16
1SDFLZB1005004871267  EAP  1 00145875DRIVER 11691583     400006005546218057021A16
```

Note: This sample is from Great Falls ANGB as determined by the stock record account of "4626" in positions 67-70. Refer to Appendix D for the 1SD format.

```
1SDFLZB1005003357318  EAN  1 00001864LOCK CAM 1169677    400012002746268057021A16
1SDFLZB1005006999913  EAN  1 00004454GEAR ROTOR 7269664 500004003346268057021A16
1SDFLZB1005006999922  EAN  1 00000626ROTOR TRAK 7268703 400039006646268057021A16
1SDS9CB1005007225087  EAN  9 00000179BRUSH CLEAN SM 20MM300020008846268057021A16
1SDFLZB1005007545269  EAN  1 00022871SOLENOID 11010205  200006002746268057021A16
```

Note: This sample is from Tucson ANGB as determined by the stock record account of "3044" in positions 67-70. Refer to Appendix D for the 1SD format.

```
1SDFLZB1005000683797  EAN  1 00000742CENT SEC201F974-102500074011530448064021A16
1SDFLZB1005002686421  EAN  1 00008436SCOOP DRIVE ASSEMBL300004002730448064008A3Z
1SDFLZB1005003357318  EAN  1 00001664CAM LOCK 11691677   400007006530448064021A16
1SDS9CB1005009991435  EAN  9 00000019BRUSH K843235-8     300113023030448064021A16
1SDFLZB1005010463536  EAT  S701538000TRANSFER 201F963    300006002730448064008A3Z
```

Appendix I: D165A-MICAP History

Q-D087D-MIH-DY-LST (WSMIS)   DATE: 05/10/91 - 12.05.25 C.T. D165B:05/09/91

GENERAL LISTING REPORT FOR D165A-MICAP HISTORY
SUBSETS SELECTED: MONTH: 88/10-90/10; MDS: F-16S; SRAN: FB6324;
CAUSE CODE: A,B
****

MICAP DOCUMENT NUMBER	NSN/MMC	FSC	TOTAL MICAP HOURS	SOS GROUP	CAUSE CODE	BUDGET CODE	TERM CODE	QTY	ERRC
FB632400030447	1280010811521WF	1280	115	OO-ALC	A	S	1	1	
FB632400039100	5310012372637	5310	46	OTHER	A		3	5	
FB632400040122	5970008122967	5970	122	DLA	A	9	2	20	N
FB632400040407	3040010550452GG	3040	113	WR-ALC	A	1	1	1	
FB632400040408	5305006899513	5305	131	DLA	A	9	2	1	

From the above data set, the NSN, total MICAP hours and cause code were extracted and transcribed to an ASCII file. The following is a sample of the ASCII file:

NSN	TOTAL MICAP HOURS	CAUSE CODE
1280010811521	115	A
5310012372637	46	A
5970008122967	122	A
3040010550452	113	A
5305006899513	131	A

Appendix J: SAS Programs for Investigative Issue 1

Note: This program merges the data based on the NSN from the ALC F-16A/B NASSL, the five MCD source bases, the 216 records loaded at Syracuse, and the cause code A and B MICAP incidents at Syracuse. PROC TABULATE is used to determine the number of records established for items which are excluded from NASSL consideration as prescribed by AFM 67-1, Vol I, Part One.

```
OPTIONS LS=80;
DATA ALCNAS;
INFILE F16NASSL;
INPUT FSG $ 1-2 FSC $ 1-4 NIIN $ 5-13 MMC $ 14-15 ALC $ 10-13;
PROC SORT DATA=ALCNAS OUT=ALCNASS NODUPLICATES;
BY NIIN;
DATA MCL;
INFILE MCC1SD;
INPUT  FSG $ 8-9 FSC $ 8-11 NIIN $ 12-20 MMC $ 21-22 MCC 1;
PROC SORT DATA=MCL OUT=MCLL NODUPLICATES;
BY NIIN;
DATA JAK;
INFILE JAK1SD;
INPUT FSG $ 8-9 FSC $ 8-11 NIIN $ 12-20 MMC $ 21-22 JAK 1;
PROC SORT DATA=JAK OUT=JAKK NODUPLICATES;
BY NIIN;
DATA GRT;
INFILE GRT1SD;
INPUT FSG $ 8-9 FSC $ 8-11 NIIN $ 12-20 MMC $ 21-22 GRT 1;
PROC SORT DATA=GRT OUT=GRTT NODUPLICATES;
BY NIIN;
DATA TUC;
INFILE TUC1SD;
INPUT FSG $ 8-9 FSC $ 8-11 NIIN $ 12-20 MMC $ 21-22 TUC 1;
PROC SORT DATA=TUC OUT=TUCC NODUPLICATES;
BY NIIN;
DATA BUR;
INFILE BUR1SD;
INPUT FSG $ 8-9 FSC $ 8-11 NIIN $ 12-20 MMC $ 21-22 BUR 1;
PROC SORT DATA=BUR OUT=BURR NODUPLICATES;
BY NIIN;
DATA HANI;
INFILE SYRASPLV;;
INPUT FSG $ 4-7 FSC $ 4-5 NIIN $ 8-16 MMC $ 17-18 HAN 2;
PROC SORT DATA=HANI OUT=HANNI NODUPLICATES;
BY NIIN;
DATA DEMS;
INFILE F7;
INPUT FSG $ 8-9 FSC $ 8-11 NIIN $ 8-16 MMC $ 21-22 HIT 1;
PROC SORT DATA=DEMS OUT=DEMMS NODUPLICATES;
BY NIIN;
```

```
DATA MICAP;
INFILE MICAP;
INPUT FSG $ 1-2 FSC $ 1-4 NIIN $ 5-13 MIC $ 10-13;
IF MIC>1 THEN MIC=1;
PROC SORT DATA=MICAP OUT=MICAPP;
BY NIIN;
DATA MASTER;
MERGE ALCNASS MCLL JAKK GRTT TUCC BURR HANNI DEMMS MICAPP;;
BY NIIN;
IF MCC=. THEN MCC=0;
IF JAK=. THEN JAK=0;
IF GRT=. THEN GRT=0;
IF TUC=. THEN TUC=0;
IF BUR=. THEN BUR=0;
IF HAN=. THEN HAN=0;
IF HIT=. THEN HIT=0;
IF MIC=. THEN MIC=0;
IF ALC=. THEN ALC=0;
IF ALC>0 THEN ALC=1;
TOTAL=MCC+JAK+GRT+BUR+TUC+HAN+ALC+HIT+MIC;
IF FSC=5345 OR FSC=5350 OR FSC=9910 OR FSC=9915 or FSC=9920 OR FSC=9930
   OR FSG=13 OR FSG=35 OR FSG=37 or FSG=55 OR FSG=65 OR FSG=71 OR FSG=72
   OR FSG=76 or FSG=77 OR FSG=78 OR FSG=79 OR FSG=80 OR FSG=83 or FSG=84
   OR FSG=85 OR FSG=87 OR FSG=88 OR FSG=89 or FSG=94;
IF TOTAL>0;
PROC SORT DATA=MASTER OUT=MASTERR NODUPLICATES;
BY NIIN;
PROC TABULATE DATA=MASTERR FORMAT=COMMA10.;
     CLASS FSC;
     TABLE FSC;
PROC TABULATE DATA=MASTERR FORMAT=COMMA10.;
     CLASS FSG;
     TABLE FSG;
PROC TABULATE DATA=MASTERR FORMAT=COMMA10.;
     CLASS TOTAL;
     TABLE TOTAL;
PROC TABULATE DATA=MASTERR FORMAT=COMMA10.;
     CLASS MCC JAK GRT TUC BUR HAN HIT ALC MIC;
     TABLE MCC JAK GRT TUC BUR HAN HIT ALC MIC;
```

Note: This program merges the data based on the NSN from the Syracuse item record (data) files F1 and F4, the ALC F-16A/B NASSL, the five MCD source bases, the 216 records loaded at Syracuse, and the MCD file created based on demands at Syracuse, and the file containing cause code A and B MICAP incidents at Syracuse. PROC TABULATE is used to determine the number of records established for items which are excluded from NASSL consideration as prescribed by AFM 67-1, Vol I, Part One.

```
options ls=132;
data f4test;
infile f4;
input nsn $ 4-16 price 27-34 erc $ 41-43 b $ 47 cp 140 fp 143 sp 146
dlc 170-174 bc $ 185 shlc $ 51 acqc $ 158;
if b='B';
PROC SORT DATA=F4TEST out=newdat noduplicates;;
BY nsn;
data f1test;
infile f1;
input nsn $ 4-16 price 27-34 erc $ 41-43 b $ 47 tp 143 fop 146 dlp 170-
174
bc $  185 isgp $ 186-189 rp $ 190 isgs $ 45 ppc $ 46 bsp 198 shlp $ 51
acqp $ 158;
if b='B';
proc sort data=f1test out=olddat noduplicates;;
by nsn;
data mcl;
infile mcclsd;
input nsn $ 8-20 erc $ 25 price 30-37 mcl 1;
proc sort data=mcl OUT=MCLL NODUPLICATES;
by nsn;
data jak;
infile jaklsd;
input nsn $ 8-20 erc $ 25 price 30-37 jak 1;
proc sort data=jak OUT=jakk NODUPLICATES;
by nsn;
data tuc;
infil [illegible];
input nsn $ 8-20 erc $ 25 price 30-37 tuc 1;
prcc sort data=tuc OUT=TUCC NODUPLICATES;
by nsn;
data grt;
infile grtlsd;
input nsn $ 8-20 erc $ 25 price 30-37 grt 1;
proc sort data=GRT OUT=GRTT NODUPLICATES;
by nsn;
data bur;
infile burlsd;
input nsn $ 8-20 erc $ 25 price 30-37 bur 1;
proc sort data=bur OUT=BURR NODUPLICATES;
by nsn;
data hanci;
infile hancsplv;
```

```
input nsn $ 4-16 han 2;
proc sort data=hanci out=hanki noduplicates;
by nsn;
data hancii;
infile hancspii;
input nsn $ 4-16 han 2;
proc sort data=hancii out=hankii noduplicates;
by nsn;
data demand;
infile f7;
input nsn $ 8-20 hit 1;
proc sort data=demand OUT=DEMANDD NODUPLICATES;
by nsn;
data alcnas;
infile f16nassl;
input nsn $ 1-13 alc 10-13;
proc sort data=alcnas out=alcnass noduplicates;
by nsn;
data micap;
infile micap;
input nsn $ 1-13 mic $ 1-4;
if mic>1 then mic=1;
proc sort data=micap out=micapp noduplicates;
by nsn;
data master;
merge newdat olddat tucc mclL jakk grtT burR hanki hankii
 demandD alcnass micapp;
by nsn;
if isgc>'0' or isgp>'0' or mcl='1' or jak='1' or tuc='1' or grt='1'
or bur='1' or han='1' or hit='1' or mic='1';
if mcl=. then mcl=0;
if jak=. then jak=0;
if tuc=. then tuc=0;
if grt=. then grt=0;
if bur=. then bur=0;
if han=. then han=0;
if hit=. then hit=0;
if mic=. then mic=0;
if isgc=. then isgc=0;
if isgp=. then isgp=0;
if alc>0 then alc=1;
IF ALC=. THEN ALC=0;
IF CP=. THEN CP=0;
IF FP=. THEN FP=0;
IF SP=. THEN SP=0;
IF TP=. THEN TP=0;
IF FOP=. THEN FOP=0;
DEMANDS=CP+FP+SP+TP+FOP;
total=mcl+jak++HAN+tuc+grt+bur+ALC;
IF TOTAL>1;
IF SHLP='A' OR SHLP='B' OR SHLP='C' OR SHLP='D' OR SHLP='E' OR
   SHLP='F' OR SHLP='G' OR SHLP='H' OR SHLP='J' OR SHLP='K' OR
```

```
   SHLP='1' OR SHLP='2' OR SHLP='3' OR SHLP='4' OR SHLP='5' OR
   ACQP='F' OR ACQP='L' OR ACQP='M' OR ACQP='N' OR ACQP='T' OR
   ACQP='V' OR ACQP='X' OR ACQP='Y' OR ACQP='Z' or acqp='K' or
   acqp='P';
PROC SORT DATA=MASTER OUT=MASTERR NODUPLICATES;
BY NSN;
PROC TABULATE DATA=MASTERR FORMAT=COMMA10.;
   CLASS SHLP;
   TABLE SHLP;
PROC TABULATE DATA=MASTERR FORMAT=COMMA10.;
   CLASS ACQP;
   TABLE ACQP;
PROC TABULATE DATA=MASTERR FORMAT=COMMA10.;
   CLASS MCL JAK TUC GRT BUR ALC HAN HIT MIC;
   TABLE MCL JAK TUC GRT BUR ALC HAN HIT MIC;
PROC TABULATE DATA=MASTERR FORMAT=COMMA10.;
   CLASS TOTAL;
   TABLE TOTAL;
```

Appendix K: SAS Program for Investigative Issues 2 - 6

Note: This program merges data from the core data files and the SPARES forecast substituting McEntire ANGB for Montana. PROC TABULATE is used to provide the summary tables with the performance measurements.

```
options ls=132;
data f4test;
infile f4;
input nsn $ 4-16 price $ 23-34 errcd $ 42 b $ 47 cp 140
 fp 143 sp 146 dlc $ 170-174;
if b='B';
PROC SORT DATA=F4TEST out=newdat;
BY nsn;
data fltest;
infile fl;
input nsn $ 4-16 price $ 23-34 errcd $ 42 b $ 47 tp 143
 fop 146 dlp $ 170-174 bc $ 185 isgp $ 186-189 rp $ 190;
if b='B';
proc sort data=fltest out=olddat;
by nsn;
data mcl;
infile mcclsd;
input nsn $ 8-20 mcl 1;
proc sort data=mcl OUT=MCLL NODUPLICATES;
by nsn;
data jak;
infile jaklsd;
input nsn $ 8-20 jak 1;
proc sort data=jak OUT=jakk NODUPLICATES;
by nsn;
data tuc;
infile tuclsd;
input nsn $ 8-20 tuc 1;
proc sort data=tuc OUT=TUCC NODUPLICATES;
by nsn;
data grt;
infile grtlsd;
input nsn $ 8-20 grt 1;
proc sort data=GRT OUT=GRTT NODUPLICATES;
by nsn;
data bur;
infile burlsd;
input nsn $ 8-20 bur 1;
proc sort data=bur OUT=BURR NODUPLICATES;
by nsn;
data hanci;
infile syrasplv;
input nsn $ 4-16 han 2;
proc sort data=hanci out=hanki noduplicates;
by nsn;
```

```
data mcefor;
infile sparemac;
input nsn $ 8-20 mac 1;
proc sort data=mcefor out=macfor noduplicates;
by nsn;
data demand;
infile f7;
input nsn $ 8-20 hit 1;
proc sort data=demand OUT=DEMANDD NODUPLICATES;
by nsn;
data micap;
infile micap;
input nsn $ 1-13 mic 1;
if mic>0 then mic=1;
proc sort data=micap out=micapp noduplicates;
by nsn;
data master;
merge newdat olddat mclL jakk tucC grtT burR hanki
 demandD micapp macfor;
by nsn;
if isgp>'0' or jak=1 or mcl=1 or tuc=1
 or grt=1 or bur=1 or han=1 or mac=1 or hit=1 or mic=1;
if mcl=. then mcl=0;
if tuc=. then tuc=0;
if grt=. then grt=0;
if bur=. then bur=0;
if han=. then han=0;
if mac=. then mac=0;
if hit=. then hit=0;
if isgp=. then isgp=0;
if jak=. then jak=0;
if cp=. then cp=0;
if fp=. then fp=0;
if sp=. then sp=0;
if tp=. then tp=0;
if fop=. then fop=0;
if mic=. then mic=0;
if errcd=' ' then errcd='M';
if dlp=' ' then dlp=0;
IF DLC=' ' THEN DLC=0;
if price=' ' then price=0;
demands=cp+fp+sp+tp+fop;
total=mcl+jak+tuc+grt+bur;
PROC SORT DATA=MASTER;
by nsn;
data isgroll;
set master;
proc sort data=isgroll;
by isgp;
data isgone;
set isgroll;
if rp='M' or rp='I';
```

```
by isgp;
if first.isgp then do;
cpt=0;
fpt=0;
spt=0;
tpt=0;
fopt=0;
mict=0;
mclt=0;
jakt=0;
tuct=0;
grtt=0;
burt=0;
tohan=0;
tomac=0;
tohit=0;
todems=0;
totot=0;
todlp=0;
TODLC=0;
end;
cpt+cp;
fpt+fp;
spt+sp;
tpt+tp;
fopt+fop;
mict+mic;
mclt+mcl;
jakt+jak;
tuct+tuc;
grtt+grt;
burt+bur;
tohan+han;
tomac+mac;
tohit+hit;
todems+demands;
totot+total;
todlp+dlp;
TODLC+DLC;
if last.isgp;
if tohan>0 or tomac>0 or tohit>0 or mict>0 or totot>0;
proc sort data=isgone;
by nsn;
data noisg;
set master;
by nsn;
if rp='M' or Rp='I' then delete;
cpt=cp+0;
fpt=fp+0;
spt=sp+0;
tpt=tp+0;
fopt=fop+0;
```

```
mict=mic+0;
mclt=mcl+0;
jakt=jak+0;
tuct=tuc+0;
grtt=grt+0;
burt=bur+0;
todlp=dlp+0;
TODLC=DLC+0;
todems=demands+0;
tohan=han+0;
tomac=mac+0;
tohit=hit+0;
totot=total+0;
if tohan>0 or tohit>0 or totot>0 or mict>0;
proc sort data=noisg out=nisg nodups;
by nsn;
data final;
set isgone nisg;
by nsn;
IF TOHAN>0;
extdol=todlp*price*.01;
proc TABULATE DATA=FINAL;
CLASS ERRCD;
VAR EXTDOL;
TABLE ERRCD ALL,
  EXTDOL*F=DOLLAR16.2 EXTDOL*N;
DATA ISS3A;
SET ISGONE NISG;
IF TOHAN=0 AND TOHIT=0 THEN DELETE;
IF TOHAN>0 THEN TOHAN=1;
IF TOHIT>0 THEN TOHIT=1;
EXTDOL=TODLP*PRICE*.01;
FILL=TOHAN-TOHIT;
IF FILL=0 THEN ACTUAL='FILL';
IF FILL=1 THEN ACTUAL='EXCS';
IF FILL<0 THEN ACTUAL='BACK';
PROC TABULATE DATA=ISS3A;
CLASS ACTUAL ERRCD;
VAR EXTDOL;
TABLE ACTUAL*ERRCD ALL,
  EXTDOL*F=DOLLAR16.2 EXTDOL*N;
DATA ISS3B;
SET ISGONE NISG;
IF TOHAN=0 AND TODEMS=0 THEN DELETE;
IF TOHAN>0 THEN TOHAN=1;
IF TODEMS>0 THEN TODEMS=1;
EXTDOL=TODLP*PRICE*.01;
FILL=TOHAN-TODEMS;
IF FILL=0 THEN ALLDEMS='FILL';
IF FILL=1 THEN ALLDEMS='EXCS';
IF FILL<0 THEN ALLDEMS='BACK';
PROC TABULATE DATA=ISS3B;
```

```
CLASS ALLDEMS ERRCD;
VAR EXTDOL;
TABLE ALLDEMS*ERRCD ALL,
  EXTDOL*F=DOLLAR16.2 EXTDOL*N;
DATA ISS3C;
SET ISGONE NISG;
IF TOMAC=0 AND TOHIT=0 THEN DELETE;
IF TOMAC>0 THEN TOMAC=1;
IF TOHIT>0 THEN TOHIT=1;
EXTDOL=TODLP*PRICE*.01;
FILL=TOMAC-TOHIT;
IF FILL=0 THEN MACHIT='FILL';
IF FILL=1 THEN MACHIT='EXCS';
IF FILL<0 THEN MACHIT='BACK';
PROC TABULATE DATA=ISS3C;
CLASS MACHIT ERRCD;
VAR EXTDOL;
TABLE MACHIT*ERRCD ALL,
  EXTDOL*F=DOLLAR16.2 EXTDOL*N;
DATA ISS3D;
SET ISGONE NISG;
IF TOMAC=0 AND TODEMS=0 THEN DELETE;
IF TOMAC>0 THEN TOMAC=1;
IF TODEMS>0 THEN TODEMS=1;
EXTDOL=TODLP*PRICE*.01;
FILL=TOMAC-TODEMS;
IF FILL=0 THEN MACDEMS='FILL';
IF FILL=1 THEN MACDEMS='EXCS';
IF FILL<0 THEN MACDEMS='BACK';
PROC TABULATE DATA=ISS3D;
CLASS MACDEMS ERRCD;
VAR EXTDOL;
TABLE MACDEMS*ERRCD ALL,
  EXTDOL*F=DOLLAR16.2 EXTDOL*N;
```

Appendix L: SAS Program for Investigative Issue 7

Note: This program provided the forecast performance without the forecast or demand data being rolled up to the master item record in the I&SG. PROC TABULATE was used to provide a summary table of forecast performance.

```
options ls=80;
data f4test;
infile f4;
input nsn $ 4-16 price $ 23-34 errcd $ 42 b $ 47 cp 140 fp
143
 sp 146 dlc $ 170-174;
if b='B';
PROC SORT DATA=F4TEST out=newdat noduplicates;
BY nsn;
data fltest;
infile fl;
input nsn $ 4-16 price $ 23-34 errcd $ 42 b $ 47 tp 143 fop
146
 dlp $ 170-174 bc $ 185 nppcp $ 46 isgp $ 186-189 rp $ 190
splp 208;
if b='B';
proc sort data=fltest out=olddat noduplicates;
by nsn;
data mcl;
infile mcclsd;
input nsn $ 8-20 mcl 1;
proc sort data=mcl OUT=MCLL NODUPLICATES;
by nsn;
data jak;
infile jaklsd;
input nsn $ 8-20 jak 1;
proc sort data=jak OUT=jakk NODUPLICATES;
by nsn;
data tuc;
infile tuclsd;
input nsn $ 8-20 tuc 1;
proc sort data=tuc OUT=TUCC NODUPLICATES;
by nsn;
data grt;
infile grtlsd;
input nsn $ 8-20 grt 1;
proc sort data=GRT OUT=GRTT NODUPLICATES;
by nsn;
data bur;
infile burlsd;
input nsn $ 8-20 bur 1;
proc sort data=bur OUT=BURR NODUPLICATES;
by nsn;
```

```
data hanci;
infile syrasplv;
input nsn $ 4-16 han 2;
proc sort data=hanci out=hanki noduplicates;
by nsn;
data demand;
infile f7;
input nsn $ 8-20 hit 1;
proc sort data=demand OUT=DEMANDD NODUPLICATES;
by nsn;
data micap;
infile micap;
input nsn $ 1-13 hours 17-20 cause $ 24 mic 1-4;
if mic>0 then mic=1;
proc sort data=micap out=micapp noduplicates;
by nsn;
data master;
merge newdat olddat mclL jakk tucC grtT burR hanki
 demandD micapp;
by nsn;
if isgp>'0' or jak=1 or mcl=1 or tuc=1
 or grt=1 or bur=1 or han=1 or hit=1 or mic=1;
if mcl=. then mcl=0;
if tuc=. then tuc=0;
if grt=. then grt=0;
if bur=. then bur=0;
if han=. then han=0;
if hit=. then hit=0;
if isgp=. then isgp=0;
if jak=. then jak=0;
if splp=. then splp=0;
if cp=. then cp=0;
if fp=. then fp=0;
if sp=. then sp=0;
if tp=. then tp=0;
if fop=. then fop=0;
if hours=. then hours=0;
if mic=. then mic=0;
if errcd=' ' then errcd='MIS';
if dlp=' ' then dlp=0;
IF DLC=' ' THEN DLC=0;
if price=' ' then price=0;
dems=cp+fp+sp+tp+fop;
total=mcl+jak+tuc+grt+bur;
PROC SORT DATA=MASTER out=masterr;
by nsn;
data issu2;;
set masterr;;
by nsn;
if han>0;
extdol=dlp*price*.01;
proc tabulate data=issu2;
```

```
class errcd;
var extdol;
table errcd all,
   extdol*F=dollar16.2 extdol*n;
data iss3a;
set masterr;
if han>0 or hit>0;
extdol=dlp*price*.01;
if han=0 and hit=0 then delete;
fill=han-hit;
if fill=1 then RESULT='EXCS';
if fill=0 then RESULT='FILL';
if fill<0 then RESULT='BACK';
proc tabulate data=iss3a;
class RESULT ERRCD;
var extdol;
table RESULT*ERRCD ALL,
   extdol*f=16.2 extdol*n;
DATA ISS3B;
SET masterr;
IF HAN>0 OR DEMS>0;
IF DEMS>1 THEN DEMS=1;
if dems=0 and han=0 then delete;
EXTDOL=dlp*price*.01;
FILL=HAN-DEMS;
IF FILL=1 THEN RESULT='EXCS';
IF FILL=0 THEN RESULT='FILL';
IF FILL<0 THEN RESULT='BACK';
PROC TABULATE DATA=ISS3B;
CLASS RESULT ERRCD;
VAR EXTDOL;
TABLE RESULT*ERRCD ALL,
   EXTDOL*F=16.2 EXTDOL*N;
```

Appendix M. SAS Program for Investigative Issue 8

Note: This program merged the four forecasts developed in this research. PROC TABULATE was used to provide summary tables of items demanded and forecasted, demanded and not forecasted, and forecasted and not demanded. In addition, the program provided data to calculate a cumulative fill rate percentage for those items forecasted and subsequently demanded.

```
options ls=132;
data f4test;
infile f4;
input nsn $ 4-16 price $ 23-34 errcd $ 42 b $ 47 cp 140
 fp 143 sp 146 dlc $ 170-174;
if b='B';
PROC SORT DATA=F4TEST out=newdat;
BY nsn;
data fltest;
infile fl;
input nsn $ 4-16 price $ 23-34 errcd $ 42 b $ 47 tp 143
 fop 146 dlp $ 170-174 bc $ 185 isgp $ 186-189 rp $ 190;
if b='B';
proc sort data=fltest out=olddat;
by nsn;
data mcl;
infile kansal6;
input nsn $ 8-20 mcl 1;
proc sort data=mcl OUT=MCLL NODUPLICATES;
by nsn;
data jak;
infile jackal6;
input nsn $ 8-20 jak 1;
proc sort data=jak OUT=jakk NODUPLICATES;
by nsn;
data tuc;
infile tucsal6;
input nsn $ 3-20 tuc 1;
proc sort data=tuc OUT=TUCC NODUPLICATES;
by nsn;
data grt;
infile montal6;
input nsn $ 8-20 grt 1;
proc sort data=GRT OUT=GRTT NODUPLICATES;
by nsn;
data bur;
infile burlal6;
input nsn $ 8-20 bur 1;
proc sort data=bur OUT=BURR NODUPLICATES;
by nsn;
data twypct;
```

```
infile f1620pct;
input nsn $ 8-20 twy 1;
proc sort data=twypct out=twpct noduplicates;
by nsn;
data thypct;
infile f1630pct;
input nsn $ 8-20 thy 1;
proc sort data=thypct out=thpct noduplicates;
by nsn;
data frtypct;
infile f1640pct;
input nsn $ 8-20 fty 1;
proc sort data=frtypct out=fopct noduplicates;
by nsn;
data nspc;
infile sbss;
input nsn $ 11-23 nspc 115;
proc sort data=nspc out=nsp noduplicates;
by nsn;
data demand;
infile f7;
input nsn $ 8-20 hit 1;
proc sort data=demand OUT=DEMANDD NODUPLICATES;
by nsn;
data micap;
infile micap;
input nsn $ 1-13 mic 1;
if mic>0 then mic=1;
proc sort data=micap out=micapp noduplicates;
by nsn;
data master;
merge newdat olddat mclL jakk tucC grtT burR
 demandD micapp twpct thpct fopct nsp;
by nsn;
if isgp>'0' or jak=1 or mcl=1 or tuc=1
 or grt=1 or bur=1 or hit=1 or mic=1 or twy=1 or
 thy=1 or fty=1 or nspc=1;
if mcl=. then mcl=0;
if tuc=. then tuc=0;
if grt=. then grt=0;
if bur=. then bur=0;
if twy=. then twy=0;
if thy=. then thy=0;
if fty=. then fty=0;
if nspc=. then nspc=0;
if hit=. then hit=0;
if isgp=. then isgp=0;
if jak=. then jak=0;
if cp=. then cp=0;
if fp=. then fp=0;
if sp=. then sp=0;
if tp=. then tp=0;
```

```
if fop=. then fop=0;
if mic=. then mic=0;
if errcd=' ' then errcd='M';
if dlp=' ' then dlp=0;
IF DLC=' ' THEN DLC=0;
if price=' ' then price=0;
demands=cp+fp+sp+tp+fop;
total=mcl+jak+tuc+grt+bur;
PROC SORT DATA=MASTER;
by nsn;
data isgroll;
set master;
proc sort data=isgroll;
by isgp;
data isgone;
set isgroll;
if rp='M' or rp='I';
by isgp;
if first.isgp then do;
cpt=0;
fpt=0;
spt=0;
tpt=0;
fopt=0;
mict=0;
mclt=0;
jakt=0;
tuct=0;
grtt=0;
burt=0;
ttwy=0;
tthy=0;
tfty=0;
tnspc=0;
tohit=0;
todems=0;
totot=0;
todlp=0;
TODLC=0;
end;
cpt+cp;
fpt+fp;
spt+sp;
tpt+tp;
fopt+fop;
mict+mic;
mclt+mcl;
jakt+jak;
tuct+tuc;
grtt+grt;
burt+bur;
ttwy+twy;
```

```
tthy+thy;
tfty+fty;
tnspc+nspc;
tohit+hit;
todems+demands;
totot+total;
todlp+dlp;
TODLC+DLC;
if last.isgp;
if ttwy>0 or tthy>0 or tfty>0 or tnspc>0 or tohit>0 or
 mict>0 or totot>0;
proc sort data=isgone;
by nsn;
data noisg;
set master;
by nsn;
if rp='M' or Rp='I' then delete;
cpt=cp+0;
fpt=fp+0;
spt=sp+0;
tpt=tp+0;
fopt=fop+0;
mict=mic+0;
mclt=mcl+0;
jakt=jak+0;
tuct=tuc+0;
grtt=grt+0;
burt=bur+0;
todlp=dlp+0;
TODLC=DLC+0;
todems=demands+0;
ttwy=twy+0;
tthy=thy+0;
tfty=fty+0;
tnspc=nspc+0;
tohit=hit+0;
totot=total+0;
if ttwy>0 or tthy>0 or tfty>0 or tnspc>0 or tohit>0 or
 totot>0 or mict>0;
proc sort data=noisg out=nisg noduplicates;
by nsn;
DATA ISS3A;
SET ISGONE NISG;
IF Ttwy=0 AND TOHIT=0 THEN DELETE;
IF ttwy>0 THEN ttwy=1;
IF TOHIT>0 THEN TOHIT=1;
EXTDOL=TODLP*PRICE*.01;
FILL=ttwy-TOHIT;
IF FILL=0 THEN twymeas='FILL';
IF FILL=1 THEN twymeas='EXCS';
IF FILL<0 THEN twymeas='BACK';
PROC TABULATE DATA=ISS3A;
```

```
CLASS twymeas ERRCD;
VAR EXTDOL;
TABLE twymeas*ERRCD ALL,
  EXTDOL*F=DOLLAR16.2 EXTDOL*N;
DATA ISS3b;
SET ISGONE NISG;
IF TTHY=0 AND TOHIT=0 THEN DELETE;
IF TTHY>0 THEN TTHY=1;
IF TOHIT>0 THEN TOHIT=1;
EXTDOL=TODLP*PRICE*.01;
FILL=TTHY-TOHIT;
IF FILL=0 THEN thymeas='FILL';
IF FILL=1 THEN thymeas='EXCS';
IF FILL<0 THEN thymeas='BACK';
PROC TABULATE DATA=ISS3b;
CLASS thymeas ERRCD;
VAR EXTDOL;
TABLE thymeas*ERRCD ALL,
  EXTDOL*F=DOLLAR16.2 EXTDOL*N;
DATA ISS3c;
SET ISGONE NISG;
IF Tfty=0 AND TOHIT=0 THEN DELETE;
IF tfty>0 THEN tfty=1;
IF TOHIT>0 THEN TOHIT=1;
EXTDOL=TODLP*PRICE*.01;
FILL=tfty-TOHIT;
IF FILL=0 THEN ftymeas='FILL';
IF FILL=1 THEN ftymeas='EXCS';
IF FILL<0 THEN ftymeas='BACK';
PROC TABULATE DATA=ISS3c;
CLASS ftymeas ERRCD;
VAR EXTDOL;
TABLE ftymeas*ERRCD ALL,
  EXTDOL*F=DOLLAR16.2 EXTDOL*N;
DATA ISS3d;
SET ISGONE NISG;
IF tnspc=0 AND TOHIT=0 THEN DELETE;
IF tnspc>0 THEN tnspc=1;
IF TOHIT>0 THEN TOHIT=1;
EXTDOL=TODLP*PRICE*.01;
FILL=tnspc-TOHIT;
IF FILL=0 THEN nspmeas='FILL';
IF FILL=1 THEN nspmeas='EXCS';
IF FILL<0 THEN nspmeas='BACK';
PROC TABULATE DATA=ISS3d;
CLASS nspmeas ERRCD;
VAR EXTDOL;
TABLE nspmeas*ERRCD ALL,
  EXTDOL*F=DOLLAR16.2 EXTDOL*N;
DATA ISS3e;
SET ISGONE NISG;
if tohit>0 and ttwy>0;
```

```
extdol=todlp*price*.01;
if fopt>0 then fopt=1;
if (tpt+fopt>0) then tpt=1;
if (spt+tpt>0) then spt=1;
if (fpt+spt>0) then fpt=1;
if (cpt+fpt>0) then cpt=1;
proc tabulate data=iss3e;
class fopt tpt spt fpt cpt;
table fopt tpt spt fpt cpt;
```

Appendix N: SAS Programs for Investigative Issue 9

Note: This program merged 1SD images form the five source bases and calculated annual demand rates for those items forecasted by SPARES. PROC SORT procedures were used to determine the minimum threshold of demand for items forecasted.

```
options ls=132;
data kans;
infile kansa16;
input rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data tucs;
infile tucsa16;
input rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data jack;
infile jacka16;
input rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data mont;
infile monta16;
input rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data burl;
infile burla16;
input rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data range;
set kans tucs jack mont burl;
proc sort data=range out=range1;
by nsn descending spc;
data rollup;
set range1;
by nsn;
if first.nsn then do;
  rddr=0;
  rddfr=0;
  end;
  rddr+ddr;
  rddfr+ddfr;
if last.nsn;
crd=rddr*.365;
nd=rddfr*.0365;
proc sort data=rollup out=source noduplicates;
by nsn;
data twenty;
infile f1620pct;
input twy 1 nsn $ 8-22;
proc sort data=twenty out=twen noduplicates;
```

```
by nsn;
data thirty;
infile f1630pct;
input thy 1 nsn $ 8-22;
proc sort data=thirty out=thir noduplicates;
by nsn;
data forty;
infile f1640pct;
input fty 1 nsn $ 8-22;
proc sort data=forty out=four noduplicates;
by nsn;
data kans1;
infile kansal6;
input kans 1 nsn $ 8-22;
proc sort data=kans1 out=kans2 noduplicates;
by nsn;
data tucs1;
infile tucsal6;
input tucs 1 nsn $ 8-22;
proc sort data=tucs1 out=tucs2 noduplicates;
by nsn;
data jack1;
infile jackal6;
input jack 1 nsn $ 8-22;
proc sort data=jack1 out=jack2 noduplicates;
by nsn;
data mont1;
infile montal6;
input mont 1 nsn $ 8-22;
proc sort data=mont1 out=mont2 noduplicates;
by nsn;
data burl1;
infile burlal6;
input burl 1 nsn $ 8-22;
proc sort data=burl1 out=burl2 noduplicates;
by nsn;
data med;
merge kans2 tucs2 jack2 mont2 burl2;
by nsn;
if kans=. then kans=0;
if tucs=. then tucs=0;
if jack=. then jack=0;
if mont=. then mont=0;
if burl=. then burl=0;
total=kans+tucs+jack+mont+burl;
proc sort data=med out=medmast noduplicates;
by nsn;
data master;
merge source twen thir four medmast;
by nsn;
if twy=. then twy=0;
if thy=. then thy=0;
```

```
if fty=. then fty=0;
if twy=1 or thy=1 or fty=1;
proc sort data=master;
by nd crd;
proc print data=master;
var nsn erc crd nd twy thy fty total kans tucs jack mont burl;
proc sort data=master;
by crd nd;
proc print data=master;
var nsn erc crd nd twy thy fty total kans tucs jack mont burl;
```

Note: This program merged the record files from the five source bases and the different forecasts developed in this study. PROC TABULATE was to provide summary totals of those records common between source bases and the gaining base and those records subsequently demanded and forecasted.

```
options ls=80;
data kans;
infile kansal6;
input rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data tucs;
infile tucsal6;
input rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data jack;
infile jackal6;
input rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 73-80;
data mont;
infile montal6;
input rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data burl;
infile burial6;
input rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data range;
set kans tucs jack mont burl;
proc sort data=range out=range1;
by nsn descending spc;
data rollup;
set range1;
by nsn;
if first.nsn then do;
  rddr=0;
  rddfr=0;
  end;
  rddr+ddr;
  rddfr+ddfr;
if last.nsn;
crd=rddr*.365;
nd=rddfr*.0365;
proc sort data=rollup out=source nodupl icates;
by nsn;
data twenty;
infile f1620pct;
input twy i nsn $ 8-22;
proc sort data=twenty out=twen noduplicates;
by nsn;
data thirty;
```

```
infile f1630pct;
input thy 1 nsn $ 8-22;
proc sort data=thirty out=thir noduplicates;
by nsn;
data forty;
infile f1640pct;
input fty 1 nsn $ 8-22;
proc sort data=forty out=four noduplicates;
by nsn;
data kans1;
infile kansal6;
input kans 1 nsn $ 8-22;
proc sort data=kans1 out=kans2 noduplicates;
by nsn;
data tucs1;
infile tucsal6;
input tucs 1 nsn $ 8-22;
proc sort data=tucs1 out=tucs2 noduplicates;
by nsn;
data jack1;
infile jackal6;
input jack 1 nsn $ 8-22;
proc sort data=jack1 out=jack2 noduplicates;
by nsn;
data mont1;
infile montal6;
input mont 1 nsn $ 8-22;
proc sort data=mont1 out=mont2 noduplicates;
by nsn;
data burl1;
infile burlal6;
input burl 1 nsn $ 8-22;
proc sort data=burl1 out=burl2 noduplicates;
by nsn;
data hits;
infile f7;
input hit 1 nsn $ 8-22;
proc sort data=hits out=hhits noduplicates;
by nsn;
data mcd;
merge kans2 tucs2 jack2 mont2 burl2;
by nsn;
if kans=. then kans=0;
if tucs=. then tucs=0;
if jack=. then jack=0;
if mont=. then mont=0;
if burl=. then burl=0;
total=kans+tucs+jack+mont+burl;
proc sort data=mcd out=mcdmast noduplicates;
by nsn;
data master;
merge source twen thir four hhits mcdmast;
```

```
by nsn;
if twy=. then twy=0;
if thy=. then thy=0;
if fty=. then fty=0;
if hit=. then hit=0;
if total=. then total=0;
if burl=. then burl=0;
if tucs=. then tucs=0;
if jack=. then jack=0;
if kans=. then kans=0;
if mont=. then mont=0;
proc sort data=master;
by nsn;
proc tabulate data=master;
class total;
var twy thy fty hit kans tucs jack mont burl;
table total all,
    total twy thy fty hit kans tucs jack mont burl;
proc tabulate data=master;
class hit;
var kans tucs jack mont burl total;
table hit all,
    kans tucs jack mont burl total;
```

Appendix O: SAS Program to Tabulate Data from Core Files

Note: This SAS program merged record formats from the core data files. PROC TABULATE was used to provide a summary table of records across ERRCD categories.

```
options ls=80;
data f4test;
infile f4;
input irc 1 nsn $ 4-16 price 27-34 errcd $ 41-43 b $ 47 cp 140 fp 143
sp 146 dlc 170-174 bc $ 185 shlc $ 51 acqc $ 158;
if b='B';
PROC SORT DATA=F4TEST out=newdat noduplicates;
BY nsn;
data f1test;
infile f1;
input irp 1 nsn $ 4-16 price 27-34 errcd $ 41-43 b $ 47 tp 143 fop 146
dlp 170-174 bc $  185 isgp $ 186-189 rp $ 190 isgs $ 45 ppc $ 46 bsp 198
shlp $ 51 acqp $ 158;
if b='B';
proc sort data=f1test out=olddat noduplicates;
by nsn;
data mcl;
infile mcclsd;
input nsn $ 8-20 erc $ 25 price 30-37 mcl 1;
proc sort data=mcl OUT=MCLL NODUPLICATES;
by nsn;
data jak;
infile jaklsd;
input nsn $ 8-20 erc $ 25 price 30-37 jak 1;
proc sort data=jak OUT=jakk NODUPLICATES;
by nsn;
data tuc;
infile tuclsd;
input nsn $ 8-20 erc $ 25 price 30-37 tuc 1;
proc sort data=tuc OUT=TUCC NODUPLICATES;
by nsn;
data grt;
infile grtlsd;
input nsn $ 8-20 erc $ 25 price 30-37 grt 1;
proc sort data=GRT OUT=GRTT NODUPLICATES;
by nsn;
data bur;
infile burlsd;
input nsn $ 8-20 erc $ 25 price 30-37 bur 1;
proc sort data=bur OUT=BURR NODUPLICATES;
by nsn;
data syrasplv;
infile syrasplv;
input nsn $ 4-16 han 2;
```

```
proc sort data=syrasplv out=splv noduplicates;
by nsn;
data demand;
infile f7;
input nsn $ 8-20 hit 1;
proc sort data=demand OUT=DEMANDD NODUPLICATES;
by nsn;
data micap;
infile micap;
input nsn $ 1-13 mic 1-4;
if mic>1 then mic=1;
proc sort data=micap out=micapp noduplicates;
by nsn;
data alcnas;
infile f16nass1;
input nsn $ 1-13 alc 10-13;
if alc>1 then alc=1;
proc sort data=alcnas out=alcnass noduplicates;
by nsn;
data master;
merge newdat olddat mcll jakk tucc burr grtt alcnass
 micapp demandd splv;
by nsn;
if erc='N' and errcd=. then errcd='XB3';
if erc='T' and errcd=. then errcd='XD2';
if erc='P' and errcd=. then errcd='XF3';
proc sort data=master out=masterr noduplicates;
by nsn;
proc tabulate data=masterr;
class errcd;
var irc irp mcl tuc jak grt bur han hit alc mic;
table errcd all,
      irc irp mcl tuc jak grt bur han hit alc mic;
run;
```

Note: This SAS program concatenated the 1SD images from the five source bases. PROC TABULATE was used to build a summary table of images by SRD.

```
options ls=132;
data kans;
infile kans4621;
input kans 1 rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data tucs;
infile tucs3044;
input tucs 1 rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data jack;
infile jack4830;
input jack 1 rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data mont;
infile mont4626;
input mont 1 rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data burl;
infile burl4678;
input burl 1 rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data syra;
infile f7;
input syra 1 rid $ 4-6 nsn $ 8-22 erc $ 25 price $ 30-37 spc $ 57
ddr $ 58-62 ddfr $ 63-66 srd $ 78-80;
data range;
set kans tucs jack mont burl syra;
if syra=. then syra=0;
if kans=. then kans=0;
if tucs=. then tucs=0;
if jack=. then jack=0;
if mont=. then mont=0;
if burl=. then burl=0;
if syra=1 or burl=1 or tucs=1 or jack=1 or mont=1 or kans=1;
total=kans+tucs+jack+mont+burl;
proc sort data=range;
by nsn spc;
proc TABULATE DATA=RANGE;
CLASS srd;
var kans tucs jack mont burl syra;;
table srd all,
    kans tucs jack mont burl syra;
```

Appendix P: SAS Program to Analyze Recent MCD File

Note: This program uses PROC TABULATE procedures to provide summary totals of XB3 items across benck stock and SPC categories and also identifies those records with a DDFR of .0000.

```
OPTIONS LS=80;
DATA DDFR;
INFILE R37;
INPUT NSN $ 8-22 ERC $ 25 price 30-37 BSF $ 56 SPC $ 57
DDR $ 58-62 DDFR $ 63-66;
IF erc='N';
PROC TABULATE DATA=DDFR;
CLASS SPC;
TABLE SPC;
proc tabulate data=ddfr;
class BSF;
table BSF;
proc tabulate data=ddfr;
class spc bsf;
var price;
table spc*bsf all,
  price*f=dollar16.2 price*n;
DATA DDFR;
INFILE R37;
INPUT NSN $ 8-22 ERC $ 25 price 30-37 BSF $ 56 SPC $ 57
DDR $ 58-62 DDFR $ 63-66;
IF erc='N';
if ddfr='0000';
PROC TABULATE DATA=DDFR;
CLASS SPC;
TABLE SPC;
proc tabulate data=ddfr;
class BSF;
table BSF;
proc tabulate data=ddfr;
class spc bsf;
var price;
table spc*bsf all,
  price*f=dollar16.2 price*n;
```

Appendix Q: SURGE Program (37)

Note: This SURGE program was developed by the Supply Systems Management Staff at the Lowry Technical Training Center, Lowry AFB CO. The program replicates the R65/GV910 program used to consolidate MCD from multiple sources.

```
p!
!RUN GV21SD,,2USAF
!SYM,D PRINT$.
!XQT USAF*GVABSUD001.GV801A
CANCEL
UTL003SURGE,IL       , 1SD MERGE PGM
 MAIN: SEQUENCE
  OPEN INPUT DISK-4 USING '2USAF*1SDA' ;
  OPEN OUTPUT DISK-3 USING '2USAF*1SDB' ;
MOVE 0 TO #DDR ;
MOVE 0 TO #DR ;
MOVE 0 TO #DDFR ;
MOVE 0 TO #DF ;
MOVE 0 TO #CT ;
MOVE SPACES(6) TO DDR ;
MOVE SPACES(4) TO DDFR ;
MOVE SPACES(81) TO ASD ;
READ DISK-4 ;
MOVE $DISK-4-RCD[1,81] TO ASD ;
 GET-ASD: REPEAT UNTIL $STATUS <> '0'
  CK-NSN: CHOOSE $DISK-4-RCD[8,22] <> ASD[8,22]
    MOVE #DDR / 5 TO DDR EDITING '99999' ;
    MOVE #DDFR / 5 TO DDFR EDITING '9999' ;
    MOVE DDR TO ASD[58,62] ;
    MOVE DDFR TO ASD[63,66] ;
    MOVE ASD TO $DISK-3-RCD[1,81] ;
    WRITE DISK-3 ;
    WRITE DISK-3 ;
    MOVE SPACES(132) TO $DISK-3-RCD ;
MOVE 0 TO #DDR ;
MOVE 0 TO #DR ;
MOVE 0 TO #DDFR ;
MOVE 0 TO #DF ;
MOVE SPACES(6) TO DDR ;
MOVE SPACES(4) TO DDFR ;
MOVE SPACES(81) TO ASD ;
MOVE #CT + 1 TO #CT ;
MOVE $DISK-4-RCD[1,81] TO ASD ;
  CK-NSN: END
  CK-NSN: END
 MOVE $DISK-4-RCD[58,62] TO #DR ;
 MOVE $DISK-4-RCD[63,66] TO #DF ;
 MOVE #DDR + #DR TO #DDR ;
```

```
 MOVE #DDFR + #DF TO #DDFR ;
MOVE 0 TO #DDFR ;
MOVE 0 TO #DF ;
  CK-SPC: CHOOSE $DISK-4-RCD[57,57] = '1'
    MOVE '1' TO ASD[57,57] ;
  CK-SPC: END
READ DISK-4 ;
GET-ASD: END
CLOSE DISK-3 ;
RE-OPEN INPUT DISK-3 ;
FORMAT OFF ;
READ DISK-3 ;
 PRT-1SD: REPEAT UNTIL $STATUS <> '0'
  PRINT $DISK-3-RCD[1,81] ;
  READ DISK-3 ;
 PRT-1SD: END
MAIN: END
STOP
??STOP
!FIN
EOF:60
0:
```

Appendix R: SAS Replication of R65/GV910 and RECOMP

Note: This SAS program replicated the SBSS R65/GV910 and RECOMP programs. Algorithms were based on those described in AFM 67-1, Vol II, Part Two, (19) and AFLMC studies (38).

```
options ls=80;
data kans;
infile kansA16;
input IMA 1 rid $ 4-6 nsn $ 8-22 erc $ 25 UP $ 30-37 spc $ 57
  ddr 58-62 ddfr 63-66 srd $ 78-80;
data tucs;
infile tucsA16;
input IMA 1 rid $ 4-6 nsn $ 8-22 erc $ 25 UP $ 30-37 spc $ 57
  ddr 58-62 ddfr 63-66 srd $ 78-80;
data jack;
infile jackA16;
input IMA 1 rid $ 4-6 nsn $ 8-22 erc $ 25 UP $ 30-37 spc $ 57
  ddr 58-62 ddfr 63-66 srd $ 78-80;
data mont;
infile montA16;
input IMA 1 rid $ 4-6 nsn $ 8-22 erc $ 25 UP $ 30-37 spc $ 57
  ddr 58-62 ddfr 63-66 srd $ 78-80;
data burl;
infile burlA16;
input IMA 1 rid $ 4-6 nsn $ 8-22 erc $ 25 UP $ 30-37 spc $ 57
  ddr 58-62 ddfr 63-66 srd $ 78-80;
data range;
set kans tucs jack mont burl;
PRICE=UP*.01;
proc sort data=range out=range1;
by nsn descending spc;
data rollup;
set range1;
by nsn;
if first.nsn then
   do;
   rddr=0;
   rddfr=0;
   RIMA=0;
   end;
   rddr+ddr;
   rddfr+ddfr;
   RIMA+IMA;
if last.nsn;
proc sort data=rollup out=rolled;
   by nsn;
data finmed;
set rolled;
Nddr=rddr/RIMA*.001;
```

```
nddfr=Rddfr/RIMA*.0001;
IF (ERC='N' AND SPC=1) THEN STOCK=1;
IF (ERC='N' AND NDDFR>.0222) THEN STOCK=1;
IF (ERC='P' AND NDDFR>.0054) THEN STOCK=1;
IF (ERC='T' AND NDDFR>.0054) THEN STOCK=1;
IF (ERC='P' AND NDDFR=.0054) THEN STOCK=1;
IF (ERC='T' AND NDDFR=.0054) THEN STOCK=1;
IF (ERC='P' AND NDDFR<.0054) THEN DELETE;
IF (ERC='T' AND NDDFR<.0054) THEN DELETE;
IF (ERC='N' AND SPC=2 AND PRICE>10 AND NDDFR<.0027) THEN
DELETE;
IF (ERC='N' AND SPC=3 AND PRICE>1 AND NDDFR<.0027) THEN
DELETE;
if (ERC='N' AND SPC=4 AND DDFR<.0027) THEN DELETE;
IF (ERC='N' AND SPC=5 AND DDFR<.0027) THEN DELETE;
if rid ne 'JBB' or rid ne 'JBH' then oc=5.2;
if rid='JBB' or rid='JBH' then oc=19.94;
hc=.15;
if rid ne 'JBB' or rid ne 'JBH' then costfac=8.3;
if rid='JBB' or rid='JBH' then costfac=16.3;
if RID='AKZ' or RID='N32' then OST=26;
if RID='B14' or RID='B16' or RID='JBH' then OST=24;
if RID='B17' then OST=41;
if RID='F4U' then OST=0;
if RID='FFZ' or RID='FGZ' OR rid='N35' then OST=23;
if RID='FHZ' THEN OST=15;
if RID='FLZ' or RID='S9C' OR RID='S9E' then OST=18;
if RID='FPD' THEN OST=25;
if RID='FPZ' or RID='GSA' OR RID='S9I' then OST=18;
if RID='JBB' then OST=17;
IF rid='S9G' THEN OST=19;
IF RID='S9M' OR RID='S9T' THEN OST=20;
if RID='AKZ' or RID='N32' then AOST=26/365;
if RID='B14' or RID='B16' or RID='JBH' then AOST=24/365;
if RID='B17' then AOST=41/365;
if RID='F4U' then AOST=0;
if RID='FFZ' or RID='FGZ' OR rid='N35' then AOST=23/365;
if RID='FHZ' THEN AOST=15/365;
if RID='FLZ' or RID='S9C' OR RID='S9E' then AOST=18/365;
if RID='FPD' THEN AOST=25/365;
if RID='FPZ' or RID='GSA' OR RID='S9I' then AOST=18/365;
if RID='JBB' then AOST=17/365;
IF rid='S9G' THEN AOST=19/365;
IF RID='S9M' OR RID='S9T' THEN AOST=20;
IF RID='AKZ' THEN VOO=1798;
IF RID='B14' THEN VOO=248;
IF RID='B16' THEN VOO=1176;
IF RID='B17' THEN VOO=0;
IF RID='F4U' THEN VOO=0;
IF RID='FFZ' THEN VOO=1317;
IF RID='FGZ' THEN VOO=2672;
IF RID='FHZ' THEN VOO=3144;
```

```
IF RID-'FLZ' THEN VOO-1571;
IF RID-'FPD' THEN VOO-0;
IF RID-'FPZ' THEN VOO-1497;
IF RID-'GSA' THEN VOO-471;
IF RID-'JBB' THEN VOO-700;
IF RID-'JBH' THEN VOO-958;
IF RID-'N32' THEN VOO-2239;
IF RID-'N35' THEN VOO-1460;
IF RID-'S9C' THEN VOO-931;
IF RID-'S9E' THEN VOO-712;
IF RID-'S9I' THEN VOO-1494;
IF RID-'S9M' THEN VOO-210;
IF RID-'S9T' THEN VOO-661;
IF RID-'S9G' THEN VOO-1313;
MODEM-NDDR*30;
ANDEM-NDDR*365;
EOQI-NDDR*365*PRICE;
EOQII-SQRT(EOQI);
EOQIII-COSTFAC*EOQII;
EOQ-EOQIII/PRICE;
IF EOQ<MODEM THEN EOQ-MODEM;
IF EOQ>ANDEM THEN EOQ-ANDEM;
OSTQ-OST*NDDR;
LOT-NDDR/NDDFR;
SLQI-NDDFR*OST*LOT*LOT;
SLQII-NDDR*NDDR*VOO;
SLQIII-SLQI+SLQII;
SLQ-SQRT(SLQIII);
SLQSUB-2*OSTQ;
IF SLQSUB<SLQ THEN SLQ-SLQSUB;
ROP-OSTQ+SLQ;
NCT-4;
NCQ-NCT*NDDR;
REPFACT-3*(OSTQ+NCQ);
REPSLQ-SQRT(REPFACT);
USC-35;
CSC-35;
IF SPC-2 THEN USC-.8;
IF SPC-3 THEN USC-.4;
IF SPC-4 THEN USC-.15;
IF SPC-5 THEN USC-.15;
IF SPC-2 THEN CSC-25;
IF SPC-3 THEN CSC-23;
IF SPC-4 THEN CSC-10;
IF SPC-5 THEN CSC-10;
CY-NDDFR*365;
CRD-NDDR*365;
EUOC-8.38;
LIA-.16;
BOC-3.6;
CTM-15.98;
CTA-5.54;
```

```
BOST=31/365;
PBO=.16;
CCTNSI=(CSC*AOST)/BOST;
CCTNSII=CCTNSI+EUOC;
CCTNS=CY*CCTNSII;
UCTNSI=(CRD*USC*AOST)/BOST;
UCTNSII=CY*EUOC;
UCTNS=UCTNSI+UCTNSII;
CCTSA=((EOQ/2)+ROP-(CRD*AOST));
CCTSI=CCTSA*HC*PRICE;
CCTSII=(CRD/EOQ)*OC;
CCTSB=CCTNSI+BOC;
CCTSIII=CY*PBO*CCTSB;
CCTS=CTM+CCTSI+CCTSII+CCTSIII+CTA;
UCTSA=(CRD*USC*AOST)/BOST;
UCTSB=CY*BOC;
UCTSC=UCTSA+UCTSB;
UCTSI=PBO*UCTSC;
UCTS=CTM+CCTSI+CCTSII+UCTSI+CTA;
IF (ERC='N' AND STOCK NE 1 AND CCTNS>CCTS) THEN STOCK=1;
IF (ERC='N' AND STOCK NE 1 AND UCTNS>UCTS) THEN STOCK=1;
IF ERC='N' AND STOCK=1 THEN EOQDL=EOQ+OSTQ+SLQ+.999;
IF (ERC='T' AND STOCK=1 AND PRICE>750) THEN
REPDEL=OSTQ+NCQ+REPSLQ+.5;
IF ERC='T' AND STOCK=1 AND (PRICE<750 OR PRICE=750)
THEN REPDL=OSTQ+NCQ+REPSLQ+.9;
IF ERC='P' AND STOCK=1 AND (PRICE<750 OR PRICE=750) THEN
REPDEL=EOQ+
OSTQ+NCQ+REPSLQ+.9;
IF ERC='P' AND STOCK=1 AND PRICE>750 THEN
REPDEL=OSTQ+NCQ+REPSLQ+.5;
IF STOCK=1;
PROC PRINT DATA=FINMCD UNIFORM;
VAR NSN ERC PRICE SPC REPDEL EOQDL STOCK;
```

Appendix S: SAS Program to Measure Commonality Approach

Note: This SAS program merged record formats from the core data files then deleted those records which were not common to two or more source bases. PROC TABULATE was used to provide a table summary of forecast results.

```
options ls=132;
data f4test;
infile f4;
input nsn $ 4-16 price $ 23-34 errcd $ 42 b $ 47 cp 140
 fp 143 sp 146 dlc $ 170-174;
if b='B';
PROC SORT DATA=F4TEST out=newdat;
BY nsn;
data fltest;
infile fl;
input nsn $ 4-16 price $ 23-34 errcd $ 42 b $ 47 tp 143
 fop 146 dlp $ 170-174 bc $ 185 isgp $ 186-189 rp $ 190;
if b='B';
proc sort data=fltest out=olddat;
by nsn;
data mcl;
infile kansal6;
input nsn $ 8-20 mcl 1;
proc sort data=mcl OUT=MCLL NODUPLICATES;
by nsn;
data jak;
infile jackal6;
input nsn $ 8-20 jak 1;
proc sort data=jak OUT=jakk NODUPLICATES;
by nsn;
data tuc;
infile tucsal6;
input nsn $ 8-20 tuc 1;
proc sort data=tuc OUT=TUCC NODUPLICATES;
by nsn;
data grt;
infile montal6;
input nsn $ 8-20 grt 1;
proc sort data=GRT OUT=GRTT NODUPLICATES;
by nsn;
data bur;
infile burlal6;
input nsn $ 8-20 bur 1;
proc sort data=bur OUT=BURR NODUPLICATES;
by nsn;
data twypct;
infile f1620pct;
input nsn $ 8-20 twy 1;
```

```
proc sort data=twypct out=twpct noduplicates;
by nsn;
data thypct;
infile f1630pct;
input nsn $ 8-20 thy 1;
proc sort data=thy ct out=thpct noduplicates;
by nsn;
data frtypct;
infile f1640pct;
input nsn $ 8-20 fty 1;
proc sort data=frtypct out=fopct noduplicates;
by nsn;
data nspc;
infile sbss;
input nsn $ 11-23 nspc 115;
proc sort data=nspc out=nsp noduplicates;
by nsn;
data demand;
infile f7;
input nsn $ 8-20 hit 1;
proc sort data=demand OUT=DEMANDD NODUPLICATES;
by nsn;
data micap;
infile micap;
input nsn $ 1-13 mic 1;
if mic>0 then mic=1;
proc sort data=micap out=micapp noduplicates;
by nsn;
data master;
merge newdat olddat mclL jakk tucC grtT burR
 demandD micapp twpct thpct fopct nsp;
by nsn;
if isgp>'0' or jak=1 or mcl=1 or tuc=1
 or grt=1 or bur=1 or hit=1 or mic=1 or twy=1 or
 thy=1 or fty=1 or nspc=1;
if mcl=. then mcl=0;
if tuc=. then tuc=0;
if grt=. then grt=0;
if bur=. then bur=0;
if twy=. then twy=0;
if thy=. then thy=0;
if fty=. then fty=0;
if nspc=. then nspc=0;
if hit=. then hit=0;
if isgp=. then isgp=0;
if jak=. then jak=0;
if cp=. then cp=0;
if fp=. then fp=0;
if sp=. then sp=0;
if tp=. then tp=0;
if fop=. then fop=0;
if mic=. then mic=0;
```

```
if errcd=' ' then errcd='M';
if dlp=' ' then dlp=0;
IF DLC=' ' THEN DLC=0;
if price=' ' then price=0;
demands=cp+fp+sp+tp+fop;
total=mcl+jak+tuc+grt+bur;
PROC SORT DATA=MASTER;
by nsn;
data isgroll;
set master;
proc sort data=isgroll;
by isgp;
data isgone;
set isgroll;
if rp='M' or rp='I';
by isgp;
if first.isgp then do;
cpt=0;
fpt=0;
spt=0;
tpt=0;
fopt=0;
mict=0;
mclt=0;
jakt=0;
tuct=0;
grtt=0;
burt=0;
ttwy=0;
tthy=0;
tfty=0;
tnspc=0;
tohit=0;
todems=0;
totot=0;
todlp=0;
TODLC=0;
end;
cpt+cp;
fpt+fp;
spt+sp;
tpt+tp;
fopt+fop;
mict+mic;
mclt+mcl;
jakt+jak;
tuct+tuc;
grtt+grt;
burt+bur;
ttwy+twy;
tthy+thy;
tfty+fty;
```

```
tnspc+nspc;
tohit+hit;
todems+demands;
totot+total;
todlp+dlp;
TODLC+DLC;
if last.isgp;
if ttwy>0 or tthy>0 or tfty>0 or tnspc>0 or tohit>0 or
 mict>0 or totot>0;
proc sort data=isgone;
by nsn;
data noisg;
set master;
by nsn;
if rp='M' or Rp='I' then delete;
cpt=cp+0;
fpt=fp+0;
spt=sp+0;
tpt=tp+0;
fopt=fop+0;
mict=mic+0;
mclt=mcl+0;
jakt=jak+0;
tuct=tuc+0;
grtt=grt+0;
burt=bur+0;
todlp=dlp+0;
TODLC=DLC+0;
todems=demands+0;
ttwy=twy+0;
tthy=thy+0;
tfty=fty+0;
tnspc=nspc+0;
tohit=hit+0;
totot=total+0;
if ttwy>0 or tthy>0 or tfty>0 or tnspc>0 or tohit>0 or
 totot>0 or mict>0;
proc sort data=noisg out=nisg noduplicates;
by nsn;
DATA ISS3c;
SET ISGONE NISG;
if totot=1 then totot=0;
IF totot=0 AND TOHIT=0 THEN DELETE;
if totot>1 then totot=1;
IF TOHIT>0 THEN TOHIT=1;
EXTDOL=TODLP*PRICE*.01;
FILL=totot-TOHIT;
IF FILL=0 THEN commeas='FILL';
IF FILL=1 THEN commeas='EXCS';
IF FILL<0 THEN commeas='BACK';
PROC TABULATE DATA=ISS3c;
CLASS commeas ERRCD;
```

```
VAR EXTDOL;
TABLE commeas*ERRCD ALL,
  EXTDOL*F=DOLLAR16.2 EXTDOL*N;
```

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Vita

Captain Paul L. Bunker was born in Concord, New Hampshire on 23 January 1952. He graduated from Bishop Brady High School in Concord in 1970 and attended Georgia Southern College and Adams State College in Alamosa, CO. He enlisted in the USAF on July 5, 1973 and served in numerous assignments in the Inventory Management career field. In December 1980, he graduated with a Bachelor of General Studies from the University of New Hampshire and received his commission in the USAF upon graduating from Officer Training School in June 1983. He served as the Chief, Material Management Branch and Chief, Customer Support Branch at the 554th Supply Squadron at Nellis AFB, Nevada until April 1985. He then served as the 1605th MASW Chief, Fuels Management Branch at Lajes Field, the Azores, Portugal, from June 1985 to May 1986. His last duty assignment prior to his AFIT studies was as Instructor and Course Administrator for the Supply Operations Officer Course and Advanced Supply Management Course at Lowry AFB, Colorado. He arrived at the Air Force Institute of Technology in May 1990 and entered the School of Systems and Logistics, enrolling in the Inventory Management Program.

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13. ABSTRACT (Maximum 200 words)

This research assessed the performance of the Spare Parts for the Activation of Relocated Systems (SPARES) forecast model used to develop the spares requirements forecast for the August 1988 activation of the 174TFW at Syracuse ANGB NY. SPARES was developed by the Air Force Logistics Management Center in August 1988 to replace existing Standard Base Supply System (SBSS) forecasting procedures. SPARES uses mission change data (MCD) from five similar-size source bases to determine the probability of future demand (PFD) for items at the gaining base. Before implementing SPARES in the SBSS, forecast performance must be measured and model weaknesses identified and corrected. SPARES correctly forecasted 72 percent of the demanded items when a PFD of 20 percent was used; however, 58 percent of the items forecasted did not have subsequent demands. SPARES forecasted 692 items which had less than two customer demands at the five source bases combined. This indicates either the model's program coding is incorrect or deficiencies exist in theoretical program logic. Deficiencies in the MCD collection system also had an impact on SPARES performance. Based on these findings, SPARES program coding and logic as well as the MCD collection system must be reviewed before SPARES is implemented in the SBSS.

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