R **AD-A237 400**

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (*Leave blank*)

2. REPORT DATE
15 Dec 89

3. REPORT TYPE AND DATES COVERED
Summary Aug 88 - Dec 89

4. TITLE AND SUBTITLE
Technology Insertion (TI)/Industrial Process Improvement (IP) Task Order No. 1 Contract Summary Report/Quick Fix Plan for OC-ALC Book 1 of 2

5. FUNDING NUMBERS
Contract

6. AUTHOR(S)
McDonnell Douglas Missile Systems Company

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
McDonnell Douglas Missile Systems Company
St. Louis, Missouri 63166

8. PERFORMING ORGANIZATION REPORT NUMBER
F33600-88-D-0567

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
HQ AFLC/LGME
WPAFB OH 45433

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
F33600-88-D-0567

11. SUPPLEMENTARY NOTES
Prepared in cooperation with OC-ALC/MAB & MAT & HQ AFLC.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Statement A

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

Technology Insertion (TI)/Industrial Process Improvement (IPI) Summary Report for OC-ALC. This document contains Focus Study and Quick Fix Recommendations for 13 Resource Control Centers (RCC's). These RCC's are: MABPAB, MABPFF, MATPAA, MATPAB, MATPAT, MATPCA, MATPCB, MATPCC, MATPCD, MATPCM, MATPFA, MATPFE, MATPFF.

14. SUBJECT TERMS MAINTENANCE, TECHNOLOGY INSERTION, DATA BASE, QUICK-FIX, AFLC, AF, MABPAB, MABPFF, MATPAA, MATPAB, MATPAT, MATPCA, MATPCB, MATPCC, MATPCD, MATPCM, MATPFA, MATPFE, MATPFF

15. NUMBER OF PAGES
269

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unclassified

TECHNOLOGY INSERTION-ENGINEERING SERVICES
PROCESS CHARACTERIZATION
TASK ORDER NO. 1

VOLUME III
OC-ALC
BOOK 1 OF 2

CONTRACT SUMMARY REPORT AND QUICK FIX PLAN
23 OCTOBER 1989
REVISION A
15 DECEMBER 1989

CONTRACT NO. F33600-88-D-0567
CDRL SEQUENCE NO. B008 AND B007

MCDONNELL DOUGLAS
McDonnell Douglas Missile Systems Company
St. Loiuis, Missouri 63166-0516 (314) 232-0232

TECHNOLOGY INSERTION-ENGINEERING SERVICES
PROCESS CHARACTERIZATION
TASK ORDER NO. 1

VOLUME III
OC-ALC
BOOK 1 OF 2

CONTRACT SUMMARY REPORT
23 OCTOBER 1989
REVISION A
15 DECEMBER 1989

CONTRACT NO. F33600-88-D-0567
CDRL SEQUENCE NO. B008

MCDONNELL DOUGLAS
McDonnell Douglas Missile Systems Company
St. Louis, Missouri 63166-0516 (314) 232-0232

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

AFLC	AIR FORCE LOGISTICS COMMAND
ALC	AIR LOGISTICS CENTER
APU	AUXILARY POWER UNIT
ASNT	AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING
ATE	AUTOMATIC TEST EQUIPMENT
CBA	COST BENEFIT ANALYSIS
CN	CONTROL NUMBER
CRT	CATHODE RAY TUBE
CSD	CONSTANT SPEED DRIVE
CSR	CONTRACT SUMMARY REPORT
DDB	DATABASE DOCUMENTATION BOOK
DMMIS	DEPOT MAINTENANCE MANAGEMENT INFORMATION SYSTEM
EOQ	ECONOMIC ORDER QUANTITY
FIFO	FIRST IN-FIRST OUT
FPI	FLUORESCENT PENETRANT INSPECTION
FSR	FOCUS STUDY RECOMMENDATION
FY	FISCAL YEAR
I.D.	IDENTIFICATION
IE	INDUSTRIAL ENGINEER
IRR	INTERNAL RATE OF RETURN
JIT	JUST-IN-TIME
M	MANUFACTURING
MCAIR	MCDONNELL AIRCRAFT COMPANY
MDMSC	MCDONNELL DOUGLAS MISSILE SYSTEMS COMPANY
MIC	MATERIAL INVENTORY CONTROL
MIG	METAL INERT GAS
MISTR	MANAGEMENT OF ITEMS SUBJECT TO REPAIR
MPI	MAGNETIC PARTICLE INSPECTION
MRPII	MATERIAL REQUIREMENT PLANNING
NC OR N/C	NUMERICAL CONTROL

NDI	NONDESTRUCTIVE INSPECTION
NPV	NET PRESENT VALUE
OC-ALC	OKLAHOMA CITY AIR LOGISTICS CENTER
PDM	PLANNED DEPOT MAINTENANCE
PM	PREVENTIVE MAINTENANCE
PME	PREVENTATIVE MAINTENANCE OF EQUIPMENT
PCN	PRODUCTION CONTROL NUMBER OR PART CONTROL NUMBER
PN	PART NUMBER
P.O.	PURCHASE ORDER
QDR	QUALITY DEFICIENCY REPORT
QFP	QUICK FIX PLAN
RCC	RESOURCE CONTROL CENTER
ROI	RETURN ON INVESTMENT
ROM	ROUGH ORDER OF MAGNITUDE
RTV	ROOM TEMPERATURE VULCANIZING (ELASTOMER)
SA-ALC	SAN ANTONIO AIR LOGISTICS CENTER
SM-ALC	SACRAMENTO AIR LOGISTICS CENTER
T	TEMPORARY
TI	TECHNOLOGY INSERTION
TI-ES	TECHNOLOGY INSERTION-ENGINEERING SERVICES
TIG	TUNGSTEN INERT GAS
TO	TASK ORDER
TQM	TOTAL QUALITY MANAGEMENT
UDOS 2.0	UNIVERSAL DEPOT OVERHAUL SIMULATOR 2.0
WCD	WORK CONTROL DOCUMENT
WG	WAGE GRADE
WIP	WORK IN PROCESS

INDEX OF PAGE CHANGES OC-ALC CSR				
REVISION DATE AND LETTER	PAGES AFFECTED			REMARKS
	REVISED	ADDED	REMOVED	
12-15-89-A	TITLE PAGE (BOOK 1 OF 2) ii 6.0-1 6.0-10 6.0-11 6.0-15 6.0-17 6.0-20 6.2-1 6.2-2 6.2-3 6.2-11 6.2-12 6.2-13 6.2-17 6.2-18 6.5-5 6.5-8 6.5-9 6.5-10 6.5-12 6.5-14 6.7-1 6.7-2 6.7-6 6.8-3 6.9-1 6.9-14 6.9-16 6.10-2 6.11-1 6.11-2 6.11-5 6.11-8 6.11-11 6.11-16 6.11-17 6.12-2 6.12-4 6.12-5 6.12-6 6.12-7	xiv xv 6.11-1A 6.19-2A		INCORPORATE CUSTOMER COMMENTS

LSC-20694

INDEX OF PAGE CHANGES OC-ALC CSR				
REVISION DATE AND LETTER	PAGES AFFECTED			REMARKS
	REVISED	ADDED	REMOVED	
12-15-89-A	6.12-11			INCORPORATE CUSTOMER COMMENTS
	6.12-12			
	6.12-15			
	6.12-17			
	TITLE PAGE (BOOK 2 OF 2)			
	6.13-1			
	6.13-2			
	6.13-3			
	6.13-5			
	6.13-7			
	6.13-8			
	6.13-11			
	6.13-12			
	6.13-14			
	6.13-16			
	6.13-26			
	6.13-28			
	6.14-1			
	6.15-1			
	6.19-1			
	6.19-2			
	6.19-12			

LSC-20694

OC-ALC CONTRACT SUMMARY REPORT

6.0 OKLAHOMA CITY AIR LOGISTICS CENTER (OC-ALC)

During the third quarter 1989, McDonnell Douglas Missile Systems Company (MDMSC) completed process characterization of 20 Resource Control Centers (RCCs) at OC-ALC in Oklahoma City, Oklahoma. The process characterization was performed as a part of the Technology Insertion-Engineering Services (TI-ES) Program.

The ALC identified each of the RCCs to be characterized. MDMSC selected the repair processes within the RCC to be modeled based on the 80/20 workload concept, i.e.; 20% of the parts represent 80% of the workload. The repair processes were modeled for two purposes; first, to establish a baseline from which improvements can be measured and second, to identify improvements.

Experimentation Produced the Following Findings:

- FY 88 - All RCCs met the required schedules
- FY 90 - All RCCs will meet the required schedules
- Surge - Six RCCs will require additional equipment or manpower to meet their respective surge requirements

Equipment

MABPFF	-	(1)	Additional transport fixture
MATPAT	-	(1)	Additional test cell must be refurbished to relieve test cell #25 - OC 1028
MATPFF	-	(2)	Additional #945808 AFCS Test Set

Manpower

MATPAB	-	19 Additional mechanics
MATPFA	-	1 Additional mechanic
MATPIW	-	4 Additional welders

Process characterization revealed that substantial opportunities for improvement exists in all RCCs. After review of the opportunity improvements recorded by MDMSC during process characterization, it was discovered that many of these improvement ideas had already been addressed by OC-ALC management. Also, several opportunities for improvement were noted which have applications throughout the ALC or at several of the RCCs characterized. One improvement opportunity, the replacement of degreasing solvent with a biodegradable cleaner, described in detail in paragraphs 6.17 and 6.17.4 of the CSR, is described briefly here due to its importance to the AFLC as perceived by MDMSC. MDMSC has identified a product which seems to be economical, effective and absent from environmental effects. In particular, a product known as Bio-Act® has been highlighted as a candidate for a substitute solvent for many cleaning requirements. It should be noted that Bio-Act® is not the only biodegradable alternative available, and should be compared with similar products. This non-toxic metal cleaner is an effective alternative for ozone-depleting chlorofluorocarbons and chlorinated hydrocarbons for removing cutting oils, cosmoline, and other grease or oil films from metals. Most biodegradables will not corrode metal surfaces and are non-alkaline which eliminates the hazards often associated with caustic metal cleaners.

In addition to MATPIA, RCCs that fabricate and/or assemble advanced electronic devices can also benefit from these solvents. Electronic devices call for the use of effective cleaning agents in many processes. Hologenated solvents have usually been the cleaners of choice. These materials have many desirable characteristics, but nearly all of them have come under fire in recent years due to their harmful environmental effects. Use restrictions, production limits, or other curbs are either in place or are likely to be implemented in the near future for nearly all the chlorine-containing solvents. Safe, effective alternatives are needed quickly to avoid serious manufacturing or repairing disruptions in a number of related applications.

MDMSC and AFLC collaborated in two proposals for the investigation of acceptable substitutes for hazardous solvents currently used in cleaning processes. This item is related to these proposals (Task Order Proposals No. 2

and No. 4). Task Order Proposal No. 4 was to perform, analyze and provide an integrated description of solvent replacement investigations currently in work to AFLC/MA, together with summaries of recent developments in this technology area. For this reason, MDMSC elected not to develop a focus study for any solvent substitutions. However, MDMSC will be happy to entertain any further interest in biodegradable products as a part of any follow-on effort.

A second significant improvement opportunity, integrate all sheet metal repair shops into one centralized location, is described briefly here and in paragraph 6.1.4 of this document. Currently, sheet metal repair operations are performed in three different locations; Buildings 95, 2101, and 3001. Weapon systems repaired in these shops are the C-135, B-52, and F-111. MDMSC recommends integration of these repair efforts to minimize space requirements and optimize the utilization of resources. This can be accomplished by combining repair and manufacturing operations that require similar work force skills and equipment. In order to better support this opportunity with more facts and figures, MDMSC suggests that a complete engineering analysis be done. This analysis will include the use of simulation, utilizing new data, and current data from Task Order No. 1 where applicable. Experimentation design and analysis would be performed prior to developing a plan of action. Also, this study would evaluate setup and teardown capabilities which would be critical factors in the implementation of a flexible sheet metal shop operation. Technology Insertion Working Group members at OC-ALC expressed a strong desire to have this specific improvement opportunity addressed at Focus Study level. MDMSC believes that such a study is needed and could show significant benefits to OC-ALC. MDMSC was unable to quantify the true cost savings associated with integration of the sheet metal shops. Cost evaluation data would require an in-depth assessment which would be obtained as part of a focus study. Because of the lack of quantifiable cost data this recommendation was classified as an other observation (reference paragraph 6.1.4).

The focus study and other observations defined and pursued are described in paragraphs 6.1 through 6.20 of the Contract Summary Report (CSR). The quick fixes defined and pursued are described in paragraphs 6.1 through 6.20 of the Quick Fix Plan.

MDMSC representatives were well received by OC-ALC management and line workers during process characterization. Much of the information obtained was jointly developed by MDMSC/Air Force personnel.

This CSR presents an overview of the MDMSC effort and details recommendations to improve OC-ALC performance for 20 RCCs. Two RCCs are in the MAB Aircraft Division, and the remaining 18 are in the MAT Air Accessories Division (see Figure 6.0-1). The respective RCCs and their responsibilities are:

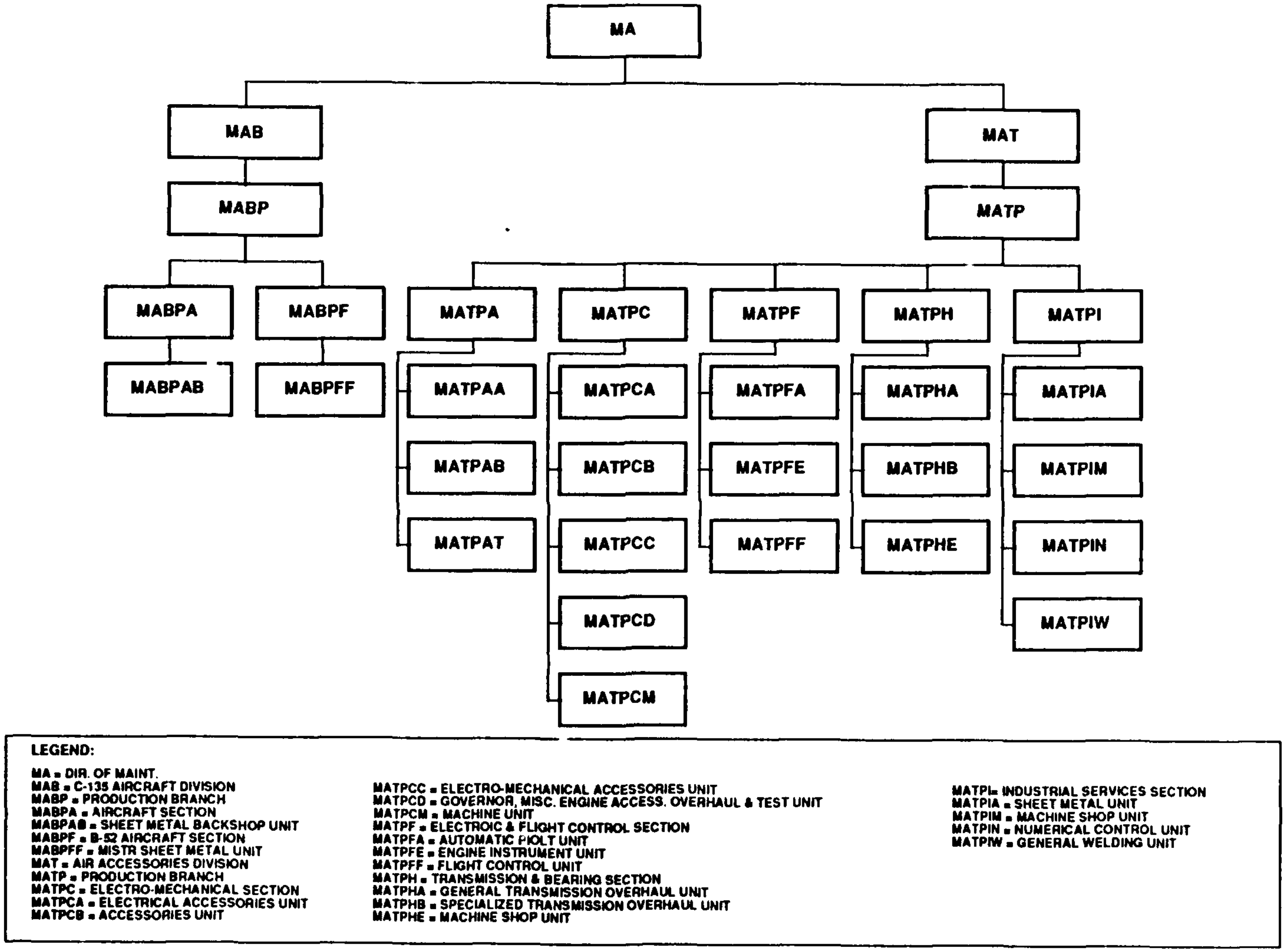
MABPAB - C-135 Sheet Metal Unit
MABPFF - B-52 Sheet Metal Unit

MATPAA - Pneudraulic Accessories
MATPAB - Pneudraulic Accessories
MATPAT - Pneudraulic Accessories

MATPFA - Electronic Accessories
MATPFE - Electronic Accessories
MATPFF - Electronic Accessories

MATPCC - Electro-Mechanical Accessories
MATPCA - Electro-Mechanical Accessories
MATPCB - Electro-Mechanical Accessories
MATPCD - Electro-Mechanical Accessories
MATPCM - Machine Unit
MATPHA - General Transmission Overhaul Unit
MATPHB - Specialized Transmission Overhaul Unit
MATPHE - Machine Shop Unit (CSD)

LSC-20523



OC-ALC RCC PROCESS CHARACTERIZATION COVERAGE
FIGURE 6.0-1

MATPIA - Sheetmetal Unit
- Design, Layout, and Manufacturing
- Manufacture and Repair
- Tubing and Cable Manufacturing
- Tubing and Cable Repair

MATPIM - General Machine Shop Unit
MATPIN - Numerical Control Unit
MATPIW - General Welding Unit

It should be noted that many of the tasks performed by the various ALC facilities are technically demanding and time consuming to perform. A well trained and proficient work force now exists, and this is what allows the completion of assigned workloads, even in the face of the many unique problems. It would be a mistake to compare the processes and tasks occurring in the Air Logistic Centers too strictly to private industry. The diversity of functions in many areas is very different from that found in private industry, as is the scale of this diversity. Considering the inherent complexity of these tasks, identification of methods improvement opportunities is of critical importance. Given current budget constraints, any area promising a reasonable return on investment should be studied.

In the case of scheduling, the TI-ES team found performance in this area to be above average in comparison to private industry standards. It should be remembered that the variation in work tasks performed within any one production shop is in many cases much greater than that found in private industry. The scheduling of product flow into and out of the various RCCs can be a monumental task. This task is made more difficult by the chronic problem of material and parts shortages, in which case the schedulers are used as expediters.

Material support and control may be the single most critical problem faced by the various RCCs studied. Components needed for repair of the various items were often in short supply, and long lead times for parts delivery were common. This has led to the process of "rob back" in many areas, where usable components and subassemblies are removed from an incoming item to finish processing an item awaiting parts.

Parts tracking procedures were found to be inadequate for the scale of the operations seen in the various RCCs studied. Much of the parts tracking procedures now existing seem to be based on the use of handwritten tags. Many areas of private industry have benefited from the use of computerized tracking systems utilizing a bar code scanner system. Given the magnitude of the task in tracking parts used in the various operations performed by the ALC bases, this form of inventory control would certainly be beneficial.

Another area of concern identified by the TI-ES team was the manner in which production planning was performed. The planners encountered at the OC-ALC facility all seem to be proficient in their tasks, and in many cases highly motivated to perform. However, both production personnel and planners commonly expressed frustration with the present system of production support within which they must work. Planners are presently assigned a weapon system, and they provide planning support to those RCCs dealing with items from their designated weapon system. The difficulty arises in that many items worked by specific production areas are very similar from one weapon system to another, and the planner may have responsibility for items worked in several RCCs. It would appear that a better system would be the designation of certain similarly worked items to specific planners. This would allow the planner to be more familiar with the various needs and characteristics of a given production shop, allowing them to create more useful documentation and labor standards. It would also facilitate the planning task across the various RCCs where similar items are processed. Considering the magnitude of the operations occurring at the various ALC bases studied, this system might well provide a better planning-production interface. It would certainly aid production personnel to have a smaller number of planners with whom to deal, and for those planners to be proficient in their understanding of operations occurring in that shop.

A major problem in the process characterization surfaced during the validation meetings at OC-ALC. Intensive analysis of historical data compiled from the

Work Control Documents (WCDs) repeatedly indicated that the data was erroneous, misleading and virtually useless in validating the simulated flow times generated by the UDOS 2.0 model. The occasional alignment of flow days was pure coincidence.

The simulated flow times were ultimately validated by using the G019C report, scheduling flow days and/or supervision expertise.

The specific problems with the WCDs are:

- The AFLC established the start of flow as the date in Block 5 which was supposed to be the date the item(s) are delivered for work. (Reference AFLCR 66-51, 29 July 1983). This document prescribed that Block 5 be left blank to be filled in by the initiator at the time of item(s) delivery. The ALC directions are in direct conflict with AFLC in that their instructions indicate that the filling out of Block 5 is optional; leave blank or enter Julian date (Reference MA Operating Instruction 66-35, 15 November 1982). This confusion resulted in the ALC using the date of printing the WCDs as the schedule date. In the ALC system of releasing WCDs, copies are batch pulled from the system on a two week basis and sometimes on the entire quarterly requirements. This has resulted in as many as 100 WCDs having the same initiation date.
- In some cases the WCDs do not depict real world processing flows and actually produce back tracking of dates due to incorrect operation sequences.
- There are recording inconsistencies such as all operations being stamped off on the same date. When the flow passes through more than one mechanic in a series of repetitive operations, assemble - check - assemble - check, it makes the date stamping arbitrary at best.
- First In-First Out work in process is non-existent as the WCDs do not indicate the item serial numbers. Therefore, tracking is impossible.
- There is no recording of delays due to priority interruptions, part shortages, rework, rejects, and condemnations placed on the WCDs. Therefore, it is impossible to explain any deltas from prescribed flow times.

- The "Rob Back" system of obtaining missing parts also adds to complete meaningless of WCD histories.
- The uselessness of WCDs histories was affirmed by ALC personnel in validation after validation. (Reference OC-ALC validation minutes).

It should also be noted that despite the continual efforts of the ALC TI representative, the Engine Division did not supply the applicable WCDs for the MATPI RCCs.

In addition to the aforementioned WCD problems, the following factors contributed to an interference in the MATPI RCCs data collection effort:

- Tasks, which were mostly temporary and manufacturing, have a high variation in process.
- An arbitrary code coupled with PCN No. was used to apply labor standards to the work performed.
- A route sheet without operation description was used (in most cases).
- Tasks are back shop operations to the primary items. (MATPI does not have ownership of items worked.)
- Non-conforming hours (S-coded work), which makes up a large percentage of the total workload, cannot be accurately profiled.

To minimize the interference of data collection and modeling of MATPIA and MATPIM, manufacturing jobs (M-coded work), a statistical approach was implemented which involves a Taguchi simulation based upon average M jobs in various manufacturing families. This method identifies the causes and relative values of variations from the mean, through a Taguchi sensitivity analysis. A sampling of historical M jobs is used to estimate the frequency of occurrence for each Taguchi factor (source of variance), resulting in a probability model that includes data for both processes required and operation time for each M job. This method has the advantage of capturing a generic average for M jobs as well as a distribution of the deviation from this average.

The accumulation of actual equipment downtime from MAD was impossible to obtain. Although there is a detailed paper work system for collecting this data, the results disappear when inputted into the MAD computer system.

The process characterization of the 20 RCCs at OC-ALC resulted in 222 improvement opportunities. Of these, four are focus studies, 23 are quick fixes, and 195 are other observations that should be considered for additional improvements.

Focus Studies (4)

MATPAT Equipment/Manpower Flexibility - to introduce greater flexibility of manpower and equipment to eliminate test cell specializations and the resulting queues which have precipitated a 3-shift operation. Estimated annual cost savings are $729,306.

MATPAT Quarterly Block Schedule System Based on Manpower and Equipment Capacity - to reduce the number of setups per item and increase the length of item runs. Estimated annual cost savings are $75,452.

MATPFF Improve Automatic Testing Equipment (ATE) Software - to increase the capability of defining the specific problem in a defective item, which will reduce repair time. Estimated annual cost savings are $468,285. Also flow time will be reduced by seven days.

MATPCB Tracking of Indirect Labor Hours is intended to give management a tool for identifying the causes of non-productive paid manhours and controlling their impact on overall ALC operations. It is included here because an opportunity was seen to reap major benefits within this RCC. Estimated annual cost savings are $656,375.

Quick Fixes (23)

MABPAB Implementing A Mobile Tagging Unit Concept is proposed as all tagging and conditioning operations may be performed at the paint shop. A reduction of one flow day is projected. An annual savings is not applicable for this improvement.

MABPFF Performing the Inspection and Buy-off of the Nose Cowls at the Paint Shop is recommended to eliminate returning the cowls back to MABPAB after painting. A reduction of one flow day is projected. An annual savings is not applicable for this improvement.

MABPFF Utilizing a Second Transport Fixture for the Bomb Bay Doors is proposed by constructing a fixture similar to one already in use. Once the doors are loaded onto a cart, they will not have to be unloaded until they are delivered to supply. A yearly savings of $1,792 may be realized.

MATPAA Transporting a Full Day's Supply of Items from the Supply Cage at the Start of the Shift is recommended that one worker be assigned to bring over a day's work to the RCC in one trip. This would prevent each individual worker from having to leave the work area to bring over single units. A yearly savings of $174,554 may be realized.

MATPAA Eliminating High Reject Solenoids may be achieved by purchasing solenoids from Consolidated Controls rather than Kaiser Ekel. Kaiser Ekel's defect rate is 40%. A yearly savings of $10,604 per year may be realized.

MATPAA Using Power Tools for Assembly/Disassembly recommended to provide a more efficient means of unfastening and fastening nuts, screws, and bolts. A yearly savings of $88,498 may be realized.

MATPAA Organizing Work Benches is recommended to create more working space through the use of rotating bins. A yearly savings of $29,499 may be realized.

MATPAB Transporting A Full Day's Supply of Items from the Supply Cage at the Start of the Shift would have one worker supply the entire area rather than individual trips by the mechanics. Estimated savings $119,233.

MATPAB Using Power Tools for Assembly/Disassembly provides a more efficient means of unfastening and fastening nuts, screws, and bolts. Savings estimate $82,125.

MATPAB Organizing Work Benches would create more working space through the use of rotating bins. Estimated savings $27,373 per year.

MATPAB Repairing Rather than Replacing (Purchasing) Cylinder Assemblies is proposed by varnish recoating of cylinder bores. A yearly savings of $11,850 may be realized.

MATPAT Reduction of Manual Lifting of Heavy Fixtures is provided by using a jib crane which would require less labor and increase safety. A yearly savings of $9,725 may be realized.

MATPCC Repairing Rather than Replacing Impellers is proposed to eliminate repair procedure be established for the impellers to eliminate the need to purchase new ones. A yearly savings of $90,360 may be realized.

MATPCC Automating the Testing of the Harness Cables is recommended by automation of the tester. This will free up the mechanic who currently runs the test. A yearly savings of $20,909 may be realized.

MATPCC Using a Bulk Handling System for the Items is recommended for the establishment of procedures to eliminate the movement of individual items by the mechanics. A yearly savings of $31,364 may be realized.

MATPFA Decreasing the Repair Time on Problem Parts by Utilizing a Work Leader proposes the creation of a leader position to prevent repair operations from being delayed because of mechanics running into problems that they do not know how to handle. Estimated savings = $253,230 per year (evaluated in conjunction with MATPFE and MATPFF).

MATPFA Decreasing the Repair Time by Retaining Experienced Workers proposes a review of the compensation rates to insure that workers feel that they are being paid fairly for the work which they do. Estimated savings = $364,933 per year (evaluated in conjunction with MATPFE and MATPFF).

MATPFE Decreasing Flow Time to Repair Pressure Ratio Transducer by deletion of test prior to repair. Estimated savings of approximately $4,803 annually.

MATPFF Refer to MATPFA

MATPCA Control Relay Box (PCN 35113A) Amplifier Assembly is repairable in many cases. As this item is not presently being repaired, the Control Relay Box is replaced at a cost of $2,700/item. Repair of this subassembly would result in a savings of approximately $98,700 annually.

MATPCB Hood Design on Manifold/Nozzle Test Stations (OC 1202 and 1132) is inadequate and unsafe. Fuel spray is escaping the chamber, collecting on floor and equipment. A redesigned hood using neoprene seals and metal tongue in groove mating would alleviate this. (Safety concern, not readily quantifiable.)

MATPCD Replacement versus Repair of Muscle Valve Housing and Cover (PCN 965711A) concerns the replacement of these items when repair processes are documented. The muscle valve housing can be reworked by plug welding and redrilling of holes. The cover can be repaired by replating. Total savings of $99,938 annually are possible.

MATPCM Installation of Digital Readouts on various milling machines and lathes would result in increased accuracy and processing times. Total annual savings possible is $37,098.

MATPHA Eliminate unnecessary testing of CSD pumps after disassembly since the failure rate is less than 1%. Test pumps at final test. Estimated savings of $74,300 per year.

MATPHB Same as above with an estimated savings of $45,500 per year.

MATPHE Reduce scrap rate by providing compartment trays for disassembled parts. These trays will eliminate various types of nicks and scratches caused by handling. An estimated savings of $373,120 per year.

MATPIW To Decrease the Flow Time on Tubing Repair, recommends the removal of a lid from a cleaning tank to streamline the process of putting the tubes into the tank and removing them later. Savings are estimated to be $8,334.

MATPIW To Decrease Flow Time by Eliminating the Transporting of Tubes, recommends that a tubing repair area be set up in RCC MATPIA to eliminate the need to move tubes to and from MATPIW. Savings are estimated to be $10,538.

The ALC may realize an estimated annual cost savings of $3,773,252 if all the focus studies and all the quick fix plan opportunities are incorporated. These savings represent a 3.5% reduction in the current yearly operating costs. See Tables 6.0-1 and 6.0-2.

It should be noted that several MDMSC recommendations may not be within the MA Directorate authority. Consequently, those applicable opportunities may not receive the necessary level of interest from the other Directorates. The current organization is a classic bureaucratic structure with authority concentrated horizontally in various functional groups. This leads to disconnects between authority and responsibility and a loss of communication. A good example is the relationship between the MA and MM Directorates. MA has responsibility for production, but no authority to change and/or improve the processes they use to produce the end product. MM has the authority to change these processes but no responsibility for their improvement. As a result, production managers in MA find it virtually impossible to control their own processes, and engineers in MM find themselves viewed as obstructions rather than aides.

To avoid this problem, many large commercial companies (MDMSC included) have developed a product-oriented organization that gives the production manager complete control over everything required to produce his product. Each manager has his own planning, scheduling, engineering, etc. capability. While this appears to be inefficient (the economics of scale are sometimes lost), the real result is normally a reduction in the amount of overhead staff and an increase in productivity and customer satisfaction.

OC-ALC FOCUS STUDY RECOMMENDATION SUMMARY

TABLE 6.0-1

MDMSC RECOMMENDATION	IMPACT	ANNUAL BUDGET SAVINGS	COST AVOIDANCE			INVESTMENT COST
			FLOW TIME REDUCTION	WIP INVENTORY REDUCTION*	FLOOR SPACE REDUCTION	
EQUIPMENT/MANPOWER FLEXIBILITY (MATPAT)	DIRECT LABOR SAVINGS	$729,306	0 DAYS	$0	0 SQ. FT.	$1,016,127
BLOCK SCHEDULE SYSTEM (MATPAT)	DIRECT LABOR SAVINGS	$75,452	0 DAYS	$0	0 SQ. FT.	$101,000
IMPROVE ATE SOFTWARE (MATPFF)	DIRECT LABOR SAVINGS	$243,739	15 DAYS (EST.)	$0	0 SQ. FT.	$470,000
TRACKING INDIRECT LABOR HOURS	DIRECT LABOR SAVINGS	$656,375	0 DAYS	$0	0 SQ. FT.	$588,188
TOTALS		$1,704,872	15 DAYS	$0	0 SQ. FT.	$2,175,315

NOTES: * WIP INVENTORY REDUCTION = $\frac{\text{\# OF FLOW DAYS REDUCED}}{\text{365 DAYS}}$ X (ASSET $ VALUE) X (YEARLY PRODUCTION RATE)

LSC-20653

OC-ALC QUICK FIX RECOMMENDATION SUMMARY
TABLE 6.0-2 (PAGE 1 OF 4)

MDMSC RECOMMENDATION	IMPACT	ANNUAL BUDGET SAVINGS	COST AVOIDANCE			INVESTMENT COST
			FLOW TIME REDUCTION	WIP INVENTORY REDUCTION*	FLOOR SPACE REDUCTION	
REPAIR CONTROL RELAY BOX, PCN 35113A (MATPCA)	MATERIAL SAVINGS	$98,700	0 DAYS	$0	0 SQ. FT.	$0
IMPROVE HOOD DESIGN ON OC1202 AND OC1132, BLDG. 3108 (MATPCB)	HEALTH AND SAFETY	$0	0 DAYS	$0	0 SQ. FT.	UNKNOWN
REWORKING MUSCLE VALVE HOUSING AND HOUSING COVER FOR 96571A CONTROL ASSEMBLY (MATPCD)	MATERIAL SAVINGS	$99,938	0 DAYS	$0	0 SQ. FT.	$0
IMPROVE MACHINE HANDLING AND ACCURACY BY INSTALLING DIGITAL READOUTS (MATPCM)	DIRECT LABOR SAVINGS (PROCESS)	$37,098	0 DAYS	$0	0 SQ. FT.	$20,950
REDUCE FLOW DAYS AND INCREASE SHOP CAPACITY OF SHEET METAL REPAIR PROCESS (MABPAB)	INVENTORY REDUCTION	$0	1 DAY (EST.)	$0	0 SQ. FT.	$0
DECREASE FLOW TIME BY PERFORMING INSPECTION OF NOSE COWLS AT PAINT SHOP (MABPFF)	INVENTORY REDUCTION	$0	1 DAY (EST.)	$0	0 SQ. FT.	$0

LSC-20654A

OC-ALC QUICK FIX RECOMMENDATION SUMMARY

TABLE 6.0-2 (PAGE 2 OF 4)

MDMSC RECOMMENDATION	IMPACT	ANNUAL BUDGET SAVINGS	COST AVOIDANCE			INVESTMENT COST
			FLOW TIME REDUCTION	WIP INVENTORY REDUCTION*	FLOOR SPACE REDUCTION	
TRANSPORT CART FOR BOMB BAY DOORS (MABPFF)	DIRECT LABOR (TRANSIT)	$1,792	1 DAY (EST.)	$0	0 SQ. FT.	$3,000
MOVE A DAY'S SUPPLY OF UNITS FROM CAGE TO WORK AREA USING ONE OPERATOR (MATPAA) (MATPAB)	DIRECT LABOR (TRANSIT)	$293,787	0 DAYS	$0	0 SQ. FT.	$0
ELIMINATE REJECTION OF SOLENOID BY PROCURING ALL SOLENOIDS FROM CONSOLIDATED CONTROLS (MATPAA)	DIRECT LABOR (REPAIR)	$10,604	0 DAYS	$0	0 SQ. FT.	$0
PROVIDE PORTABLE POWER TOOLS IN ASSY/DISASSY AREA (MATPAA) (MATPAB)	DIRECT LABOR (PROCESS)	$170,623	0 DAYS	$0	0 SQ. FT.	$24,000
ORGANIZE WORKBENCHES TO CREATE MORE SPACE FOR ASSY WORK (MATPAA) (MATPAB)	DIRECT LABOR (PROCESS)	$56,872	0 DAYS	$0	0 SQ. FT.	$8,000
REPAIR INSTEAD OF REPLACE CYLINDER ASSY BY RECOATING DAMAGED VARNISH (MATPAB)	MATERIAL SAVINGS	$11,850	0 DAYS	$0	0 SQ. FT.	$55,440
REDUCE MANUAL LIFTING OF HEAVY FIXTURES AND IMPROVE SAFETY FACTORS (MATPAT)	SAFETY AND DIRECT LABOR	$9,725	0 DAYS	$0	0 SQ. FT.	$1,000

LSC-20654

OC-ALC QUICK FIX RECOMMENDATION SUMMARY
TABLE 6.0-2 (PAGE 3 OF 4)

MDMSC RECOMMENDATION	IMPACT	ANNUAL BUDGET SAVINGS	COST AVOIDANCE			INVESTMENT COST
			FLOW TIME REDUCTION	WIP INVENTORY REDUCTION*	FLOOR SPACE REDUCTION	
BETTER UTILIZE LABOR (MATPCC)	DIRECT LABOR	$31,364	0 DAYS	$0	0 SQ. FT.	$1,000
REDUCE EXPENSES IN MATPCC BY REPAIRING IMPELLER UNITS RATHER THAN PURCHASING THEM	MATERIAL SAVINGS	$90,360	0 DAYS	$0	0 SQ. FT.	$0
REDUCE MANPOWER NEEDED TO TEST HARNESS CABLES (MATPCC)	DIRECT LABOR	$20,909	0 DAYS	$0	0 SQ. FT.	$0
DECREASE REPAIR FLOW TIME BY UTILIZING WORK LEADER (MATPFA, MATPFE, MATPFF)	DIRECT LABOR	$253,230	0 DAYS	$0	0 SQ. FT.	$2,500
DECREASE REPAIR TIME BY RETAINING EXPERIENCED WORKERS (MATPFA, MATPFE, MATPFF)	DIRECT LABOR	$364,933	0 DAYS	$0	0 SQ. FT.	$0
DECREASE FLOW TIMES TO REPAIR PRESSURE RATIO TRANSDUCER (MATPFE)	DIRECT LABOR	$4,803	0 DAYS	$0	0 SQ. FT.	UNKNOWN
ELIMINATE UNNECESSARY TESTING OF PUMPS (MATPHA) (MATPHB)	DIRECT LABOR	$119,800	0 DAYS	$0	0 SQ. FT.	$0
DECREASE FLOW TIME ON TUBING REPAIR (MATPIW)	DIRECT LABOR	$8,334	0 DAYS			$0

LSC-20654

OC-ALC QUICK FIX RECOMMENDATION SUMMARY
TABLE 6.0-2 (PAGE 4 OF 4)

MDMSC RECOMMENDATION	IMPACT	ANNUAL BUDGET SAVINGS	COST AVOIDANCE			INVESTMENT COST
			FLOW TIME REDUCTION	WIP INVENTORY REDUCTION*	FLOOR SPACE REDUCTION	
DECREASE FLOW TIME BY ELIMINATING TRANSPORT OF TUBES TO MATPIW (MATPIW)	DIRECT LABOR	$10,538	0 DAYS	$0	0 SQ. FT.	$0
REDUCE PART SCRAP RATE (MATPHE)	MATERIAL COSTS AND DIRECT LABOR	$373,120	0 DAYS	$0	0 SQ. FT.	$4,500
TOTALS		$2,068,380	3 DAYS	$0	0 SQ. FT.	$72,004

LSC-20654A

6.1 MABPAB ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

During the third quarter 1989, McDonnell Douglas Missile Systems Company (MDMSC) initiated the process characterization as a part of the Technology Insertion-Engineering Services (TI-ES) program.

Throughout the MABPAB repair process, MDMSC found a high level of craftsmanship. Mechanics have demonstrated ownership on their work and were conscious of the product quality and department schedules. However, in order for them to maintain performance, higher induction level may be required, increasing the amount of work in process.

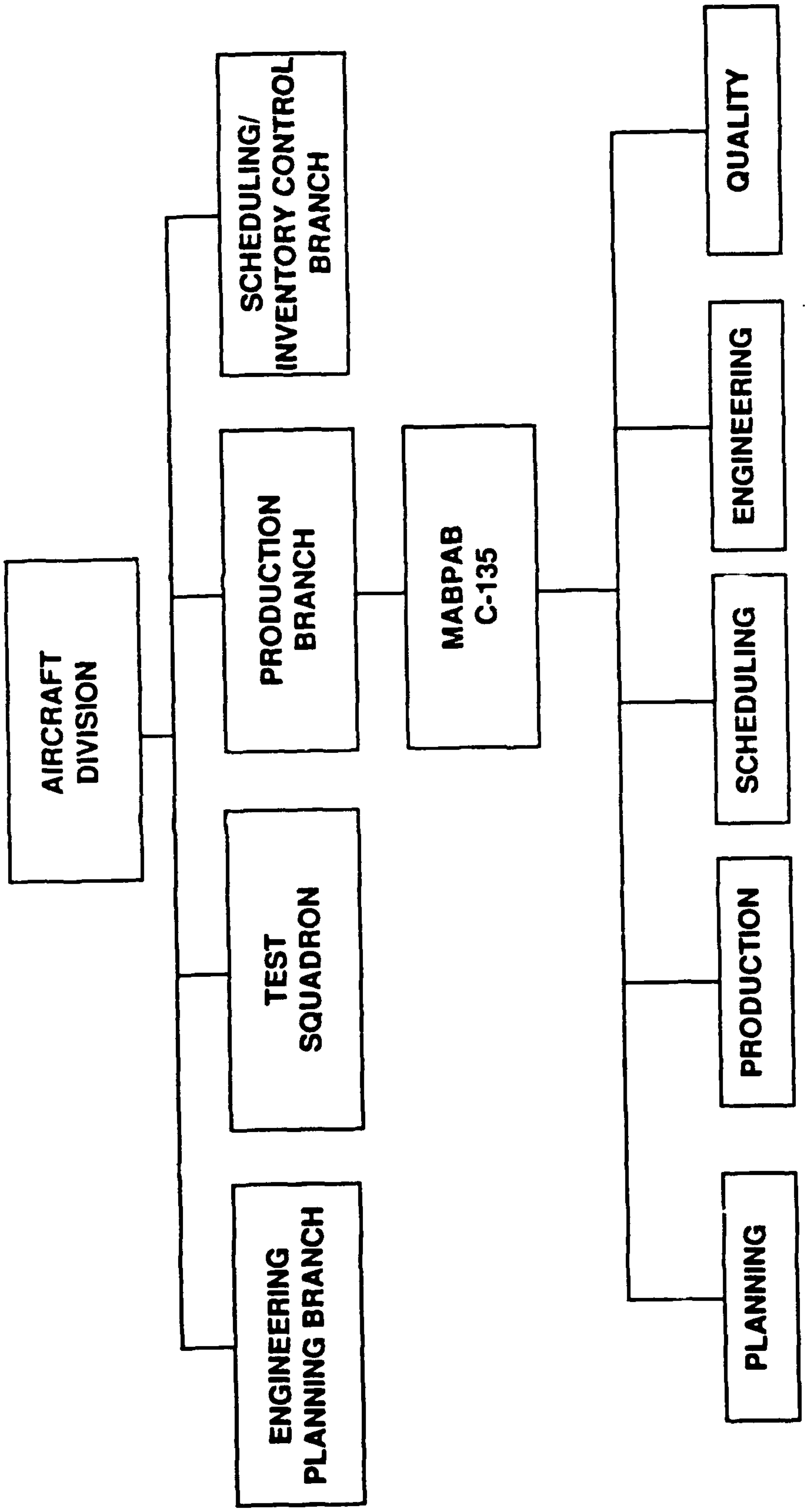
Special effort was given to the MABPAB sheet metal shop in support of the AFLC/ALC request to expedite process characterization through experimentation. The main objective of having MABPAB characterized early was to experiment on plans to relocate the sheet metal shop. At the time the data was being collected, OC-ALC management was contemplating the possibility of moving MABPAB to Building 2101 from Building 95.

This Contract Summary Report (CSR) presents an overview of the TI-ES team effort (MDMSC/OC-ALC). It discusses recommendations to improve the MABPAB sheet metal shop performance.

The success and accomplishment in this expedited effort was made possible by the outstanding support received from the OC-ALC managers and staff. Information collected was a joint effort between MDMSC and ALC personnel (see MABPAB organizational chart, Figure 6.1-1). During the data verification process, MDMSC experienced difficulty establishing historical data that could be used to validate the model. Data collected out of the WCDs was not conducive to establishing baseline. Therefore, the validation team had to use other GFI and shop expertise to validate the model.

The process characterization and experimentation revealed that relocating the MABPAB sheet metal shop from a 95,000 sq. ft. facility in Building 95, to a 65,000 sq. ft. facility in Building 2101, would significantly inhibit the shop's

LSC-20219A



MABPAB ORGANIZATION
FIGURE 6.1-1

capacity. Special considerations must be addressed in order to meet the FY 90 workload and surge demands. We will expand and provide detailed information in our experiment/surge data analysis in paragraph 6.1.2.

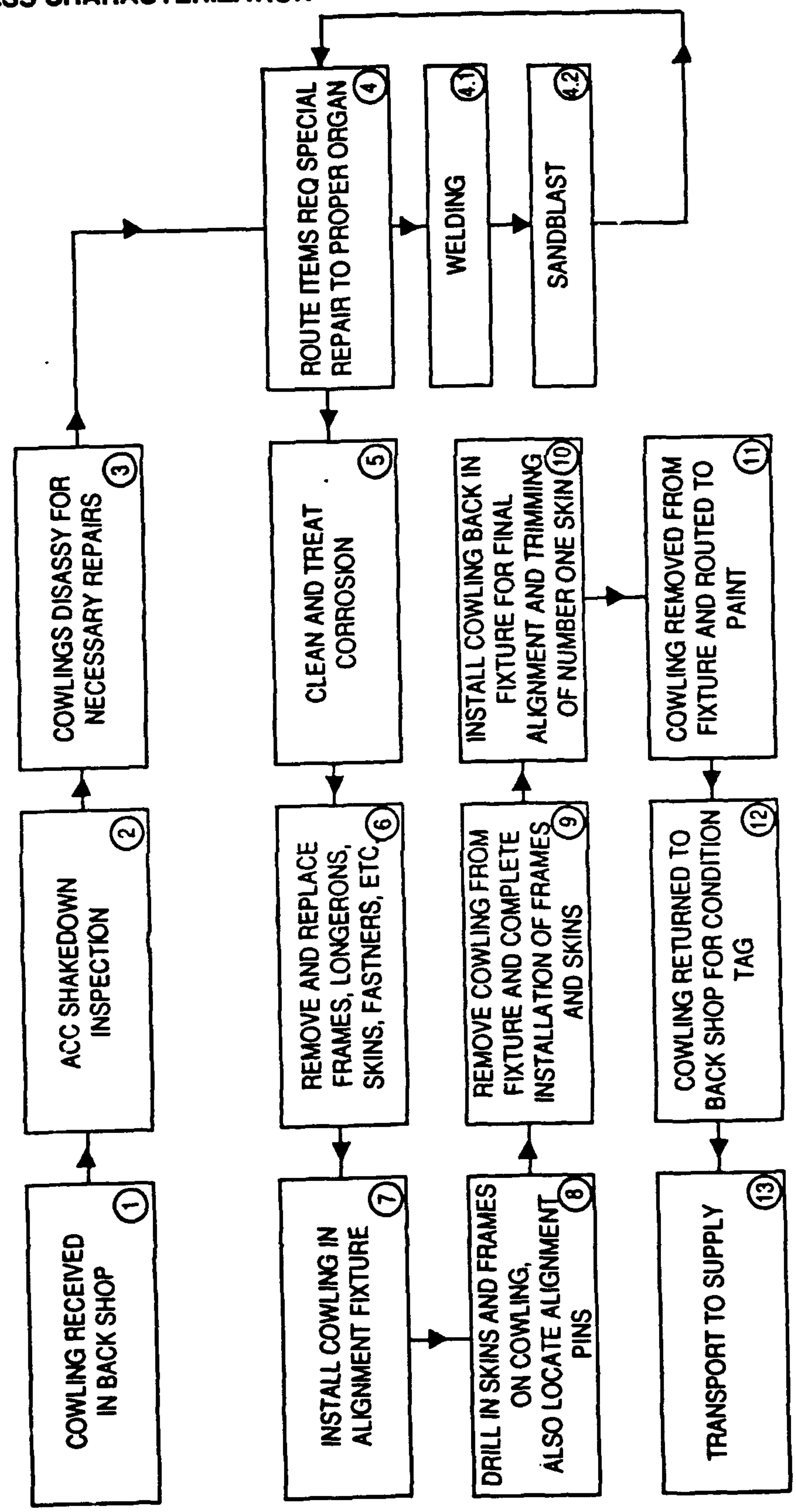
In order to support the area manager's needs to minimize flow time and increase output, several improvement opportunities have been identified. A typical process flow chart on a side cowl repair process is depicted in Figure 6.1-2.

Part of the repair process is the painting operation shown in step 11 on this flow chart. After a part is painted, and the cure process is completed, the item is brought back to MABPAB for a tag-conditioning. This process (tag-conditioning) averages three days of flow time. However, if a mobile condition-tag unit is implemented to allow a sheet metal mechanic to service the items at the paint shop, this would eliminate approximately 1-1/2 flow time days from the repair process. No cost is associated with this recommendation. This is recommended as a quick fix opportunity in the Quick Fix Plan, Volume III, paragraph 6.1.

The balance of original MABPAB improvement opportunities are described in paragraph 6.1.4 as other observations.

6.1.1 <u>Description of Current Operations</u>

After the November 1984 fire in Building 3001, the sheet metal shop (MABPAB) moved to Building 95. This relocation added approximately 12 miles of travel to the back shop repair processes. Presently, an end-item travels approximately 18 miles. This, in itself, represents between six to eight days of flow time. Depending on the type of end item, this could account for 20% to 30% of the repair process. Typical end items going through the sheet metal repair process are: flaps, elevators, rudders, nose cowls, ailerons, doors, sleeves, etc.



LSC-20218A

FLOW CHART SIDE COWL REPAIR SHOP
FIGURE 6.1-2

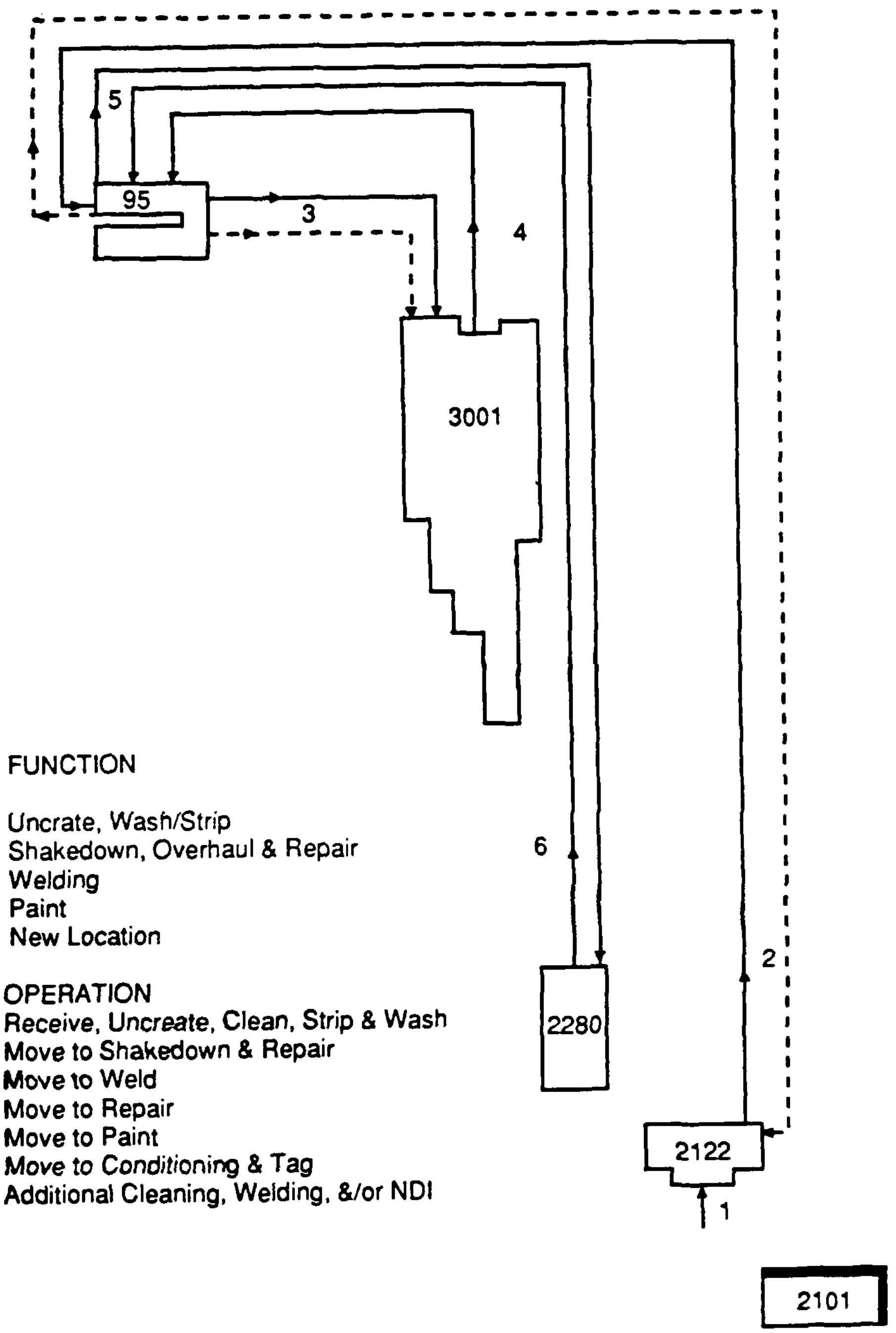
The back shop travel time could be minimized by: (1) relocating MABPAB closer to other back shops, and (2) developing MABPAB to be capable of performing more repair processes. Option one is currently being evaluated by MAD, which is to move MABPAB to Building 2101.

The sheet metal repair process begins outside Building 2122, where the end item is received and uncrated by MABPCD personnel (see Step 1, Figure 6.1.1-1). The end item is then moved inside the building to be cleaned. The cleaning process requires a paint strip, a wash, and grit blasting for most end items. This is done by MABPA personnel.

Paint stripping, grit blasting and washing are considered back shop activities and were characterized as dwell time. The model output identified an opportunity on the sleeve assembly 15236A where reoccurring back shop dwell time is projected due to inadequate cleaning done the first time (see Figure 6.1.1-2).

The end item is then moved across the base to the MABPAB sheet metal shop in Building 95, where the repair process begins (see Step 2, Figure 6.1.1-1). The handling of end items is done on trailers pulled by a truck. Moves between buildings are scheduled between 8:30 a.m. to 3:00 p.m. to accommodate incoming and outgoing traffic. At times, the wind factor prevents moving large end items across the base, which also affects the average flow days of end items. Once the end item comes into the shop, it is temporarily staged. This could take from four hours to two days before it is moved to the proper repairing area.

The first operation to be done is a visual shakedown inspection to determine the amount of work required. If welding is required, the end item is moved to MATPIW in Building 3001 (see Step 3, Figure 6.1.1-1). The welding operation could take from three to six days. After welding, it is returned to MABPAB to continue the repair process (see Step 4, Figure 6.1.1-1). The sheet metal repair process may vary, depending upon the size of the end item, and the number and size of damaged parts (longerons, ribs, clips, angles, etc.).



BUILDING FUNCTION

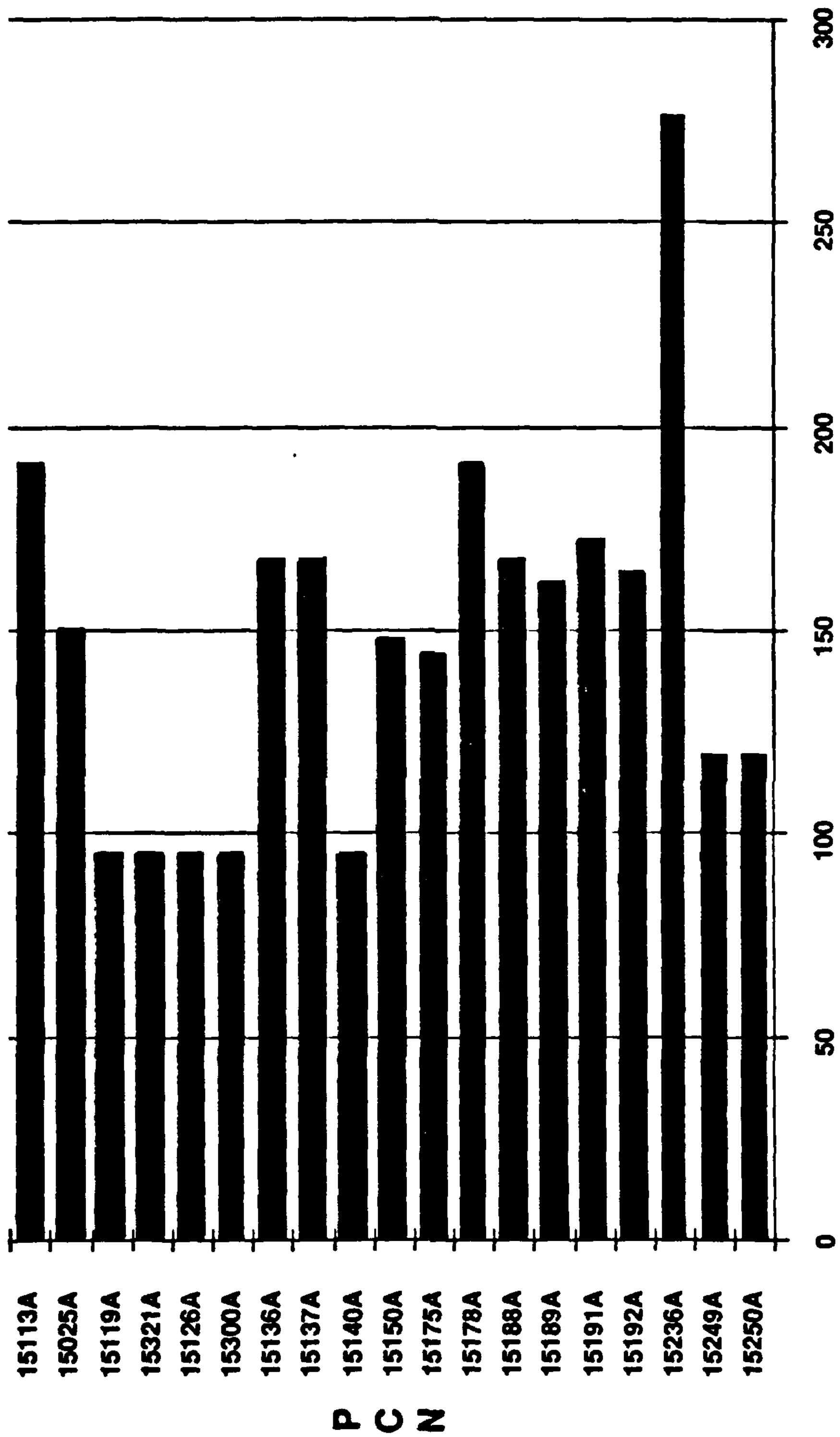
BUILDING	FUNCTION
2122	Uncrate, Wash/Strip
95	Shakedown, Overhaul & Repair
3001	Welding
2280	Paint
2101	New Location

STEP	OPERATION
1	Receive, Uncreate, Clean, Strip & Wash
2	Move to Shakedown & Repair
3	Move to Weld
4	Move to Repair
5	Move to Paint
6	Move to Conditioning & Tag
----	Additional Cleaning, Welding, &/or NDI

LSC-20232

BASIC SHEET METAL REPAIR FLOW
FIGURE 6.1.1-1

LSC-20461



MABPAB BACK SHOP DWELL TIMES
FIGURE 6.1.1-2

After the end item sheet metal work is completed, it is sent to the MABPCB paint shop in Building 2280 (see Step 5, Figure 6.1.1-1). This process takes from three to six days, depending on the MABPCB workload and schedule requirements. Once the end item is painted and the curing process is completed, it is moved across the base to MABPAB for tagging and conditioning, the final step in the sheet metal repair process (see Step 6, Figure 6.1.1-1). The item is then moved to storage if it is a MISTR item, or to the line if it is a PDM item.

6.1.2 Statistical System Performance Measures

The process characterization began on 31 March 1989. To complete this within the allowed schedule required total team integration. MDMSC received unconditional support from both ALC management and staff, which made this task possible.

The manpower, workload, and equipment profiles were provided mainly by the MABPAB staff. The operation profiles, with all of the disassembly/assembly operations, were produced through the interview process.

The WCD documents sources for the history files was collected by a staff of data entry personnel. The OC-ALC/MDMSC team found conflicting documentation on how to prepare the WCDs and no real consistency exist on how to stamp the operations. Therefore, trying to develop a historical data file base on stamped WCDs generated an erroneous base to validate the model. This issue is addressed in detail in paragraph 6.0.

The process characterization effort was completed by 19 April 1989, and the data verification effort, which prepares raw data into flat files, was completed by 28 April 1989.

The validation process began on 22 May 1988. MDMSC prepared an overview of UDOS 2.0 and a review was performed of the data collected through the interview process. An extensive presentation on how to ready and interpret the model outputs, i.e. throughput, flow hours, queues, and resource utilization, was given to the validation team.

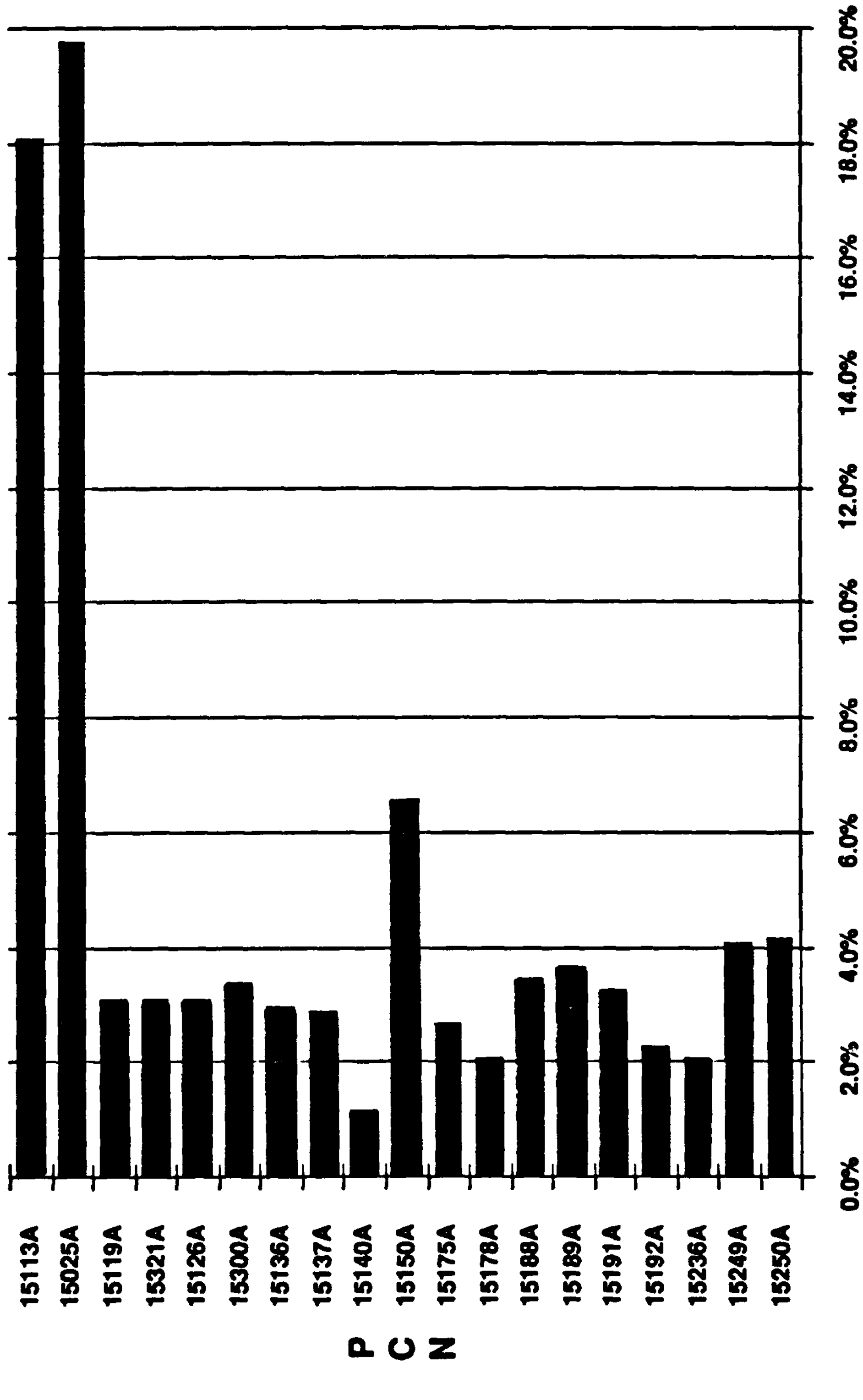
Assumptions made at the time of validation were:

- The 80/20 workload analysis was accurate and represented over 80% of the workload.
- Verification that the model will load and run on the OC-ALC VAX system.
- The mechanics' estimates will be used at face value.
- Induction quantity distributions by quarters are accurate and can influence throughput.
- Historical data, collected from the WCDs, are not accurate. The reasons for the inaccuracies are influenced by the following:
  - WCD release practices (batch print).
  - Stamping practices.
  - Work schedules (priorities).
  - Lack of parts/more work in process.
- Validation will be accomplished against engineering estimates.
- Adjust manpower to reflect:
  - 80/20 Workload
  - FY 88 Efficiency
  - PF & D Factor

The OC-ALC Technology Insertion team performed a validation analysis on the UDOS 2.0 model simulation outputs on the FY 88 80/20 workload. Nineteen end items and five subassemblies represented the 80/20 (see Figure 6.1.2-1) Actually MDMSC characterized over 90% of MABPAB workload. Three end items 15113A, 15025A, and 15150A represent over 40% of the shops workload for FY 88.

The criteria used to validate was: (1) throughput, (2) simulated flow versus G019C estimated flow days, and (3) resources utilization (queues). The results are presented in detail in the DDB.

LSC-20464



MABPAB 80/20 WORKLOAD DISTRIBUTION
FIGURE 6.1.2-1

The throughput statistical analysis done at the time of validation reflects that the model was to simulate FY 88 production levels (reference Figure 6.1.2-2). On the average, the model generated 1620 end items versus 1792 end items for FY 88 production. In the validation minutes we may find an explanation on each PCN detailed in the DDB.

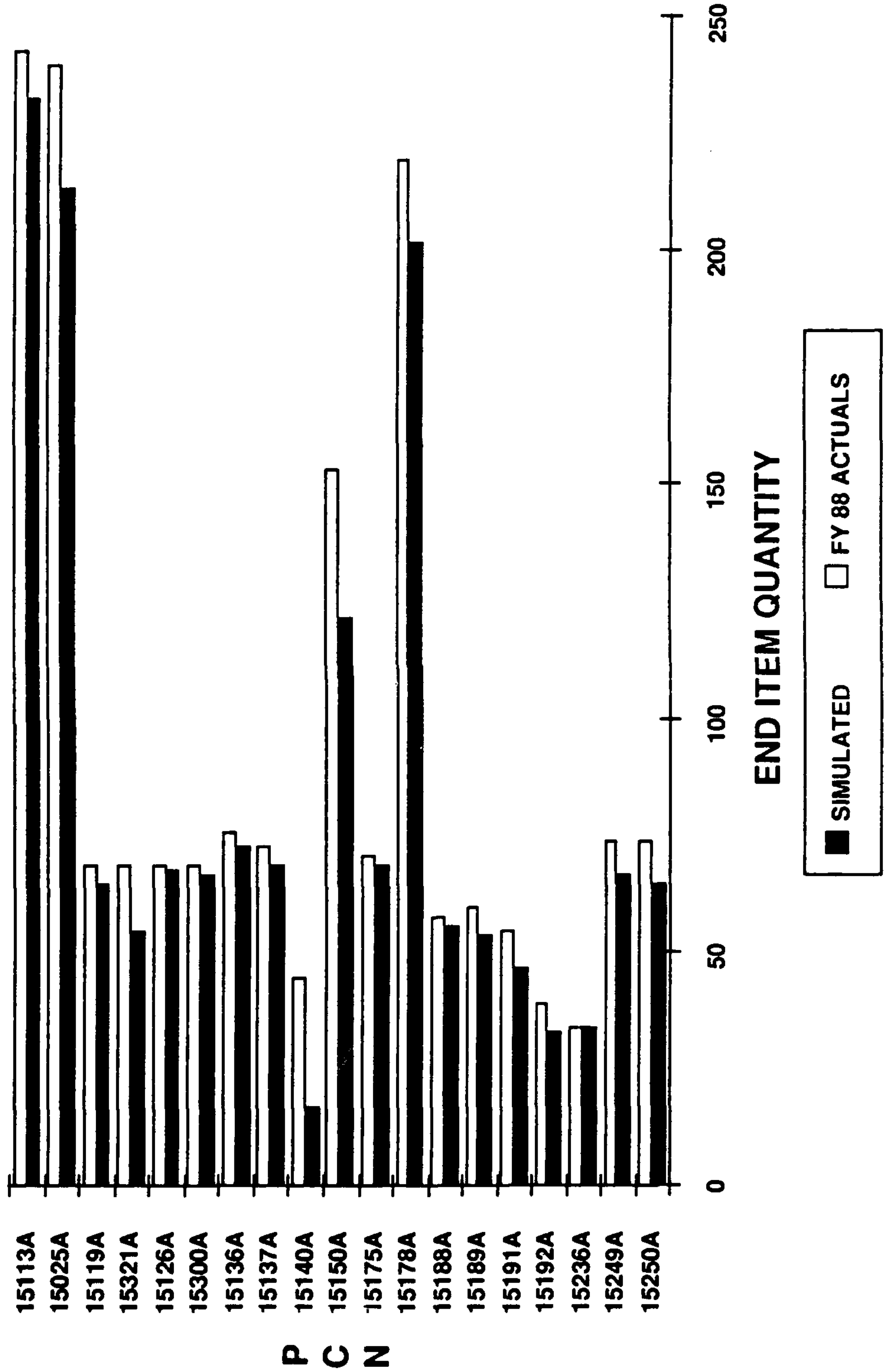
The flow hours statistical analysis was performed against the G019C report. Historical data was brought into the validation process at a later date. However, the validation team agreed to complete the validation process using simulated flow hours and engineering estimated flow hours (G019C report). On the average, the simulated flow hours reflect only 8% higher than the G019C, compared to 49% lower than the historical data (see Figure 6.1.2-3). Additional detail is available in the DDB.

The brainstorming process for experimentation on MABPAB was completed on 8 June 1989. The validation/brainstorming team followed the brainstorming process established by MDMSC. The prepositioning step, in the brainstorming process, is to communicate the problem statement or objective to all participants. The problem statement read: "How to relocate MABPAB (sheet metal shop) from its current 95,000 square foot facility to a 65,000 square foot facility and maintain the FY 90 workload and surge capacity."

Twenty-four basic ideas were generated in this process; however, only eighteen were conducive for model experimentation. An orthogonal array was developed using the Taguchi Process. The team identified three factors and established three levels on each factor. An L_9 (3^4) array is depicted in Table 6.1.2-1, and throughput as Δ, a quality characteristic, was selected.

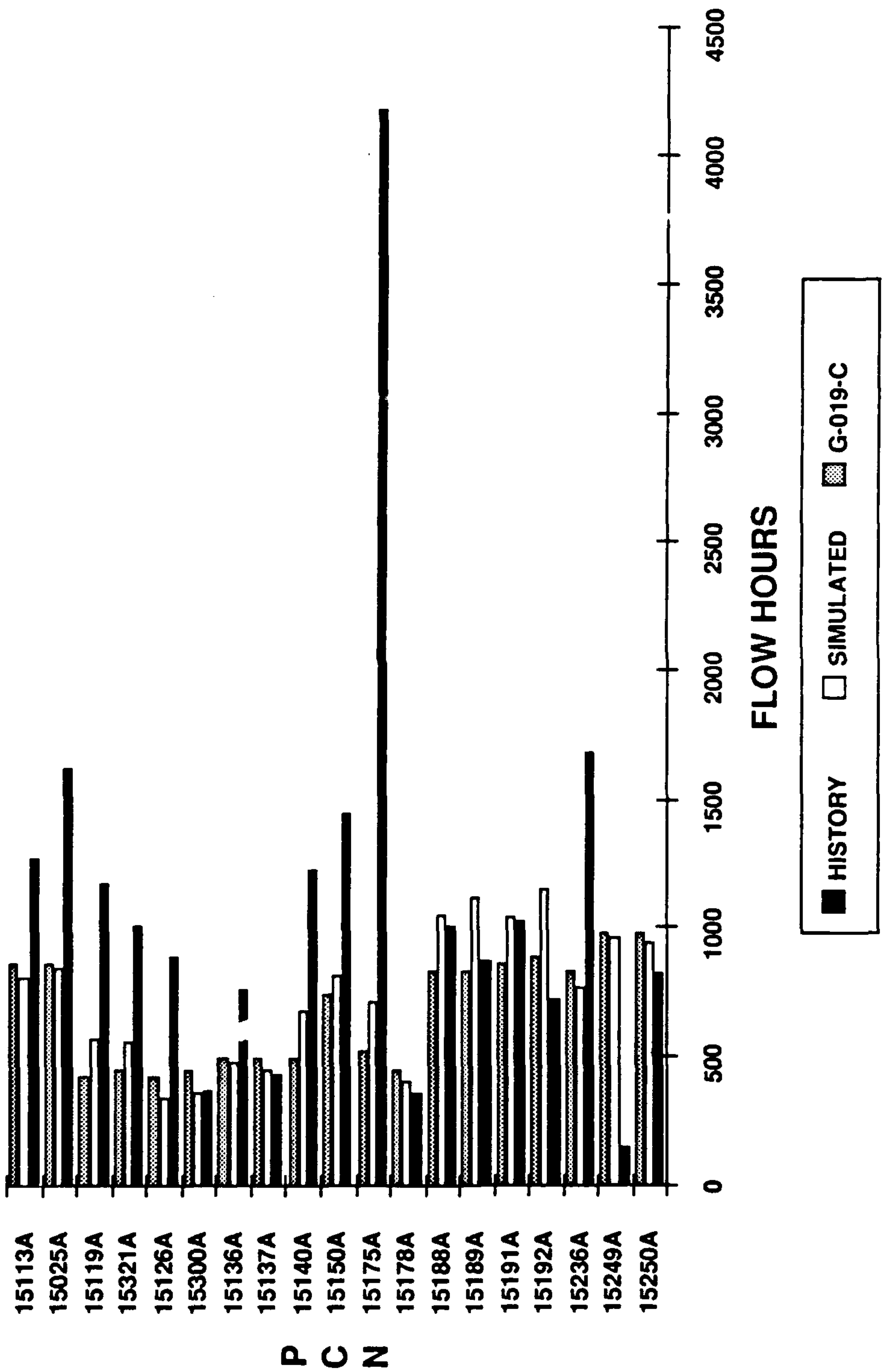
The three factors identified were: (1) manpower, (2) overtime factor, and (3) equipment. Also, the team established three levels to each factor. The levels related to manpower were: (1) first shift, (2) first and second shift, and (3) first, second and third shift. The levels related to overtime factor were: (1) no overtime, (2) Saturday overtime, and (3) Saturday and Sunday overtime. The

LSC-20465



MABPAB THROUGHPUT ANALYSIS
FIGURE 6.1.2-2

LSC-20466



MABPAB FLOW HOURS ANALYSIS
FIGURE 6.1.2-3

MABPAB TO TAGUCHI ORTHOGONAL ARRAY CROSS REFFERENCE
TABLE 6.1.2-1

TAGUCHI L_9 (3^4) ARRAY

NO.	1	2	3	4
1	1	1	NOT APPLICABLE	1
2	1	2		2
3	1	3		3
4	2	1		3
5	2	2		1
6	2	3		2
7	3	1		2
8	3	2		3
9	3	3		1

MABPAB L_9 (3^4) ARRAY

RUN #	1 MANPOWER			2 OVERTIME		4 EQUIPMENT
	1	2	3	SAT	SUN	
1	ALL					BASE
2	ALL			YES		BASE +
3	ALL			YES	YES	BASE ++
4	50%	50%				BASE ++
5	50%	50%		YES		BASE
6	50%	50%		YES	YES	BASE +
7	1/3	1/3	1/3			BASE +
8	1/3	1/3	1/3	YES		BASE ++
9	1/3	1/3	1/3	YES	YES	BASE

LSC-20457

levels related to equipment were: (1) base, (2) base + and, (3) base ++. Reference Table 6.1.2-2, which depicts each equipment level by type.

MABPAB EQUIPMENT FOR EXPERIMENTATION

TABLE 6.1.2-2

EQUIPMENT	BASE	BASE+	BASE++
BENCHES:			
119	3	4	6
126	3	4	6
134	6	8	10
249	7	9	11
FIXTURES:			
F135-8	1	2	3
F135-18	3	4	5
F335-07	1	2	3
F335-08	3	4	5
F335-09	3	4	5

LSC-20486

Table 6.1.2-3 is a summary of the results of the experimentations, and additional backup data is also provided to support the summary in the DDB. Also included in the DDB are the calculations and chart analyses on manpower, overtime, and equipment for FY 90, and the surge conditions that supports the conclusions and recommendations.

In order to meet throughput requirements once MABPAB is relocated into a 65,000 sq. ft. facility, certain considerations need to be addressed: (a) if the sheet metal shop operates on one shift, only 66.5% of the FY 90 projected workload will be attained; (b) if a surge condition is assumed, with a workload factor of 1.6 above the FY 90 workload and operating on three shifts, a throughput of 93.3% can be expected. OC-ALC management should understand that relocating MABPAB to a 65,000 sq. ft. facility will not only limit

MABPAB TAGUCHI ORTHOGONAL ARRAY
TABLE 6.1.2-3

RUN #	FACTORS & LEVELS						WORKLOAD (THROUGHPUT)			
	MANPOWER			OVERTIME		EQUIPMENT	FY 90		SURGE	
	1	2	3	SAT	SUN		QTY	%	QTY	%
1	ALL					BASE	1,595	66.5	1,836	46.8
2	ALL			YES		BASE +	2,074	86.4	2,918	74.3
3	ALL			YES	YES	BASE ++	2,191	91.3	3,253	82.9
4	50%	50%				BASE ++	2,260	94.2	3,479	88.6
5	50%	50%		YES		BASE	2,254	93.9	3,333	84.9
6	50%	50%		YES	YES	BASE +	2,327	97	3,573	91
7	1/3	1/3	1/3			BASE +	2,319	96.6	3,602	91.8
8	1/3	1/3	1/3	YES		BASE ++	2,384	99.3	3,876	98.8
9	1/3	1/3	1/3	YES	YES	BASE	2,386	99.4	3,662	93.3

LSC-20458

growth, but it will jeopardize shop capabilities when adapting different workload fluctuations.

Furthermore, on a 65,000 sq. ft. facility, the amount of work-in-process is extremely limited, and the need to optimize space utilization is essential. For example, the need to utilize vertical space will be inevitable. Special vertical storage accommodations are recommended to meet shop demands after the relocation.

The FY 90 workload was used to determine MABPAB's capabilities. MDMSC recommends using the UDOS 2.0 simulation model to experiment with at least five years of workload forecast to make a decision on the equipment required, and the space needed, to maintain the most efficient and effective sheet metal shop at Tinker Air Force Base.

Using the projected FY 90 workload surge 1.6 factor, MDMSC recommends:

- Maintain the three existing aileron assembly fixtures.
- Increase floor space to accommodate the three aileron fixtures.
- Add a second/third shift, as required.
- Do not dispose of tools and fixtures in the event the workload fluctuates.
- Allow for additional temporary storage.
- Run model experimentation with a five year workload forecast.

6.1.3 Description of Process Problems

The intent of this paragraph is to expound on major process problems for which there are focus study recommendations. Since there are no major process problems identified for MABPAB at this time, potential improvement opportunities are discussed in paragraph 6.1.4 as other observations in this report or as quick fixes in the Quick Fix Plan.

6.1.4 Other Observations

The intent of this paragraph is to discuss critical process problems which are not addressed as a quick fix or focus study.

General Area Improvements Opportunities

- Eliminate or Minimize Back Shop Dwell Times
  - Current Condition: Part of the process characterization involving shop interviews at MABPAB was to identify back shop dwell times, as seen in Figure 6.1.1-2. On the average, an end item will require 142 hours for a back shop operation. However, as part of the back shop dwell time summary report (model output), it is obvious to see that PCN 15236A (Sleeve Assembly) reflects a simulated back shop time of 277 hours, or 95%, over the average. The reason for the excessive back shop time is that the end item flows to Building 2122 more than once for grit blast, and then to Building 3001 for welding. This adds approximately five to six flow days.
  - MDMSC Recommendation: To minimize this back shop flow time, the back shop process must be improved or MABPAB should add back shop capabilities to their operations. For example, as a process improvement, the grit blasting process should be done at the same time as the cleaning operations of stripping and washing. This should be a standard practice for all end items. Another approach to improve the flow time and the sheet metal repair capacity would be to incorporate the back shop activities into MABPAB. For example, the welding operation can be part of the MABPAB repair processes. Both the grit blasting and welding processes add approximately five days to the repair time due to transit activities alone.

- Improve Workload Prioritization and Scheduling
  - Current Condition: Parts are inducted without any clear visual control that could reflect the length of time it has in the repair process.
  - MDMSC Recommendation: A color tagging system should be implemented to assist management in their effort to prioritize their workload. This will insure a first in-first out of end items within the repair process operation.
- Sheet Metal Repair Facility Integration
  - Current Condition: Two facilities exist performing sheet metal repairs, the B-52 line and the C-135 line in different buildings. This condition

is inhibiting Tinker flexibility, capacity, and expansion.

- MDMSC Recommendation: Integrate the B-52 repair line (MDBPFF) and C-135 repair line (MDBPAB) into a single sheet metal repair facility. This could provide better capability and flexibility to Tinker's sheet metal repair processes. If this integration is pursued in the future, MDMSC should advise management to consider a stand-alone sheet metal shop. The stand-alone concept is to bring into MABPAB the back shop operations, such as welding, grit blasting, and painting. However, data to support this has not been collected due to the continuing effort to move to Building 2101.

6.2 MABPFF ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

The MABPFF RCC is responsible for the repair of sheet metal items related to the B-52 aircraft. A detailed description of the activities that take place in MABPFF are provided in paragraph 6.2.1 of this documentation.

The RCC MABPFF has shown a history of being able to produce high-quality items on schedule. MDMSC believes that the primary reasons for this are a knowledgeable and well-trained work force and an ample amount of equipment. The workers in MABPFF take a great deal of pride in the work they do and the quality of the items which they turn out is excellent. The equipment required to conduct the processes in MABPFF are available in sufficient amount to prevent anything but a rare operational hold-up. The workers can normally gain access to a needed piece of equipment and the maintenance on this equipment is good.

MABPFF uses some very labor intensive methods to move items such as the wing flaps and nose cowls. Some operations within the RCC are currently set up so items have to backtrack through areas that they have already been in. These problems were the major ones observed by the MDMSC team, whose overall impression was that the repair operations in MABPFF run smoothly and effectively.

The throughput in the RCC is good, with most items being repaired in a timely manner. The throughput under the predicted surge (refer to paragraph 6.2.2 of this document) is expected to be high, provided an additional transport fixture (which has been inputted into the model under the code "Area-A-T") is made available to the RCC.

The repair technology used in MABPFF is very similar to that which is used in private industry by companies in the sheet metal repair business. Due to the relatively low number of individual PCNs that get repaired, the RCC is prevented from being able to justify more modern equipment. New equipment could be used to streamline the repair process. From its observations the MDMSC team believes that the effectiveness of the operations in MABPFF is roughly equal to that in private industry, except in those cases where private industry is able to utilize mass production technologies because of high volumes.

During the initial characterization of MABPFF, a total of seven improvement opportunities were identified (reference the Potential Improvement Opportunities section of the Database Documentation Book (DDB) for MABPFF). After review of the original set of opportunities by the MDMSC/Air Force team, two were selected to be pursued as quick fix opportunities.

The first opportunity, the Inspection of Nose Cowls in Painting, will decrease the repair time by eliminating the backtracking of the cowls. The second opportunity, the Construction of a Large-Wheel Cart to Transport Bomb Bay Doors, will eliminate the manpower and time currently needed to switch the doors onto a specially designed cart to move them over to supply. These two major opportunities are quick fix opportunities and are described in detail under separate cover. Refer to the Quick Fix Plan for MABPFF for their descriptions.

The balance of the original improvement opportunities are described in paragraph 6.2.4 of this document.

6.2.1 Description of Current Operations

The MABPFF RCC is responsible for B-52 sheet metal repair; both MISTR and PDM. This RCC is located in Building 2121. The flap repair sub-section is located in the center dock area between B-52 aircraft. The remainder of MABPFF is located on the second floor (reference floor layout drawing - MABPFF DDB). The work volume is stable after a major reduction in 1988. This reduction was the result of transferring 50% of the B-52 PDM line to San Antonio. This reduction of work volume resulted in a smaller area being occupied by MABPFF, which requires a new layout This problem is addressed further in paragraph 6.2.4 of this report.

MABPFF is responsible for the repair of the nose cowls, spoilers, wing flaps, bomb bay doors, escape hatches and miscellaneous assemblies. This RCC is also responsible for manufacturing sheet metal replacements parts not available from stock. It supports not only its own repair processes but also the B-52 aircraft lines and occasionally the KC-135 line.

The repair process is worked on two levels. The MISTR repair returns the part to an as-new condition. The assembly is torn down, all corrosion removed, and all damaged skins, ribs, etc. replaced. PDM repairs are performed as required to make the items functionally workable. Standard repairs are performed rather than a total remove and replace operation. The technical orders describe in detail the standard repairs that are allowed. Most MISTR items come from supply and upon completion return to supply. The nose cowl, bomb bay doors, and other assemblies are in this category. The wing flaps, flight controls, spoilers, and escape hatches are routed MISTR; i.e., they are removed from the aircraft as PDM, routed to the repair shop as MISTR, repaired, then returned to be reinstalled on the aircraft. MABPFF also does PDM repairs to items removed from the aircraft, such as the bomb bay doors, nose cowls, side cowls, and smaller assemblies. Note: Some items are repaired under both PDM and MISTR (the nose cowls & bomb bay doors), while others are repaired only as MISTR (the wing flaps), or PDM (the side cowls).

The repair process begins with the item being sent to the wash rack for cleaning and paint removal. An inspection is then done to determine the extent of damage. Disassembly is performed to allow for further inspection and repair. The item is then repaired and reassembled. Corrosion treatment and painting are performed if required.

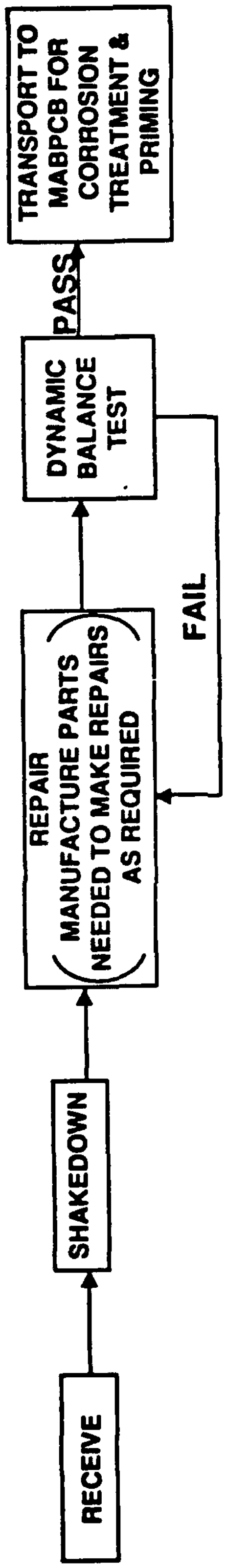
The wing flaps are the largest and most costly items repaired. There are four per aircraft, left and right inboard and left and right outboard. The flaps are moved to the wash rack, then returned for repair. The outside skins are inspected area by area by removing the inspection covers and inspecting the inside area for corrosion and other damage. The skins are removed from those areas requiring repair. Two diagrams which are used as shop aids in MABPFF are shown in the Potential Improvements section of the Database Documentation Book.

During the repair process, corrosion products are removed, ribs repaired or replaced, and the area is treated for corrosion resistance and primed. A new skin is then installed. A decision is made as to which skins can be removed at the same time. The RCC does not have an alignment fixture, but the integrity of the flap is maintained because of the skill and knowledge of the workers in this RCC. The new skins are cut to size and drilled on workbenches in the area using the old skin as a pattern. The current practice is to scribe the inspection cover opening and to use a hole saw to cut the hole. Sanding discs are used to complete the process of preparing the skins.

The equipment used in MABPFF consists of many different sizes and types of machines and tools. Because of the large size of some of the items being repaired, there are several fixtures that have been specially designed to expedite the repair process. These fixtures serve various functions; some are used to help align items (such as the upper and lower bomb bay doors), while others are used to check the balance of certain flight control items (such as elevators and rudders). A jack is available in MABPFF to assist in the handling of flight control items. Some items are repaired while they are supported by holding fixtures and/or workbenches and care must be taken by the mechanics working these items to insure that the items do not get out of alignment during the repair process.

Generic flow diagrams for the main items which get repaired in MABPFF are shown in Figures 6.2.1-1 through 6.2.1-6.

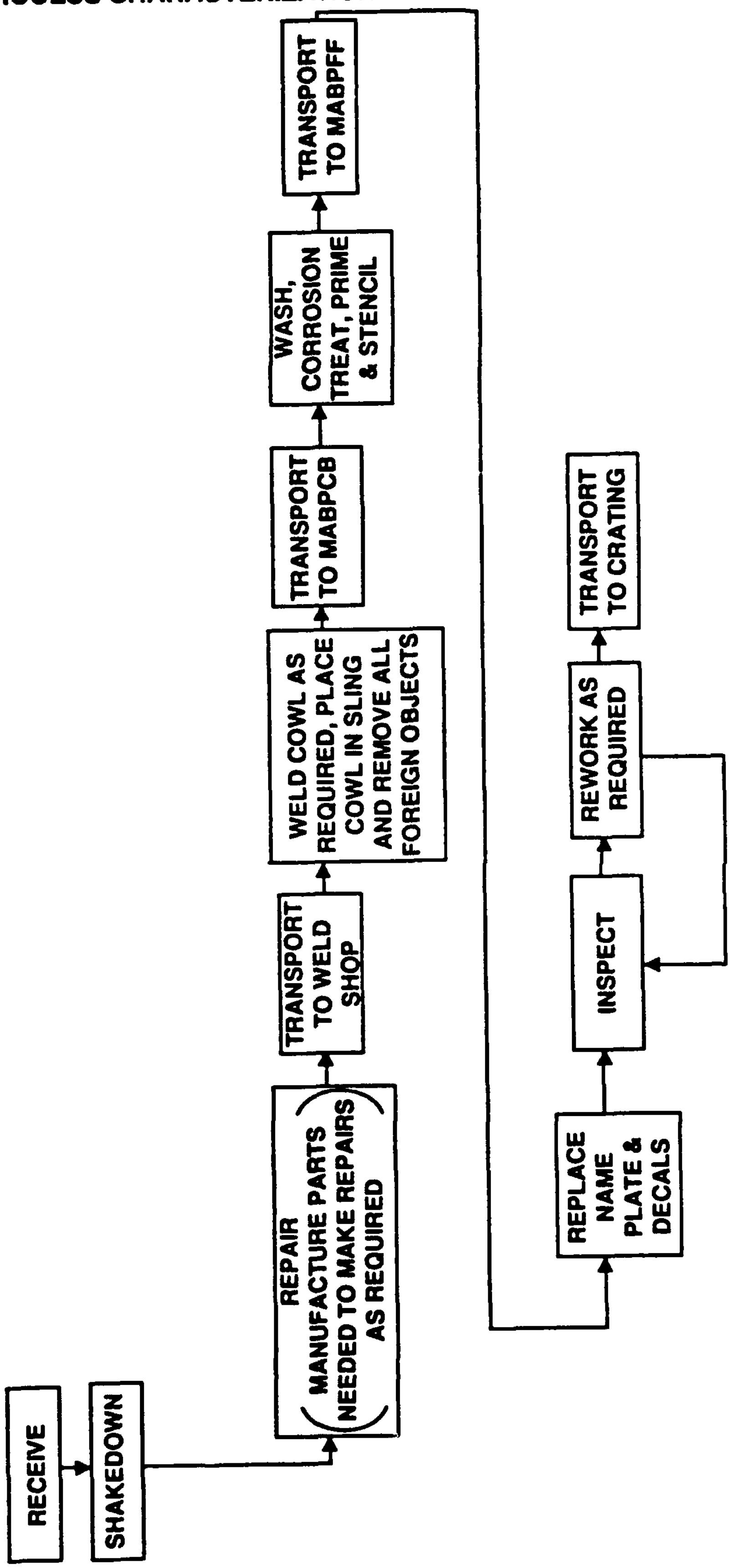
There are numerous pieces of equipment used to cut, form, and machine sheet metal. MABPFF mechanics have access to a power shear and a power brake, as well as hand-operated equipment such as hole punches, band saws,



LSC-20438

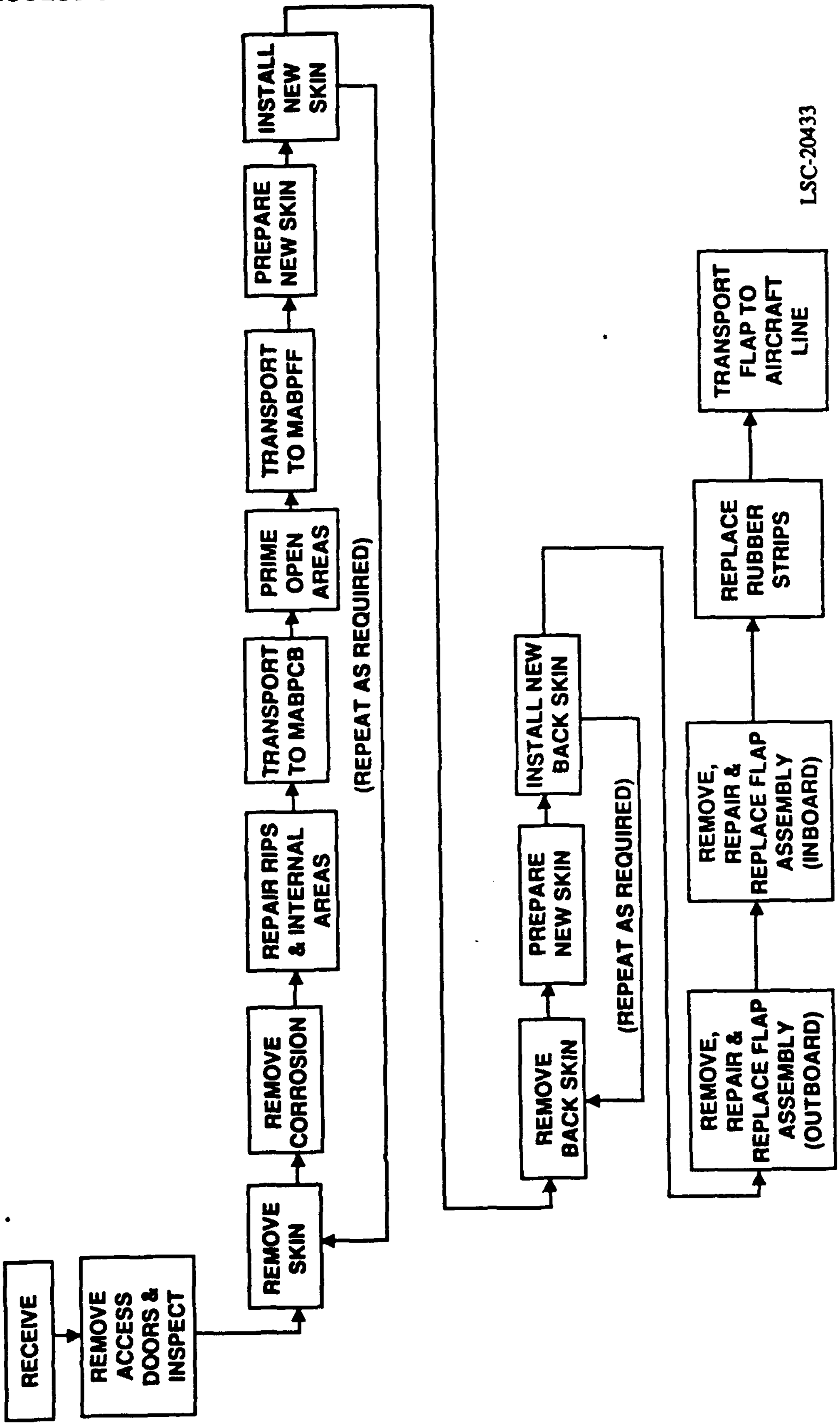
PROCESS FLOW FOR FLIGHT CONTROLS (GOVERNORS, RUDDERS)

FIGURE 6.2.1-1

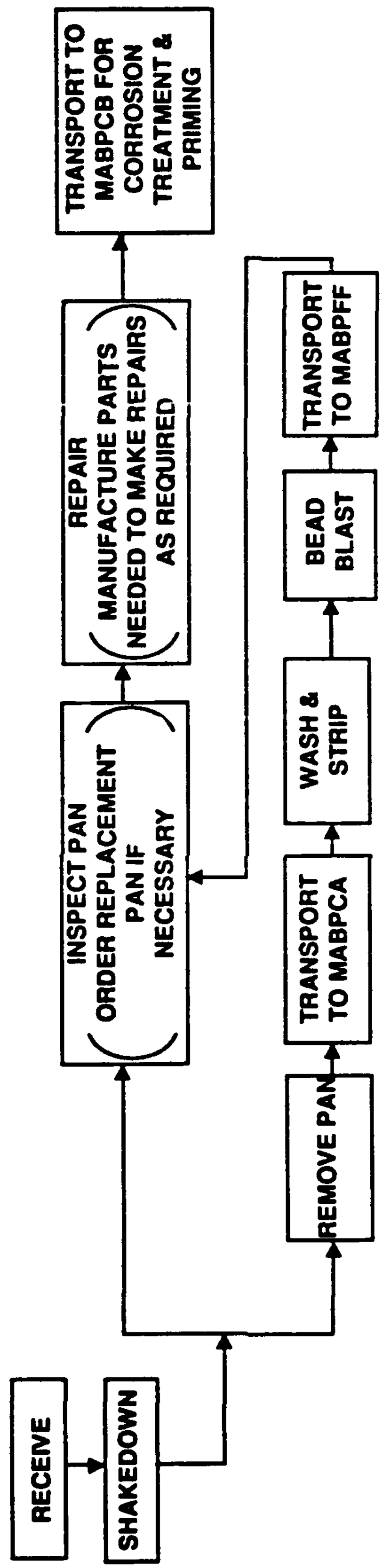


LSC-20434

PROCESS FLOW FOR ENGINE NOSE COWL
FIGURE 6.2.1-2

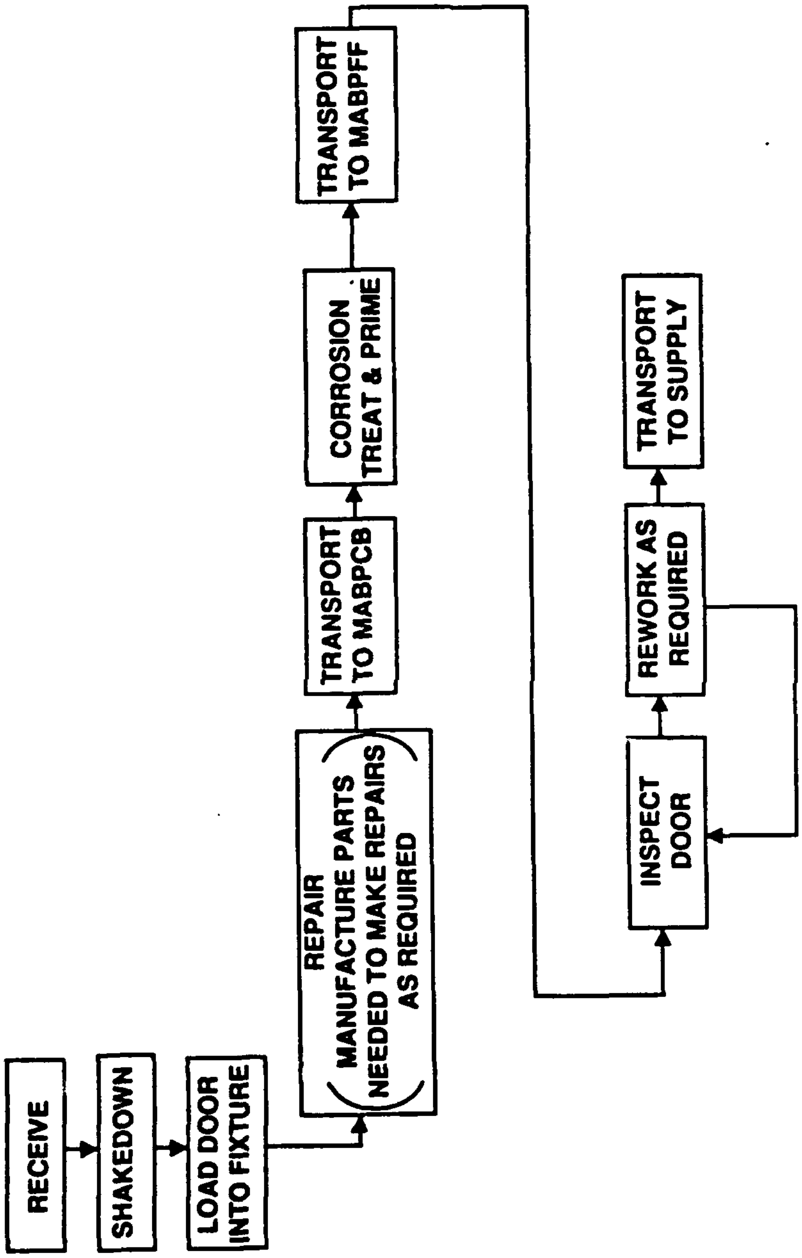


PROCESS FLOW FOR WING FLAPS
FIGURE 6.2.1-3



LSC-20437

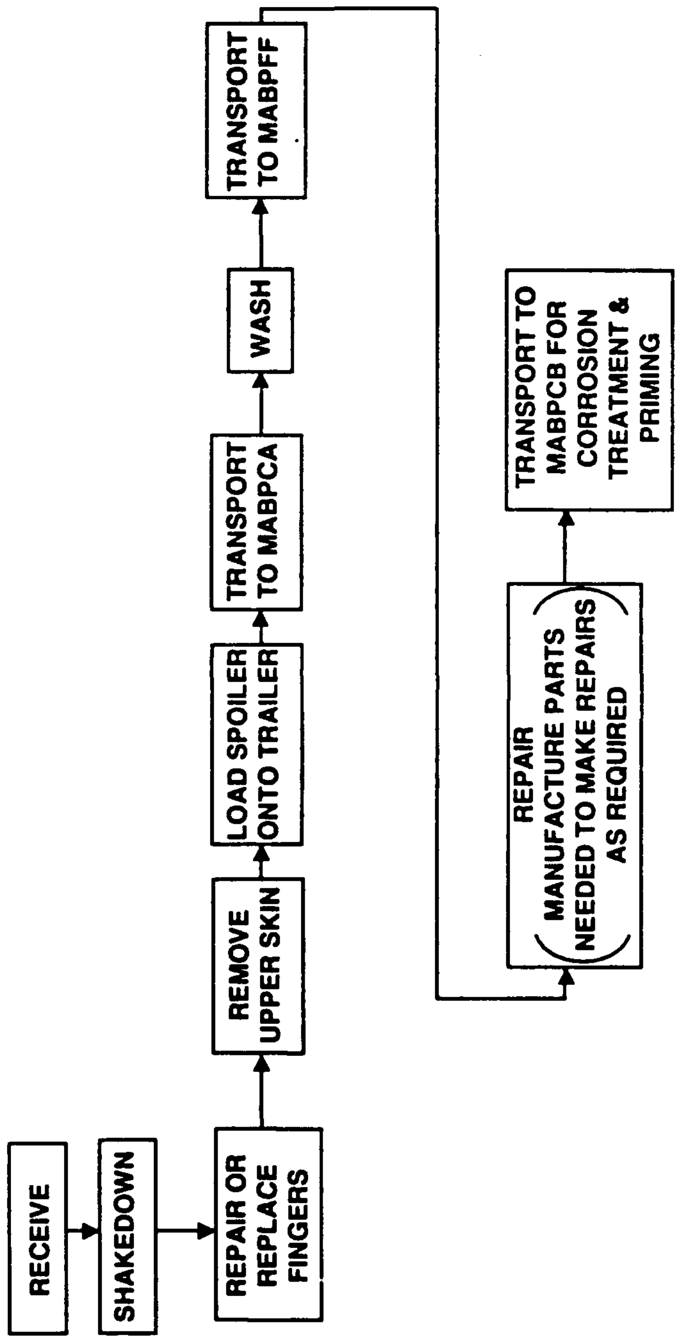
PROCESS FLOW FOR ESCAPE HATCH
FIGURE 6.2.1-4



LSC-20435

PROCESS FLOW FOR BOMB BAY DOORS
FIGURE 6.2.1-5

LSC-20436



PROCESS FLOW FOR SPOILERS
FIGURE 6.2.1-6

formers, drill presses, etc. There is also a variety of small hand tools that are used. The equipment in MABPFF is sufficient to handle the repair needs of the items which are processed through the RCC.

The layout of the work areas within MABPFF could be improved. Presently, the items which are the responsibility of a particular supervisor are often worked in areas which are physically separated from each other, which makes it hard for the supervisor to keep tight control over the work activities in all of the areas (reference paragraph 6.2.4, Other Observations).

The storage capability of MABPFF seems adequate, with an area approximately 30 feet x 50 feet being available for the storage of nose cowls. There is another storage area where the carts used to bring over the other types of items are parked.

The process related to the movement of the nose cowls back to MABPFF after painting for visual inspection and tagging needs to be revised because this backtracking adds to the transit time for the item. This in turn creates an unnecessary increase in the repair flow time. The problems related to the current method of processing the cowls will be detailed in paragraph 6.2.1 of the Quick Fix Plan.

The movement of the bomb bay doors is another case where items are not being moved using the most efficient method due to the unavailability of a specially designed cart. This situation is discussed in paragraph 6.2.2 of the Quick Fix Plan.

Most of the work (70%) which is processed through MABPFF is classified as MISTR, though a unique situation exists in this RCC. As stated before, certain items (spoilers, flight controls, inboard and outboard wing flaps, etc.) are removed from the aircraft as PDM items, yet repaired as MISTR items, after which they are installed back on the aircraft. The PDM workload constitutes approximately 25% of the total and primarily covers the refurbishment of the sheet metal assemblies which have been removed on the B-52G aircraft line. The remaining 5% of the workload covers manufacturing jobs.

The activities within MABPFF are overseen by a unit chief, who is assisted by a secretary. The unit chief has four supervisors, three of whom work first shift, while the remaining one is assigned to second shift. The supervisor's main responsibility is to see that the assigned items are repaired in a timely manner.

6.2.2 Statistical System Performance Measures

The OC-ALC Technology Insertion Team met with ALC representatives during the week of 26 June 1989 to perform a statistical comparison of the UDOS 2.0 Model Simulation Outputs for RCC MABPFF to the historical throughputs and flow times for FY 88. Other criteria, such as the utilization of manpower and equipment, were also used to assess the validity of the database. A detailed discussion of this validation process for MABPFF is included in the Experimentation section of the DDB for the RCC. The joint validation team concluded that the statistics generated by the simulation model were within an acceptable range when compared to the As-Is condition. This model database represents the As-Is condition for FY 88 and can be used as a baseline for comparison purposes.

The throughput of items in MABPFF under the FY 88 workload averaged 100%. This figure is impressive when one considers that the throughput on two PCNs, 15075A (75%) and 17297A (55%) was low because of no items being inducted during the first two quarters, with the highest inductions occurring during the fourth quarter.

A comparison of the average simulated flow hours against the average actual hours (taking into account the workload weight) revealed a difference of 43% between the values when the PCNs are treated as a group. This is high, but it drops to approximately 38% if the top four variances (due to PCNs 17302A, 74455A, 74457A, and 74459A) are excluded from the calculation.

The utilization of the equipment in MABPFF is in general very low. No piece of equipment showed better than a 25% utilization figure. The most highly utilized piece of equipment within MABPFF turned out to be a jack. Even though equipment utilization is low, no equipment can be eliminated from the RCC because of its specialization. The vast majority of equipment that was profiled in MABPFF represents one of a kind fixtures that have to be used during the repair operations.

The manpower within MABPFF is heavily utilized, with the average utilization of manpower of all skill codes during first shift at 81%. The utilization of certain skill codes, such as AS, is near 100%. The utilization of the manpower on second shift is even higher than that on first, with an overall utilization figure of 89%. The workers of skill code WS2 are almost fully utilized.

The largest queues on items within MABPFF are on PCNs 17300A and 17301A and occur because of the time delay in finding an available worker of the proper skill code. These items also go out to a back shop for additional work which further compounds the problem because the items usually have to wait after they return from the back shop until a worker becomes available to continue the repair on them.

During the brainstorming process, the ALC personnel expressed a desire to see what effect changing the scheduling of manpower would have upon the flow of items in MABPFF. The manpower in MABPFF is largely concentrated on first shift and MDMSC was asked to evaluate the effect of leveling the manpower over three shifts. The ALC also requested the induction rate as an experimental factor because it was felt that levelling the inductions over the year could improve the throughput. The RCC uses a transport fixture (which was identified as "Area-A-T" during profiling) and wanted an experiment to test the effect of adding another fixture.

The Taguchi array that was constructed for the factors and levels chosen is shown in Table 6.2.2-1. The use of this array reduced the number of experimental runs needed to test these factors from eight to four. The table also shows the overall throughput percentages for the PCNs that were profiled (refer to the Experimentation section of the MABPFF DDB for a detailed report of the results produced for the individual PCNs). The table also lists the individual PCNs which showed the best and worst throughput under each experimental run.

The results of experimentation showed significant variations in throughput, though the generally low levels of inductions caused the percentage values to be very sensitive to relatively small quantity changes in output. Because only three of the PCNs that were profiled show the inductions for the two-quarter experimental run to be ten or above, MDMSC decided not to perform a detailed analysis of the best and worst conditions because the difference between inductions and output never exceeded four units. In the majority of cases, the output either equalled the inductions or was within one unit.

The use of an additional transport fixture produced an average improvement in throughput of only 2%. The cost of building another fixture needs to be weighed against the benefits of having two fixtures available in the RCC. The experiment showed that the levelling of manpower over three shifts did not significantly improve throughput. Since the utilization of equipment is low, the concentration of manpower on first shift does not create a bottleneck in the flow it items going through MABPFF. MDMSC does not recommend the purchase of any additional equipment for this RCC.

A significant improvement in throughput occurred during experimentation when the annual inductions were levelled over the quarters. The levelling of the inductions created a situation where queues were reduced because items were more likely to hit a process when both the required manpower and equipment

MABPFF $L_4(2^3)$ TAGUCHI ORTHOGONAL ARRAY THROUGHPUT EXPERIMENTAL RESULTS - FY 90

TABLE 6.2.2-1

EXP #	INDUCTION RATE	MANPOWER ASSIGNED	EQUIPMENT QUANTITY*	NORMAL WORKLOAD		
				AVG	BEST	WORST
1	AS-IS	AS-IS	1 FIXTURE	94 %	74460A / 125%	17301A / 80%
2	AS-IS	LEVELED OVER 3 SHIFTS	2 FIXTURES	92 %	74460A / 113%	15028A / 83%
3	LEVELED	AS-IS	2 FIXTURES	98 %	74450A / 113%	15027A / 75%
4	LEVELED	LEVELED OVER 3 SHIFTS	1 FIXTURE	99 %	15028A / 125%	15027A / 75%
RECOMMENDED	LEVELED	AS-IS	2 FIXTURES			

NOTE: TRANSPORT FIXTURE (AREA A-T)

LSC-20475

are available. The recommended combination of levels for the factors examined is as follows:

	Recommended Configuration		
Factor: Rate of Inductions	Assignment of Manpower	Amount of Equip.	
Level:	Levelled	As-Is	As-Is

To evaluate the RCC's ability to respond to surge conditions, the resource usage report was analyzed to determine whether the present levels of manpower and equipment were sufficient to meet the additional demands. Around-the-clock coverage was provided by putting the workers on 12-hour shifts and working them seven days a week to simulate surge conditions. The model revealed that MABPFF is not capable of achieving full throughput under surge with the existing levels of manpower and equipment. To meet the repair requirements that MABPFF would face if its FY 90 workload was increased by the surge percentages that were provided to MDMSC by AFLC Headquarters, the following increases would have to be made in the RCC's resources:

Resource	Existing Amount	Needed Amount
Area-A-T Transport Fixture	1	2

Because of the interchangeability of skill codes, the existing amount of manpower should prove capable of processing the additional items that would come through under surge.

6.2.3 Description of Process Problems

The intent of this paragraph is to expound on major problems for which there are focus study recommendations. Since there are no major process problems identified for the MABPFF RCC, potential improvement opportunities discussed in paragraph 6.2.1 are classified as other observations in this report or quick fixes in the Quick Fix Plan.

6.2.4 Other Observations

The other observations in this section were not considered as focus studies or quick fixes because they had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist OC-ALC in developing ideas that will further enhance their repair operations.

The following observations were originally identified as Quick Fix and Focus Study improvement opportunities, but after review by the MDMSC/Air Force team, it was agreed that they should be presented as other observations.

Operational Improvements

- Revise Method for Preparing Replacement Skins for the Wing Flaps
  - Current Condition: The mechanics use the old skins as a pattern to cut the replacement skin to size and to drill the rivet holes. The access holes are made by scribing a circle onto the metal and then using a hole saw to make the hole. This process is time consuming and the skin is sometimes damaged because the hole saw skips.
  - MDMSC Recommendation: The process of preparing the skins should be analyzed to see whether changes can be made which would speed up the process and reduce the number of skins which get damaged during the preparation. A variety of equipment is already available in MABPFF and the idea of punching the rivet holes in the skin rather than drilling them should be examined. The benefits of fabricating the skins with the access holes already in them should also be examined.

- Utilize a Fixture to Speed Up the Repairs on the Spoilers
  - Current Condition: The spoilers are manually flipped and positioned during the repair process, which increases the chances of the spoiler getting damaged during the repair process.
  - MDMSC Recommendation: Study the spoiler repair process in detail and design a fixture for repositioning the spoiler while repairs are being made. The volume of spoilers repaired each year is quite high and it is the MDMSC team's belief that a spoiler fixture would improve operations in MABPFF by improving the quality of the repaired spoilers.

- Replace Components Which Require Special Operations or Handling
  - Current Condition: The rivets presently being used in MABPFF are heat treated in large quantities in Building 3001. The rivets then have to be kept in a freezer (at -50 to -80 degrees F) to maintain their soft condition. When one of the mechanics in MABPFF needs rivets, he uses a container filled with dry ice to move the rivets from the freezer to where they will be used. The rivets must be kept frozen until installation, otherwise they become too hard and brittle to use, so the mechanic must keep an eye on the dry ice level. The physical separation of the heat treat facilities from where the rivets are actually used creates a supply problem in making sure that the mechanics have rivets available when they are needed. The workload through the heat treat oven also ends up having an effect on the flow of items in MABPFF because even if the supply of rivets has run out or is getting low, there may be additional delays caused by the fact that other items have to be processed through the oven before the rivets. The need to pack the rivets in dry ice delays the repair process and creates a potential safety hazard if the mechanic's bare skin should come in contact with the dry ice. The handling of the rivets is complicated because the mechanic has to fish an individual rivet out of the container before shooting it into place.
  - MDMSC Recommendation: There are rivets available on the market which can be stored and used at room temperature, and OC-ALC should investigate whether these rivets are suitable for use to replace the ones described above. Eliminating the special handling that the rivets now require will save money in MABPFF because it will make the rivets easier to handle, which will speed up the repair process and improve worker safety. Additional savings will result from the elimination of delays caused by shortages of the heat-treated rivets, with savings also resulting from the fact that rivets will not have to be scrapped because of age hardening.

General Area Improvements

- Change the Layout of the Work Areas Within MABPFF to Allow the Supervisors Better Control of the Workers Who Are Assigned to Them
  - Current Conditions: The present layout (refer to Diagram C in the Potential Improvements section of the DDB for MABPFF) requires the supervisor to walk long distances to supervise all of the workers that he has responsibility for. This situation makes it difficult for a supervisor to be readily available to the workers in an area when they have a problem that needs attention.
  - MDMSC Recommendation: The proposed layout (see Diagram D in the DDB for MABPFF) would consolidate those work areas presently the responsibility of a particular supervisor into a common area. This will give the supervisors better control over the activities going on in his area and reduce the amount of production time currently being lost because of the unavailability of the supervisors when problems arise.

6.3 MATPAA ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

Process characterization of the MATPAA Resource Control Center (RCC) at OC-ALC was conducted by McDonnell Douglas Missile Systems Company (MDMSC) during the third quarter, FY 89 as a part of the Technology Insertion Engineering Services (TI-ES) program. The MATPAA RCC, an air accessories repair shop, was identified by the AFLC to be characterized and computer modeled by MDMSC. This effort established an operational baseline and identified technological improvements for review by the base command.

The MATPAA work force are highly experienced and motivated and therefore produce high quality items on schedule. This is accomplished despite the fact that the assembly area is extremely crowded and work benches are cluttered with large numbers of in-process parts and bins of bench stock. This makes it difficult for operators to find adequate work space. All of these factors inhibit the RCC operation to some extent but the throughput in MATPAA is very good and items are being processed without any major bottlenecks. The throughput under the surge conditions (refer to paragraph 6.3.2) is expected to be high and no additional resources will be needed to meet the surge conditions. The repair technology used in MATPAA is similar to that used in private industry. The operators are aware of the importance of producing a high quality item for the aircraft safety and therefore are more quality conscious than those in private industry.

The MDMSC team members were well received by management and line workers during the review process, and much of the information that follows was jointly developed by MDMSC/Air Force personnel. The clarity of purpose and viability of the recommendations is in good part due to the openness and cooperation provided by the MATPAA personnel and OC-ALC management.

During initial characterization of the MATPAA RCC, a total of 11 improvement opportunities were identified (reference MATPAA Database Documentation Book (DDB), Improvement Opportunities section). After review of this original set of opportunities by the MDMSC team, four improvement opportunities were selected to be pursued as quick fixes.

None of the improvement opportunities were selected to be presented as focus studies for MATPAA.

The four quick fixes applicable to the MATPAA RCC are summarized below:

- One operator should move, at one time, all units to be repaired daily from the storage area (cage) to the work area to reduce the handling time. At present each operator walks to the cage and back, every time, for each unit worked. Handling only one unit at a time is not a productive approach.
- All solenoids (FSN 1660-00-677-2071) should be purchased from Consolidated Controls Corp. in order to minimize the rejection rate. At present, this solenoid is also purchased from Kaiser Ekel Valve Corp. Solenoids from Kaiser Ekel experience approximately a 40% rejection rate by operators.
- Portable power tools (electric/battery) should be provided in the disassembly/assembly areas to reduce the disassembly/assembly process time. Presently, only manual hand tools are used in the disassembly/assembly areas.
- Workbenches should be organized in the assembly area to improve productivity. At present, the workbenches are cluttered with large numbers of in-process parts and bins of bench stock. This leaves inadequate space for assembly work and adversely affects the performance of an operator during assembly.

These four quick fixes are described in detail under separate cover in section 6.3 for MATPAA in the OC-ALC Quick Fix Plan. The remainder of the original MATPAA improvement opportunities are presented as other observations and are described in paragraph 6.3.4.

6.3.1 Description of Current Operation

MATPAA is one of three RCCs within the accessories division (MAT) of OC-ALC located in Building 210. MATPAA is responsible for repair of pneumatic accessories such as regulators and valves for a variety of USAF aircraft.

The bulk of the equipment in MATPAA consists of ovens, paint booths, a parts washer, a chemical tank, and a large variety of test stands. The test stands are located throughout the facility.

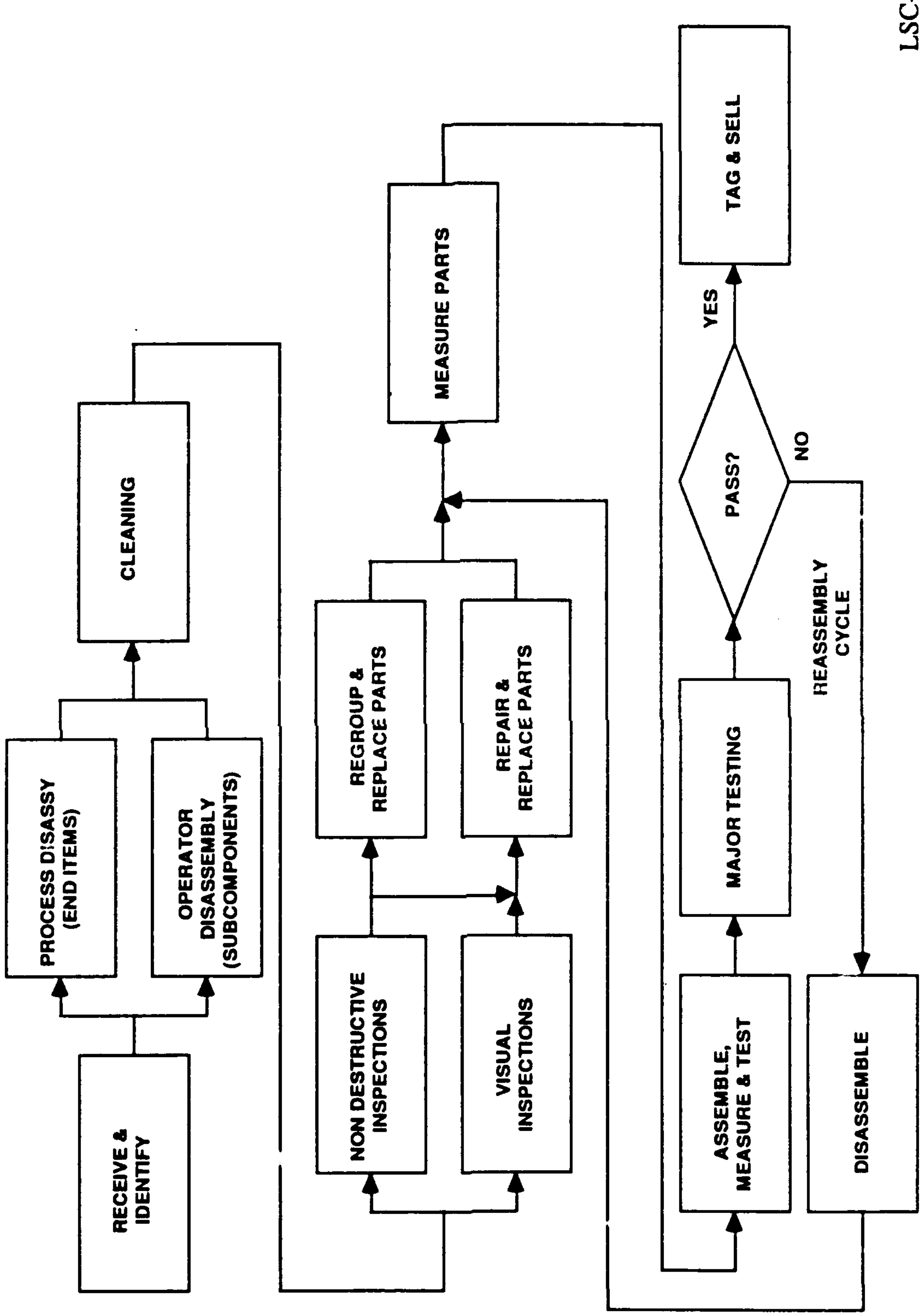
The other equipment used in MATPAA belongs to MATPAB and consists of cleaning equipment: a degreaser, wet/grit blasters, and acid/water/anti-rust tanks; material handling equipment: roller conveyors, an overhead crane, and a forklift truck; and non-destructive inspection equipment: a magnetic particle and a fluorescent penetrant.

The repair operations at MATPAA begin with the disassembly of an end item and all of its subcomponents. All of these parts are then cleaned and inspected by visual/non-destructive methods. Reassembly of an end item is done using repaired component parts and replacement parts, if required. After reassembly, simple tests are performed using MATPAA test equipment. Any testing requiring high pressure/flow or heated air are performed in the sister RCC MATPAT test cell. A detailed description of pneumatic accessories repair processes is available in MATPAA DDB, Section 2.4 (Repair Work Technologies). Included in this document is the pictorial repair process flow diagram for pneumatic accessories (see Figure 6.3.1-1).

The main assembly area of MATPAA is generally clean and well lighted, but extremely crowded. Work stations are arranged side by side and back to back with minimum space for aisles. Several of the aisles between workbenches are blocked by pieces of test equipment. The workbenches are cluttered with large numbers of in-process parts and bins of bench stock, leaving inadequate space for work in many cases.

The primary workload in MATPAA consists of MISTR work. Virtually all material handling in MATPAA is performed by mechanics. The parts are small and easily hand carried or pushed on small carts. The material handling equipment used in MATPAA is an overhead crane and a forklift truck in the receiving area, and roller conveyors in the disassembly, cleaning and inspection areas.

LSC-20405



FLOW PROCESS OF MATPAA
FIGURE 6.3.1-1

The storage area in MATPAA is the production staging area. This is a chain-link cage enclosing 1920 sq. ft. and located behind the 930 sq. ft. receiving area. The front half of the cage is filled with an enormous clutter of parts, boxes which may or may not contain parts, and a tangle of packing material. The back half of the cage is filled with shelving units loaded with a variety of parts.

MATPAA has a stable work force and a well defined workload. The direct work force consists of 65 pneumatic system mechanics. Four pneumatic system mechanics (DI-10), which belong to MATPAB, spend 30% of their time doing MATPAA NDI work. The indirect work force consists of three supervisors, two material handlers, and one painter.

During the course of the MDMSC review, the MATPAA mechanics and supervisors worked well and diligently with one another to complete their tasks. Cooperation and communications between MATPAA and it's sister RCC MATPAT were excellent.

6.3.2 Statistical System Performance Measures

The OC-ALC MATPAA validation team, with members from MDMSC and OC-ALC met during the week of 25 July 1989.to validate the UDOS 2.0 Model for this RCC. A statistical comparison was performed of the UDOS 2.0 Model Simulation outputs for RCC MATPAA and the actual FY 88 throughputs and flow times. The standard flow times from the G019C report were used to validate the model output because the history was considered inaccurate. Other criteria, such as the utilization of manpower and equipment, were also used to assess the validity of the database. Details of the validation are available in the validation meeting minutes previously delivered by MDMSC, and in the validation section of the DDB.

Inductions versus throughputs match 100%. A comparison of the simulated flow hours against actual hours, taking into account the workload weight, revealed a difference of 2% between the values when the PCNs are treated as a group. Only one PCN 94271A revealed a difference of 44% when the simulated flow hours were compared with actual hours.

The utilization of the equipment in MATPAA varies widely from a high of 65% to low of 1%. The average utilization of manpower of all skill codes during the first shift is approximately 52%. This ranged form a high of 85% (PB) to a low of 19% (AP).

During the brainstorming process for MATPAA, the ALC personnel expressed a desire to see what effect changing the levels of manpower and equipment would produce upon the flow of items. It was also requested that the model be used to examine what the effect of having a 24 hour reduction in the back shop operations would be. The RCC presently has two wet blast machines (identified with the codes OC2980 and OC2981) and though the utilization of this equipment was fairly low under the FY 88 workload (an average of 5%), it was decided to perform experimentation with an additional wet blast machine included. The validation process revealed that there was low utilization of manpower in FY 88, so it was requested that the existing level of manpower be reduced by four and all weekend work be eliminated as a factor in experimentation.

The L_4 Taguchi array constructed for the factors and levels chosen is shown in Table 6.3.2-1. The use of this array reduced the number of experimental runs needed to test these factors from eight to four. The table also shows the overall throughput percentages for the PCNs that were profiled (refer to the Experimentation section of the MATPAA DDB for a detailed report of the MATPAA results produced for the individual PCNs), and the individual PCNs which showed the best and worst throughput under each experimental run.

The results produced by the experimentation showed that under the FY 90 workload, all experimental conditions were equally capable of producing high throughput. To further investigate the effect of the different factors, the average flow time of a PCN through MATPAA under each experimental run was examined. Refer to Table 6.3.2-2 for the comparison of the times.

MATPAA $L_4(2^3)$ TAGUCHI ORTHOGONAL ARRAY THROUGHPUT EXPERIMENTAL RESULTS - FY 90

TABLE 6.3.2-1

EXP #	EQUIPMENT QUANTITY*	BACK SHOP FLOW TIME**	MANPOWER ASSIGNED	NORMAL WORKLOAD***		
				AVG	BEST	WORST
1	2	AS-IS	AS-IS	99 %	93979A / 103	95217A / 83
2	2	24 HOUR REDUCTION	NO WEEKENDS 4 LESS EA CODE	99 %	95470A / 106	31336A / 81
3	3	AS-IS	NO WEEKENDS 4 LESS EA CODE	99 %	95470A / 106	31336A / 81
4	3	24 HOUR REDUCTION	AS-IS	99 %	92063A / 107	95217A / 83
RECOMMENDED	3	24 HOUR REDUCTION	AS-IS	99 %	92063A / 107	95217A / 83

NOTES:

* RCC CURRENTLY USES TWO WET BLAST MACHINES (IDENTIFIED AS OC 2980 & OC 2981). A THIRD WET BLAST WAS IDENTIFIED FOR EXPERIMENTATION DURING BRAINSTORMING.

** REDUCTION OF MATPCC BACK SHOP DWELL TIME WAS IDENTIFIED FOR EXPERIMENTATION DURING BRAINSTORMING.

*** ONLY PCNs WITH AVERAGE QUARTERLY INDUCTIONS OF AT LEAST TEN (10) WERE CONSIDERED IN THE BEST/WORST ANALYSIS.

LSC-20467

MATPAA $L_4(2^3)$ TAGUCHI ORTHOGONAL ARRAY FLOW TIME EXPERIMENTAL RESULTS - FY 90

TABLE 6.3.2-2

EXP #	EQUIPMENT QUANTITY	BACK SHOP FLOW TIME	MANPOWER ASSIGNED	NORMAL WORKLOAD AVERAGE FLOW TIME
1	2	AS-IS	AS-IS	200.9
2	2	24 HOUR REDUCTION	NO WEEKENDS 4 LESS EA CODE	233.8
3	3	AS-IS	NO WEEKENDS 4 LESS EA CODE	234.3
4	3	24 HOUR REDUCTION	AS-IS	193.02

LSC-20468

The increase from two to three in the number of wet blast machines in MATPAA showed a slight decrease in flow time when the additional machine was added. MDMSC does not believe that this reduction would justify the expense of buying and installing another machine.

The reduction in the MATPCC back shop flow time also reduced the average flow time, as would be expected. The reduction was relatively minor, but this is because the flow time for all PCNs were averaged and not all of these items are sent to MATPCC for processing. Improvements in MATPCC flow times will produce corresponding improvements in MATPAA flow times for parts that pass through both RCCs.

The throughput results showed that the reduction in manpower and the elimination of weekend work did not impact the RCC's ability to get items out, but the average time to repair an item did increase substantially. MDMSC recommends that the RCC continue to use the model to determine the point at which the manpower can be reduced to an acceptable level without increasing the average flow time to repair an item excessively.

MDMSC believes that, given the situations discussed before, the optimal combination of levels for the factors examined during experimentation is as follows:

	Optimal Configuration		
Factor:	No. of Wet Blast Machines	Back Shop Flow Time in MATPCC	Amount of Manpower
Level:	2	24 hr. reduction	As-Is

To evaluate MATPAA's ability to respond to surge conditions, the resource usage report was analyzed to determine whether the present levels of manpower and equipment are sufficient to meet the additional demand. No additional resources would be required in MATPAA to enable it to meet the increased demand that would occur under surge, though the work force would have to work 12 hour shifts to meet the war time surge requirements.

6.3.3 Description of Process Problems

The intent of this paragraph is to expound on major process problems for which there are focus study recommendations. As there are no focus study recommendations identified for MATPAA, potential improvement opportunities discussed in paragraph 6.3.1 are classified as other observations in this report or as quick fixes in the Quick Fix Plan.

6.3.4 Other Observations

The other observations described in this section were not considered as quick fixes because they were difficult to quantify or had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist OC-ALC in developing ideas that will further enhance their operations.

The observations which follow were originally identified as quick fix improvement opportunities and are detailed as such in the MATPAA DDB. After review by the MDMSC/Air Force team, it was mutually agreed that they should be presented as other observations for future reference.

General Area Improvement Opportunities

- Install Air Curtains
  - Current Condition: The present overhead doors are kept open for transporting material in/out of the facilities. A transparent overhead door has been installed to allow visibility and to let the natural sunlight in. When the transparent door is closed it blocks the transfer of indoor and outdoor air/heat. The doors are open 90% of the time which allows the transfer of indoor and outdoor air/heat thus making the air conditioning unit work harder to maintain the indoor temperature.
  - MDMSC Recommendation: Install industrial air curtains to blow forceful air downward creating an invisible barrier that will block the transfer of indoor and outdoor air/heat. This method will help to maintain indoor climate/temperature, decrease the cost to run the air conditioning unit, provide continuous natural sunlight, minimize the use of the doors, and reduce the in/out transporting time.

- Replace the Present Overhead Crane in the Receiving Area With a Suitable Jib Crane
  - Current Condition: Heavy parts/boxes in the receiving area are handled by an overhead crane which does not cover the whole area. Fork lift truck is used to handle parts/boxes in the area not covered by the overhead crane.
  - MDMSC Recommendation: Replace the overhead crane with a jib crane suitable to cover the whole receiving area. This will minimize the handling of parts in the receiving area by the forklift truck and reduce material handling time.

- Divide the Production Staging Area (Cage) on the Basis of Family Group of Parts
  - Current Condition: Parts are stored in a disarrayed manner. Considerable amount of time is lost by operators searching for parts.
  - MDMSC Recommendation: In order to minimize the time lost by operators searching for parts, divide the production staging area on the basis of family group of parts.

- Isolate Operator's Task to Reduce the Flow Time
  - Current Condition: Skillful and certified operators perform all tasks such as disassembly, cleaning, assembly, testing, repairing, etc. Disassembly and cleaning tasks can be performed by operators of lower skills and in parallel with assembly, testing, and repairing tasks which require skillful and certified operators.
  - MDMSC Recommendation: Isolate skillful and certified operators to perform the critical tasks of assembly, testing, and repairing and lower skill operators to perform general tasks of disassembly and cleaning thus creating parallel operations to reduce the flow time.

- Provide Tote Boxes/Containers With Divider in the Cage (Production Staging Area)
  - Current Condition: Parts in the cage are kept in shelving jumbled with each other. Parts are without protective packaging and as a result get damaged in storage and handling.
  - MDMSC Recommendation: Provide tote boxes/containers with dividers in the cage. The dividers will prevent parts from touching each other thus minimizing damage to parts in storage and handling.

- Add a Shelf on the Back of the Work Benches
  - Current Condition: The work benches are without adequate storage shelf thus cluttered with a large number of in-process parts, bins, tools, etc. leaving inadequate space for work.
  - MDMSC Recommendation: Add a shelf on the back of the work bench approximately 15 inches high for storage of small parts, bins, tools, etc. to provide more work surface. This will minimize damage to parts due to crowded work area and improve the performance of an operator.

- Develop a Generic Test Stand to Test Virtually Any Part in the RCC
  - Current Condition: Parts repaired in MATPAA are tested on a bewildering array of pneumatic test stands. Most of the stands are unique and can only be used to test a small fraction of the different parts in the RCC. The failure of a test stand often results in a work stoppage of those parts which must be tested on the unique, broken test stand.
  - MDMSC Recommendation: A generic test stand should be developed, which, by using various test modules and fittings, can test virtually any part in the RCC. The use of a generic test stand would reduce dangerous "unique equipment" bottlenecks and increase the overall reliability of the test operation.

6.4 MATPAB ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

Process characterization of the MATPAB Resource Control Center (RCC) at OC-ALC was conducted by McDonnell Douglas Missile Systems Company (MDMSC) during the third quarter, FY 89 as a part of the Technology Insertion Engineering Services (TI-ES) program. The MATPAB RCC, an air accessories repair shop, was identified by the AFLC to be characterized and computer modeled by MDMSC. This effort established an operational baseline and identified technological improvements for review by the base command.

The MATPAB work force is highly experienced and motivated and therefore produce high quality items on schedule. This is accomplished despite the fact that the assembly area is extremely crowded and work benches are cluttered with large numbers of in-process parts and bins of bench stock. This makes it difficult for operators to find adequate work space. Sometimes operators receive wrong items, such as screws, nuts, bolts, etc., which do not conform to the specifications. All of these factors inhibit the RCC operation to some extent but the throughput in MATPAB is good and items are being processed without any major bottlenecks. Under the surge conditions the equipment within MATPAB is still capable of processing all of the items. Manpower, however, becomes a strong restriction on throughput during surge and a significant increase in the number of operators would be needed if MATPAB is to meet the wartime surge demand.

The repair technology used in MATPAB is similar to that used in private industry. The operators are aware of the importance of producing a high quality item for the aircraft safety and therefore are more quality conscious than those in private industry.

The MDMSC team members were well received by management and line workers during the review process, and much of the information that follows was jointly developed by MDMSC/ALC personnel. The clarity of purpose and the viability of the recommendations is, in good part, due to the openness and cooperation provided by the MATPAB personnel and OC-ALC management.

During initial characterization of the MATPAB RCC, a total of seven improvement opportunities were identified (reference MATPAB Database Documentation Book (DDB), Improvement Opportunities section). After review of this original set of opportunities by the MDMSC team, four improvement opportunities were selected to be pursued as quick fixes.

None of the improvement opportunities were selected to be presented as focus studies for MATPAB.

The four quick fixes applicable to the MATPAB RCC are summarized below.

- One operator should move all units to be repaired daily from the storage area (cage) to the work area at one time to reduce the handling time. At present, each operator walks to the cage every time for each unit worked. Handling only one unit at a time is not a productive approach.
- Cylinder body assemblies (363779-1) with damaged varnish coating within the cylinder bores should be recoated in order to minimize cost. At present, the cylinder body is discarded and replaced with a new body because of the damaged coating.
- Portable power tools (electric/battery) should be provided in the disassembly/assembly areas to reduce the disassembly/assembly process time. Presently, only manual hand tools are used in the disassembly/assembly areas.
- Work benches should be organized in the assembly area to improve productivity. At present, the work benches are cluttered with large numbers of in-process parts and bins of bench stock. This leaves inadequate space for assembly work. This adversely affects the performance of an operator during assembly.

These four quick fixes are described in detail under separate cover in section 6.4 for MATPAB in the OC-ALC Quick Fix Plan. The remainder of the original MATPAB improvement opportunities are presented as other observations and are described in paragraph 6.4.4.

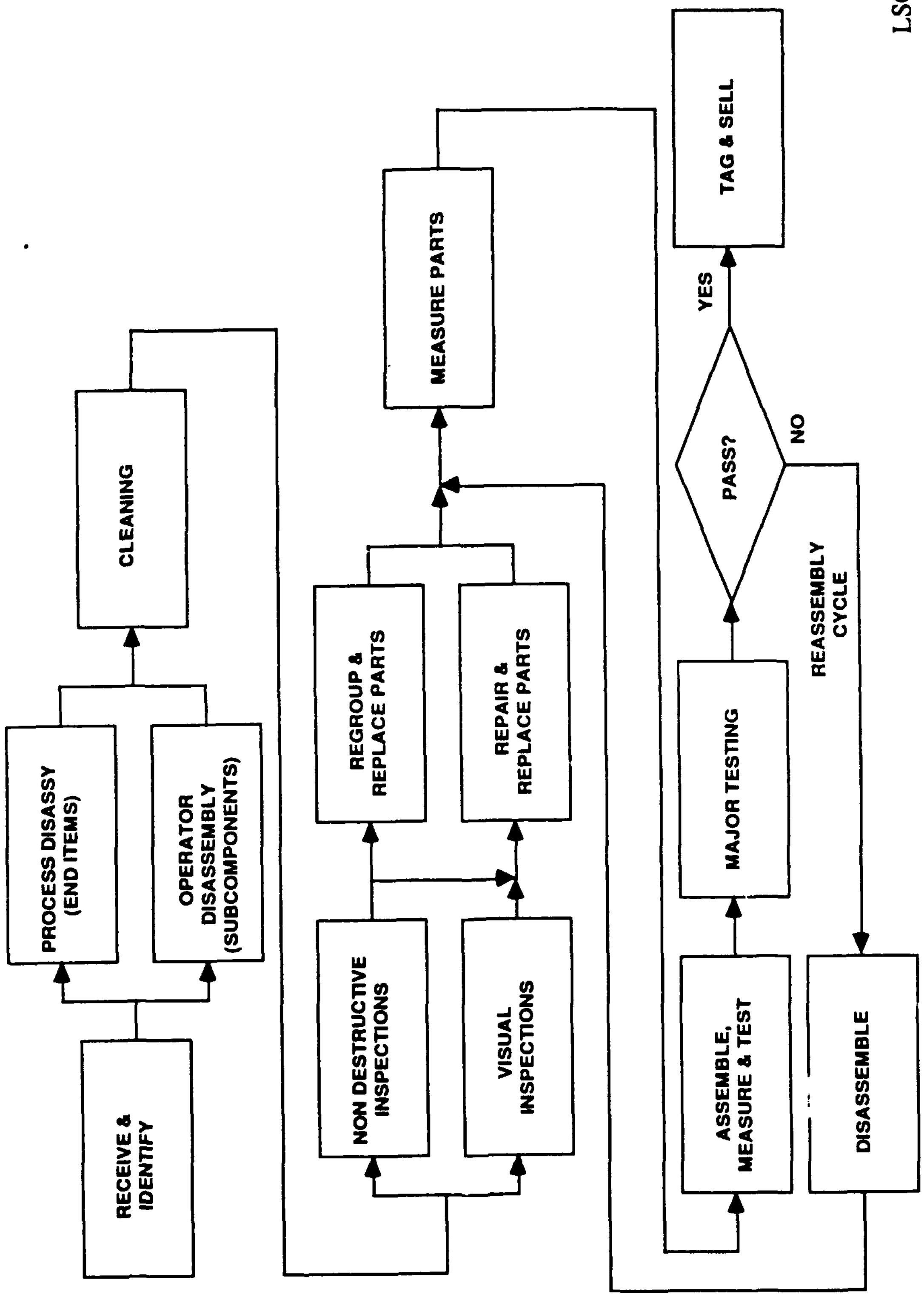
6.4.1 Description of Current Operations

MATPAB is one of three RCCs within the Accessories Division (MAT) of OC-ALC located in Building 210. MATPAB is responsible for the repair of pneumatic accessories such as air turbines, drives, valves, pumps, etc. and is divided into five major process areas: disassembly, cleaning, inspection visual/NDI, assembly, and test. The primary workload in MATPAB consists of MISTR (Management of Items Subject To Repair) work.

The bulk of equipment in MATPAB consists of cleaning equipment; such as a degreaser, wet/grit blasters, acid/water/anti-rust tanks, material handling equipment; such as roller conveyors, an overhead crane, and a forklift truck, non-destructive inspection equipment; such as magnetic particle and fluorescent penetrant, and other equipment, such as test stands, etc.

The repair operations of MATPAB begin with the disassembly of an end item and all subcomponents. All component parts are then cleaned and inspected. Reassembly of an end item is accomplished by assembling repaired component parts or replacement parts, as required. After reassembly, simple tests are performed with MATPAB test equipment. Any testing requiring high pressure/flow or heated air is performed in the sister RCC MATPAT test cell. A detailed description of pneumatic accessories repair processes is available in the MATPAB Database Documentation Book, Section 2.4 (Repair Process Technologies). Included in this document is the pictorial repair process flow diagram for pneumatic accessories (see Figure 6.4.1-1).

The main assembly area of MATPAB is generally clean and quite well lit, but extremely crowded. Work stations are arranged side by side and back to back with minimum space for aisles. Several of the aisles between workbenches are blocked by pieces of test equipment. The work area layout should be revised. The equipment and workbenches should be arranged per the layout. The workbenches are cluttered with large numbers of in-process parts and bins of bench stock, leaving inadequate space for proper work in many situations. In order to create adequate space on the workbenches, each workbench should have rotating steel bench bins for bench stock and small parts.



FLOW PROCESS OF MATPAB
FIGURE 6.4.1-1

LSC-20416

Virtually all material handling in MATPAB is performed by mechanics. The parts are small and easily hand carried or pushed on small carts. The material handling equipment used in MATPAB is an overhead crane and a forklift truck in the receiving area, and roller conveyors in the disassembly, cleaning and inspection areas.

The storage area in MATPAB is the production staging area. The staging area is a chain-link cage 1920 sq. ft. in area located behind the 930 sq. ft. receiving area. The front half of the cage is filled with an enormous clutter of parts, boxes which may or may not contain parts, and a tangle of packing material. The back half of the cage is filled with shelving units loaded with a variety of parts. The production staging area should be organized by dividing the area on the basis of family groups. Better housekeeping practices should be initiated.

MATPAB has a stable work force and a well defined workload. The direct work force consists of 99 pneumatic system mechanics. Four pneumatic system mechanics (DI-10) spend 30% of their time doing MATPAA NDI work. The indirect work force consists of three supervisors, two material handlers, and one painter.

During the course of the MDMSC review, the MATPAB mechanics and supervisors worked well with one another to complete their tasks. Cooperation and communication between MATPAB and it's sister RCC MATPAT are excellent.

6.4.2 <u>Statistical System Performance Measures</u>

The OC-ALC MATPAB validation team with members from MDMSC and OC-ALC met during the week of 25 July 1989 to validate the UDOS 2.0 model for MATPAB. A statistical comparison was performed between the UDOS 2.0 Model Simulation outputs for RCC MATPAB and the actual FY 88 throughputs and flow times. The standard flow times from the G019C report were used to validate the model output because the history was considered inaccurate. Other criteria, such as the utilization of manpower and equipment, were also used to assess the validity of the database. The details of this validation are available in the validation meeting minutes, previously delivered by MDMSC, and the Experimentation section of the DDB.

The utilization of the equipment in MATPAB varies widely from a high of 46% to a low of 1%. The average utilization of manpower of all skill codes during the first shift is approximately 46%. This ranged form a high of 56% (PB) to a low of 32% (AP).

During the brainstorming which followed validation, the ALC personnel requested that experimentation be performed to show whether certain poorly utilized pieces of backup equipment could be removed from MATPAB without negatively impacting the flow of items through the RCC. The seven pieces of equipment that were chosen for experimentation were OC 3555, OC 3559, OC 2115, OC 2117, OC 2442, OC 2118, and OC 4679. The levels used for experimentation were the As-Is condition, where one each of the equipment listed above is available for use as a backup, and a level where the equipment was removed from the RCC.

The L_8 Taguchi array constructed for the factors and levels is shown in Table 6.4.2-1. The use of this array reduced the number of experimental runs needed to test these factors from 128 to seven. The table shows the overall throughput percentages for the PCNs that were profiled (refer to the Experimentation section of the MATPAB DDB for a detailed report of the results produced for the individual PCNs) and the individual PCNs which showed the best and worst throughput under each experimental run. The outputs from the experimental runs showed no significant differences. Table 6.4.2-2 was constructed to show what happens to the average flow time per item under the different experimental conditions.

The results of experimentation showed that under the FY 90 workload, the RCC can eliminate all of the backup equipment used as factors during experimentation, without sacrificing throughput. Overall, the experimentation showed that very little difference occurred between the conditions when the backup equipment was available and when it was removed from the RCC.

MATPAB $L_8(2^7)$ TAGUCHI ORTHOGONAL ARRAY THROUGHPUT EXPERIMENTAL RESULTS - FY 90

TABLE 6.4.2-1

EXP #	BALANCING MACHINES					OVENS		NORMAL WORKLOAD*		
	OC 3555	OC 3559	OC 2115	OC 2117	OC 2442	OC 2118	OC 4697	AVG	BEST	WORST
1	1	1	1	1	1	1	1	98 %	93031A / 109	93071A / 89
2	1	1	1	0	0	0	0	99 %	93031A / 109	93071A / 89
3	1	0	0	1	1	0	0	98 %	93031A / 109	93071A / 89
4	1	0	0	0	0	1	1	98 %	93031A / 107	93071A / 89
5	0	1	0	1	0	1	0	100 %	93031A / 109	93071A / 89
6	0	1	0	0	1	0	1	99 %	93031A / 109	93071A / 89
7	0	0	1	1	0	0	1	99 %	93031A / 109	93071A / 89
8	0	0	1	0	1	1	0	98 %	93031A / 109	93071A / 89
RECOMMENDED	0	0	0	0	0	0	0			

NOTE: * ONLY PCNs WITH AVERAGE QUARTERLY INDUCTIONS OF AT LEAST10 WERE USED TO CALCULATE THE BEST/WORST CONDITIONS.

MATPAB $L_8(2^7)$ TAGUCHI ORTHOGONAL ARRAY FLOW HOURS EXPERIMENTAL RESULTS - FY 90

TABLE 6.4.2-2

	BALANCING MACHINES					OVENS		NORMAL WORKLOAD
EXP #	OC 3555	OC 3559	OC 2115	OC 2117	OC 2442	OC 2118	OC 4697	AVERAGE FLOW TIME
1	1	1	1	1	1	1	1	307.5
2	1	1	1	0	0	0	0	264.9
3	1	0	0	1	1	0	0	308.3
4	1	0	0	0	0	1	1	265.0
5	0	1	0	1	0	1	0	308.4
6	0	1	0	0	1	0	1	265.1
7	0	0	1	1	0	0	1	265.2
8	0	0	1	0	1	1	0	307.5
RECOMMENDED	0	0	0	0	0	0	0	

LSC-20485

Because the results produced under all of the experimental conditions were so close, MDMSC concludes that the two ovens (OC 2118 and OC 4697) and the five balancing machines (OC 3555, OC 3559, OC 2115, OC 2117, and OC 2442) can be released for other use without harming the production capacity of MATPAB.

To evaluate MATPAB's ability to respond to surge conditions, the resource usage report was analyzed to determine whether the present levels of manpower and equipment are sufficient to meet the additional demand. The FY 90 workload was increased by the surge percentages that were provided to MDMSC by AFLC Headquarters and run in the simulation model.

Under the surge workload, the equipment within MATPAB is still capable of processing all of the items, though the utilization of the OC 4549 degreaser becomes very high. However, manpower becomes a strong restriction on throughput during surge and a significant increase in the number of workers would be needed if MATPAB is to meet the wartime surge demand. For MATPAB to meet the requirements of a surge workload the following increases would have to be made in the RCC's manpower:

Manpower Skill Code	Existing Amount	Needed Amount
DI	4	6
AP/BP/DP	95	112

6.4.3 Description of Process Problems

The intent of this paragraph is to expound on major process problems for which there are focus study recommendations. Since there are no major process problems identified for MATPAB at this time, potential improvement opportunities discussed in paragraph 6.4.1 are classified as other observations in this report or as quick fixes in the Quick Fix Plan.

6.4.4 Other Observations

The other observations described in this section were not considered as quick fixes because they were difficult to quantify or had a less significant impact on the areas of time, quality, or cost. These other observations are improvement opportunities which are recorded to assist OC-ALC in developing ideas that will further enhance their operations.

The observations which follow were originally identified as quick fix improvement opportunities and are detailed as such in the MATPAB DDB. After review by the MDMSC/OC-ALC TI-ES team, it was mutually agreed that they should be presented as other observations for future reference.

General Area Improvement Opportunities

- Shorten the Back Shop Repair/Plating Time and Reduce the Number of Parts Lost
  - Current Condition: Parts are sent to Building 3001 for back shop repair/plating, and flow time for some parts is too long (480 hours). This indicates a lack of priority, and sometimes parts are lost due to lack of control.
  - MDMSC Recommendation: The repair/plating RCC in Building 3001 should keep a log book to record the in/out dates. This will help to improve control, inventory, and flow time on parts requiring repair/plating.

- Eliminate the Inaccuracies and Lost Time Caused by Wrong Items
  - Current Condition: Sometimes operators receive wrong items such as screws, nuts, bolts, etc. which do not conform to the specifications and this causes inaccuracies and lost time.
  - MDMSC Recommendation: Better communication between scheduling, MIC, planning, and production management should eliminate this problem.

Operational Improvement Opportunities

- Form Larger Batches of Parts After Grit Blasting for Hot Water Rinse
  - Current Condition: After parts are cleaned in the grit blasters they are placed in small baskets individually, or in small quantity batches, and hot water rinsed in a wash basin.
  - MDMSC Recommendation: Form larger batches of parts after grit blasting for hot water rinse to reduce the cleaning time.

6.5 MATPAT ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

Resource Control Center (RCC) MATPAT is responsible for the final testing of all types of pneumatic driven accessories, gas turbines, compressors, alternator drives, valves and pumps that are remanufactured in RCCs MATPAA and MATPAB. Forty-five items, representing 80% of the FY 88 workload, were selected for process characterization. Ninety-five percent of the MATPAT workload is Management of Items Subject to Repair (MISTR).

The test operators in MATPAT are extremely conscientious, cooperative, and highly skilled in performing quality testing tasks. A high degree of cohesiveness exists in the relationship of supervision and the operators in obtaining throughput in a timely manner. Virtually all items are processed within a 24 hour period. In view of the flow of items from the repair RCCs MATPAA and MATPAB this is no small feat. The repair RCCs are chronologically scheduled and this type of schedule produces a trickle down effect in MATPAT. Each operator maintains a notebook for the specialized items he tests. The note keeping is meticulous and contains detailed procedures garnered from years of experience.

Supervision and staff functions are well aware of the equipment, manpower, and scheduling inflexibility problems which are inherent in the process. They are actively seeking solutions.

The major problems are: equipment flexibility--individual test cells are dedicated to certain items only, operator flexibility--operators are also dedicated to certain items only, and the schedules are chronologically derived with little cognizance of equipment or manpower capacities.

Therefore, MATPAT accomplishes major feats on daily basis in maintaining scheduled throughput despite the increased set-up labor precipitated by chronological scheduling.

There is no doubt, that in times of surge this RCC will accomplish the added inductions that can be theoretically produced but not without a great amount of effort on the part of MATPAT personnel.

In comparing MATPAT to private industry it is extremely obvious that the chronological scheduling system would not be tolerated. It is contrary to effectiveness of the RCC.

It was initially assumed that the WCDs would be better utilized for historical purposes than in any other RCC; however, the assumption was erroneous as the data was useless. This was documented in the validation meetings with ALC personnel (reference MATPAT validation minutes).

In characterizing the MATPAT RCC, five improvement opportunities were identified (reference MATPAT Database Documentation Book (DDB)).

The major improvement opportunity is the focus study proposed to introduce greater flexibility of manpower and equipment to eliminate test cell specializations and the resulting queues which has precipitated a three-shift operation (reference Focus Study No. 1, paragraph 6.5.4 in this report.)

Another focus study recommends the investigation of a scheduling system based on manpower and equipment capacity. The current scheduling system is based on the chronological aspects of the schedule periods (reference Focus Study No. 2, paragraph 6.5.5 in this report.)

Another improvement opportunity is a quick fix proposing the addition of simple material handling equipment to eliminate manual handling of heavy fixtures that require up to four mechanics per set-up (reference paragraph 6.5, Quick Fix No. 1 in the Quick Fix Plan report.)

Two additional process improvement opportunities, classified as Other Observations in this report, are as follows and are described in paragraph 6.5.6:

- The development of quality reject definitions, repair procedures, and intelligent communications, which will eliminate the "revolving door" posturing of items that repeatedly fail testing.
- The purchase of small, relatively inexpensive compressors, to place in the areas that presently draw air from the main compressors that supply air to the MATPAT RCC.

6.5.1 Description of Current Operation

The MATPAT RCC is the Air Accessories Testing Unit, which is located in Building 210 within the Air Accessories section (MATPA) of the Air Accessories Division (MAT) at OC-ALC.

This RCC performs the final tests on all types of pneumatic driven accessories, gas turbines, compressors, alternator drives, valves, and pumps that are repaired in RCCs MATPAA and MATPAB. MATPAT is operated on a 3-shift basis, with a skeleton crew of six mechanics on the third shift. The workload in MATPAT consists of 95% MISTR and 5% PDM, and it varies dependent upon the production of MATPAA and MATPAB.

The work force consists of 27 pneudraulic systems mechanics and one work leader under the supervision of a foreman and direction of a unit supervisor.

It must be pointed out that although the experience level and expertise is very high in MATPAT the mechanics are extremely specialized. Certain items are tested only by certain operators thereby reducing manpower flexibility.

The principal utility used while performing tests at MATPAT is heated and unheated dried compressed air. The air compressor output is 150 pounds per minute at 300 PSI, which is supplied by six Worthington 1955 model units.

The compressors are operated and maintained by MAD. The compressors are about 35 years old and require considerable maintenance. At the time characterization was performed, three of the six compressors were down for repairs. Through the years, the lines have been tapped to provide air to other areas, thereby reducing the MATPAT air supply. Also, numerous modifications have been made to the overhead piping and valving which deter cell flexibility for testing various items of different configurations.

Two major lines, one hot and one cold, extend from the compressors to the overheads and connect to the test cells, with one hot line and one cold line connecting each cell. The lines are controlled by blend valves and orifice plates. The regulating valves are antiquated.

The orifice plates date back to 1943, and the attached copper sensing lines and fittings are in poor shape. This produces many problems in attaining the prescribed mass air flow, which is formulated by the differential pressure at the monometers fed by the copper sensing lines. The test console controls date back to 1968. They are pneumatically controlled and operate very slowly.

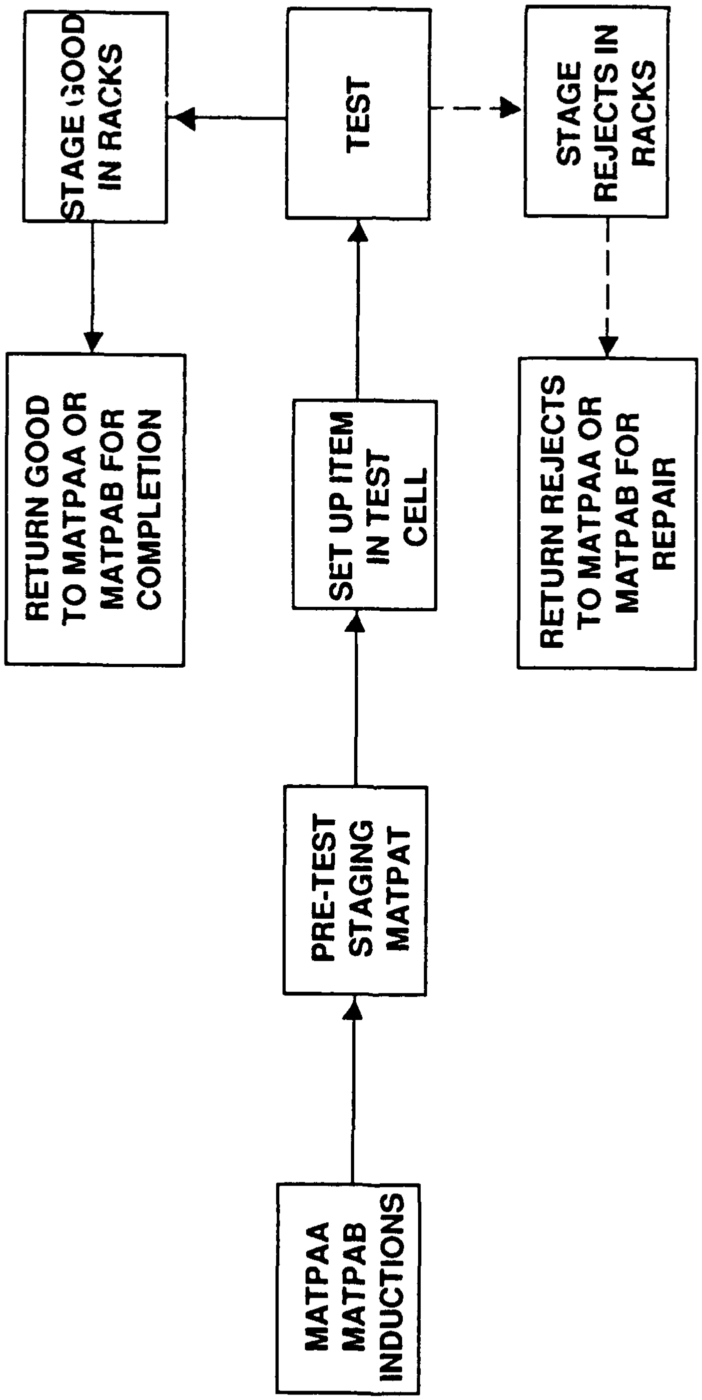
There are 25 test cells in the facility, but only 19 are in use due to lack of proper air flow, fixtures and tooling. Prototype work and shop usage also limit the availability of the cells In addition, the cells are limited to specific items only, therefore negating any flexibility of test cell utilization.

The items are hand carried from MATPAA and MATPAB into the MATPAT staging area where the test operator picks up each scheduled item and sets it up in the prescribed test rig (see Figure 6.5.1-1).

Calibration and functional tests are completed as follows:

Regulators -	Apply set flow (up & down stream pressure)
Valves -	Set pressure to provide proper flow
Turbine -	Air flow-check cooling efficiency
Drives -	Electric & hydraulic load banks to apply drive loads to assure alternator operation

LSC-20396A



GENERIC FLOW PROCESS CHART — MATPAT - ALL TESTED ITEMS
FIGURE 6.5.1-1

The tested units are returned to the staging area for pick-up, completion, and tagging. They are then moved to supply by MATPAA & MATPAB personnel.

The facility layout drawings are not representative of MATPAT. Further research indicated that updated "red line" drawings were also unavailable. Figure 6.5.1-2 is an overall revision of the test unit. In addition, marked up 1/4" scale drawings are to be found in the appendix of the Database Documentation Book. The storage facilities of MATPAT consist of 36" x 36" stand alone racks with an average of four shelves per rack which varies in spacing to accommodate the variety of item sizes. In addition, there is presently 648 sq. ft. of floor space available for the storage of test rigs. With proper housekeeping, this area appears to be adequate.

The 80/20 analysis for MATPAT consists of 45 PCNs. All PCNs are MISTR items and were selected in order of magnitude from largest amount of labor hours to 80% of the total labor hours expended by the RCC in FY 88..

Process Improvement Opportunities

Equipment/Manpower Flexibility (Focus Study #1):

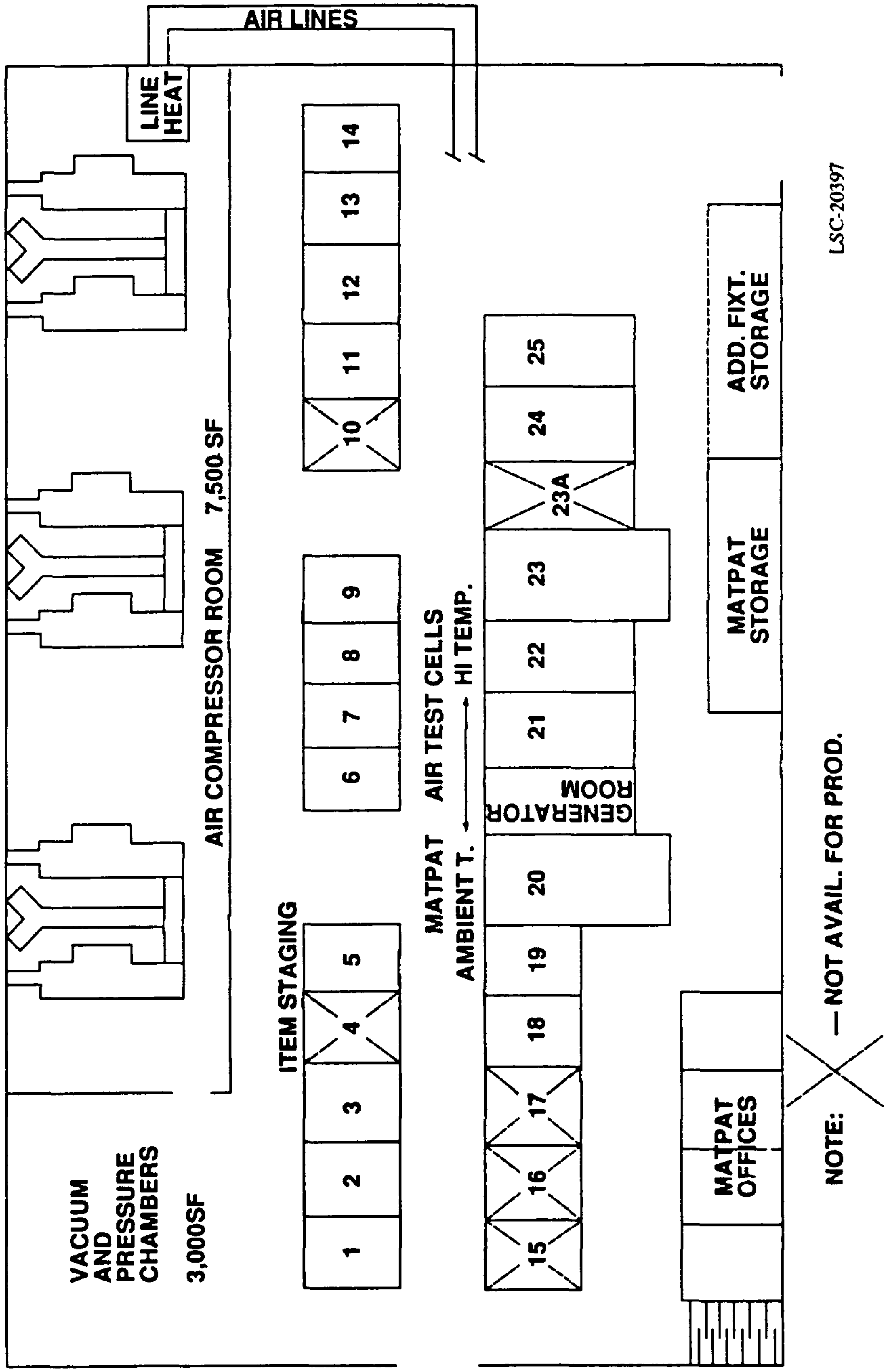
- Analyze and modify air flow piping/valving to provide more availability cells for high volume items.
- Develop more flexible tooling (roll-in rigs, adaptors, etc.) to provide greater cell utilization.
- Utilize vacant cells.
- Provide control panel flexibility.
- Provide manpower flexibility.

Schedules (Focus Study #2):

- Develop and implement a quarterly "block" schedule system which is based on manpower and equipment capacity.

Manpower (Quick Fix #1):

- Provide inexpensive jib crane to handle heavy fixtures.



MATPAT LAYOUT REVISIONS
FIGURE 6.5.1-2

6.5.2 Statistical System Performance Measures

Summary of Validation Process:

The validation process consisted of a short briefing cf UDOS 2.0, the calculation of the model run, and affirmation of validation on 20 July 1989 by ALC personnel. Validation personnel included the ALC/TI-ES site representative, the MATPAT supervisor, engineer, planner, and the scheduler.

The major assumption was that estimated scheduling flows would be compared to the model output because of inaccurate historical data, and because there is no GO19C available for MATPAT. It was further determined that the majority of the items clear the RCC in a 24 hour period. This was verified by the model output (reference - Validation Minutes).

During validation, it was jointly agreed to dedicate manpower to items during the heavy induction quarters. Discussion with shop supervision indicated that doing this would make the model outputs more reflective of actual floor operations. Also, large start-up queues were determined to be caused by equipment inflexibility.

Inductions versus throughput matched 100%. This was because virtually all items are processed in a one day period. Simulated flow hours ranged from 5.0 to 21.0, with the higher flows precipitated by high inductions into dedicated cells.

Equipment utilization ranged from a high of 65% tc a low of 2%. This is explainable due to high volume at dedicated test cells.

Manpower utilization was 72% on the first shift, 51% on the second shift, and only 25% on the third shift, which essentially is an overflow operation to complete the previous day's runs. The only significant queue was noted for PCN 31953, which has a mandatory preparatory oil soak.

Under As-Is conditions FY 90 would not present any problems as the workload is less than FY 88. Also, under surge conditions in the As-Is mode, manpower utilization is 79% with two 12-hour shifts seven days/week. Equipment utilization is surge feasible with the exception of test cell #25 (OC 1028)(6" air flow regulators) which is over utilized.

Brainstorming:

It was ascertained that experimentation would be conducted with equipment flexibility, FY 90, and surge requirements.

Experimentation:

Due to the unique nature of MATPAT, the very short flow times, and all items being in/out within a 24 hour period, MDMSC Taguchi arrays would not produce any significant results. Therefore, MDMSC determined that single factor experimentation would be more applicable.

Focus Study #1: Equipment Flexibility

The following experiments were conducted in comparison with the As-Is model output.

- The equipment flexibility was modeled at an 80% level. This was done by making 80% of the testing equipment alternates with each other, leaving 20% of the equipment to be modeled as unique.
- The manpower requirements were also modeled without any third shift or weekend work.

Findings Based on a Two Quarter Experimental Run:

80% flexibility reduced the average flow time by 26%

As-Is	Experiment
Flexibility - Minimal	80% (interchangeability between test cells)
Hours - No third shift, no weekends	No third shift, no weekends
Flows - 11.30 hours	8.37 hours

Remarks:

- Thirty percent of the parts accounted for 90% of the reduction.
- Eighty percent flexibility allowed for a more even utilization of the testing facilities by reducing the impact of surges and uneven inductions. It also increased the utilization of manpower on the first shi by 7%, and decreased the utilization of manpower on the second shift by 13%.

Recommendations:

- Eighty percent flexibility would allow the existing work to be performed on the first shift. Therefore, the second and third shifts will be available for surge conditions.
- Eighty percent flexibility would allow a 50% reduction in manpower and the virtual elimination of all overtime and weekend work. There would be no significant increase in the flow times or the work in process inventories.
- Eighty percent flexibility would allow a reduction in the number of test cells required. To determine the actual number of cells, additional experimentation is required.

Focus Study #2: "Block Scheduling" (Reference section 6.5.5)

The following experiment was conducted with the As-Is model output.

The focus study prescribes the establishment of a scheduling system based on equipment and manpower capacity rather than chronological inductions. The overall benefit is that there will be longer runs per set-up or correspondingly, there will be fewer set-ups per total inductions.

A two-quarter experimental run was modeled in which the set-up times were reduced by 50%. This change was made to reflect the number of items being run against a setup being increased to twice the current amount. This assumption of doubled lot size is very conservative when viewing the large parameters of block scheduling by quarter.

Findings Based on a Two Quarter Experimental Run:

As-Is run = Average hrs. labor x inductions =	12,496	hours
Experimental run = Average hrs. x inductions =	11,233	
Two quarter delta =	1,263	hours
	x 2	
Four quarter delta =	2,526	hours

Therefore, the difference between the model runs is the resultant effect of the reduction of set-up hours due to "block scheduling."

6.5.3 Description of Process Problems

A major problem (reference paragraph 6.5.4) associated with MATPAT is the lack of testing flexibility in both facilities and manpower. The experience and expertise levels of the test operators are extremely high; however, they are highly specialized on certain items only. This generates long queues when a large volume of specialized items are scheduled, or the specialized operator is absent from work.

There are several limitations in the facilities that limit the flexibility of testing items in different test cells:

- Air flow piping and valving limit the use of multiple cells for high volume items.
- Single purpose tooling also prevents the utilization of multiple cells.
- Some cells are occupied with shop tests, prototypes and engineering trials.

Another major process problem (reference paragraph 6.5.5) is the scheduling system used in the MATPA section. The schedules are based on the number (64) of quarterly work days expressed as a daily %. The schedules are released for a ten day period. The tenth day % is applied to the requirements, and the resultant number of items is spread evenly over the ten day period for an equal number of items per day.

In effect, scheduling is accomplished on a chronological basis, not by manpower and equipment capacity. Therefore, increased set-ups and excessively short runs are precipitating longer flow times.

6.5.4 Recommended Focus Study: Provide for Greater Equipment and Manpower Flexibility in the Testing of Pneudraulic Air Accessories

This focus study will provide a complete analysis of the piping/valving requirements to update the current facilities for flexible test cell operation.

The problem of heated air not reaching the far extremes of the piping system will be approached by installing an in-line heater at the most advantageous point in the hot air line.

Double air source requirements will be addressed in the piping evaluation. It is recommended to free up those test cells which are used only to provide the second air source to test cells which currently require two sources of air. Also, large air flows (8") will be reviewed to expand test cell availability.

In addition, more flexible tooling, such as roll-in rigs, quick change orifice plates, adapters, etc. will be analyzed and catalogued for groups of items.

Concurrent with the upgrading of facilities and equipment, MDMSC recommends compiling and publishing a test operator's bench book for the testing of every item processed through MATPAT. The manual would compliment and supplement the Technical Orders and be compiled by MDMSC coordinators utilizing the knowledge and individual notebooks of the specialized test operators.

The operators bench book would detail each step in the testing procedure for each item along with quality and safety highlights. The manual would be coordinated through the MDMSC coordinators and the responsible engineers, planners production supervisors, and quality personnel. This will require an expansion of their present job assignments.

In summary, for a surge condition, this focus study is mandatory.

This focus study was developed, in part, from the information contained in Table 6.5.4-1 which details the areas that will be affected by this focus study. Also shown is the MDMSC assessment of the level of effort required in the focus study to evaluate individual areas of analysis.

6.5.4.1 Rationale Leading to Change

It appeared obvious in characterizing MATPAT that a high degree of specialization was prevalent in both equipment and manpower. From interviews it also was apparent that the facilities require modifications to maintain proper air flow through the test cells.

Furthermore, it was found that designated operators test certain items only. For each item tested, the profile information could be obtained from only the operator designated to test that respective unit. For example, MDMSC could only obtain profile interview information for specific parts from only one specific operator on the night shift.

It is predicted that if test cell and manpower flexibility could be obtained, considerable benefits would be achieved through shorter flows, increased resource utilization, and the development of test operators effectively trained in the testing of virtually all items.

6.5.4.2 Potential Cost Benefit

An annual recurring cost savings of $729,306 occurs from the implementation of the recommended improvements as shown in Table 6.5.4-2. This cost savings is a result of 50% reduction in manpower.

The investment cost of the recommendations is estimated at $1,016,127. This cost includes the focus study effort and the implementation cost.

FOCUS STUDY CRITERIA CHECKLIST

TABLE 6.5.4-1 (SHEET 1 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Process/Material Flow	The resultant flexibility will change the assignments of items to multiple test cells.		X	
Equipment/Work Place Layout	New equipment will impact the test cell layouts as to flexibility.		X	
Facility Requirements	A complete overhaul of the Air Handling Piping and Valving will be analyzed.			X
Labor Standards	Labor standards will remain the same.	X		
Manpower	Manpower will be reduced as cell flexibility will prevent queues.	X		
Task Assignments	Operators will run most items as required per operator bench book.			X
Material Requirements	No change.			
Scrap Rates	Scrap rate should stabilize as test procedures are standardized per the bench book.	X		

LSC-20477A

FOCUS STUDY CRITERIA CHECKLIST

TABLE 6.5.4-1 (SHEET 2 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Material Handling & Storage Methods	Additional fixture and item storage will be reviewed.		X	
Inspection Techniques	The multi-rejections of the same item will be assessed.			X
Equipment/Tools/Fixtures	New fixturing will be evaluated.		X	
Process Delays	None expected.			
Part Identification	No changes.			
Quality	Improved standard procedures per the bench book will be quality highlighted.			X
Personnel Safety	Safety requirements would be incorporated in the operator bench book.			X
Environmental Assessments	No changes.			

LSC-20477

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 6.5.4-2 (SHEET 1 OF 2)

	CURRENT ANNUAL COSTS	PROPOSED CHANGE INVESTMENT COSTS	PROPOSED CHANGE ANNUAL COSTS
NONRECURRING COSTS (1)			
FOCUS STUDY	$0	$260,000 (2)	$0
FACILITIES			
LAND	$0	$0	$0
BUILDINGS	$0	$0	$0
SUPPORT EQUIPMENT			
DEVELOPMENT	$0	$0	$0
ACQUISITION	$0	$728,000 (3)	$0
INSTALL & CHECKOUT	$0	$11,400 (4)	$0
LOGISTICS SUPPORT			
INITIAL SPARES	$0	$0	$0
INITIAL TRAINING (DEV & PRESENTATION)	$0	$16,727 (5)	$0
TECHNICAL DATA	$0	$0	$0
TOTAL NONRECURRING COST	$0	$1,016,127	$0
RECURRING COSTS (1)			
TOUCH LABOR	$1,458,612 (6)	$0	$729,306 (7)
SUPPORT EQUIP MAINT	$0	$0	$0
SPARES AND SPARES MGMT	$0	$0	$0
TECHNICAL DATA	$0	$0	$0
MOD KITS	$0	$0	$0
CONFIGURATION DATA MGMT	$0	$0	$0
UTILITIES	$0	$0	$0
TOTAL RECURRING COSTS	$1,458,612	$0	$729,306
TOTAL COSTS	$1,458,612	$1,016,127	$729,306
ANNUAL COST SAVINGS	$729,306		

NUMBER OF MONTHS FOR FOCUS STUDY	6
NUMBER OF MONTHS TO IMPLEMENT CHANGES	6

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 6.5.4-2 (SHEET 2 OF 2)

NOTES:

(1) ONLY ITEMS THAT ARE SIGNIFICANTLY AFFECTED BY THE PROPOSED CHANGE HAVE BEEN ESTIMATED

(2) ENGINEERING ESTIMATE FOR USE IN ENGINEERING TRADE STUDIES ONLY, DOES NOT REPRESENT FIRM PRICING

(3)

REFURBISH PIPING AND VALVING SYSTEMS		$500,000
NEW CHILLER UNIT		30,000
HYDRAULIC AND ELECTRIC LOAD BANKS		10,000
SQUEEZE BOX		38,000
TURBINE STAND		100,000
IN-LINE HEATERS		30,000
(2) SCREW TYPE COMPRESSORS		20,000
	TOTAL	$728,000

EQUIPMENT ESTIMATES RECEIVED FROM OC-ALC ENGINEERING.

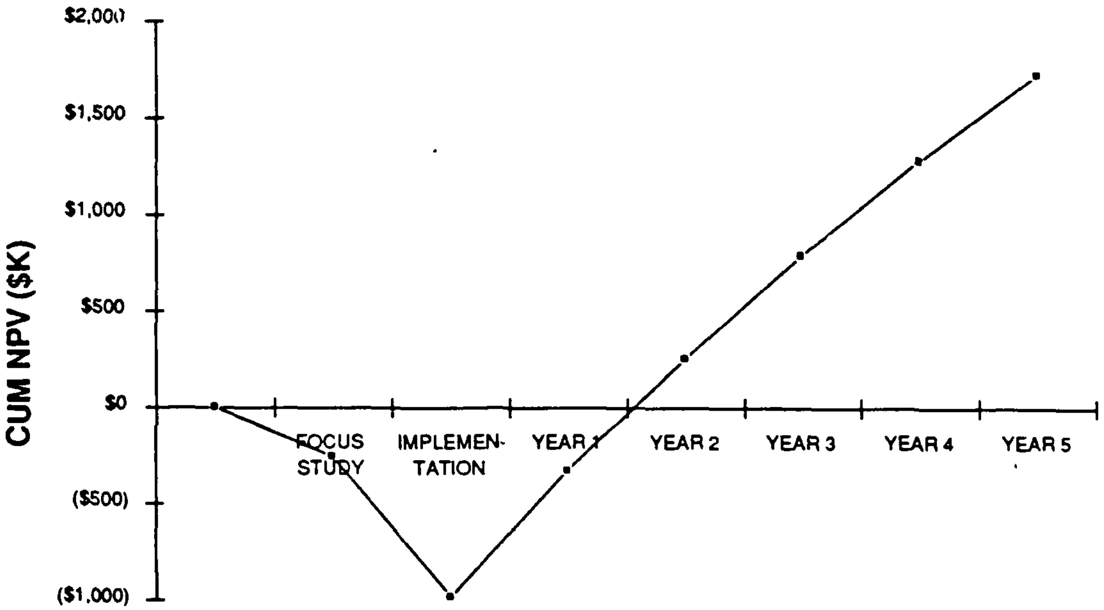
(4) INSTALLATION COST (ESTIMATED AT 5% OF EQUIPMENT COST NOT INCLUDING PIPE AND VALVE)

(5) *CROSS TRAINING (BENCH MANUAL)*
14 OPERATORS X 40 HOURS X $29.87/HR

(6) BASED ON ACTUAL NUMBER OF OPERATORS
28 OPERATORS X 1744 HRS/YEAR X $29.87/HR

(7) BASED ON 50% REDUCTION IN NUMBER OF OPERATORS
28 OPERATORS X .5 X 1744 HRS/YEAR X $29.87/HR

The Cost Benefit Analysis (CBA) shows an Internal Rate of Return (IRR) of 72% and a savings of $1,721,055 in terms of Net Present Value (NPV) using constant FY 89 dollars, see Figure 6.5.4-1. The CBA is in compliance with regulation AFR173-15, cost analysis procedures, dated 4 Mar 88 and rates per AFLCR 78-3.



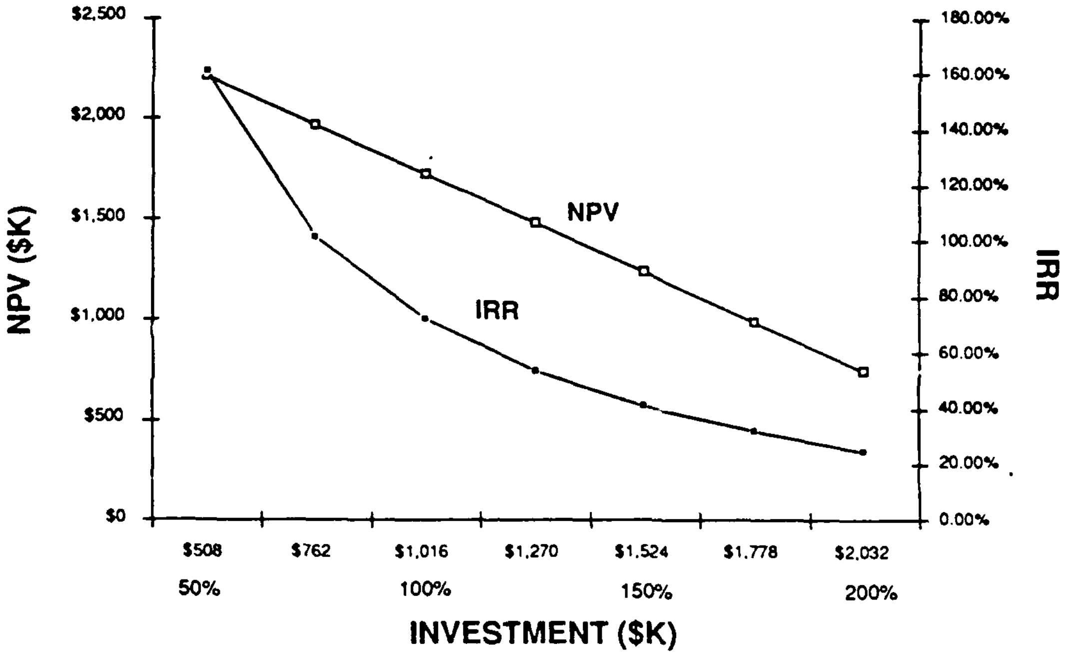
CUM NPV IN CONSTANT FY89 DOLLARS
FIGURE 6.5.4-1

The CBA covers the time frame starting with the focus study through five years after the completion of implementation. The recurring cost savings was assumed to start at the end of implementation.

The NPV takes into account the time value of money and is calculated by discounting a cash flow. The focus study cost, implementation cost, and the recurring savings were spread by fiscal year quarters and discounted back to the first quarter by using a mid-quarter discounting factor equivalent to an annual discount factor of 10%. Basically, this means a dollar that is earned in

FY 90 is worth $.91 in FY 89 terms ($1.00/1.1), due to the ability to borrow or lend at a positive interest rate.

A sensitivity analysis was performed in which the investment cost varied between 50% and 200% of the estimated costs, see Figure 6.5.4-2.



CBA SENSITIVITY ANALYSIS
FIGURE 6.5.4-2

6.5.4.3 Risk Assessment of Achieving Study Goals

The actual cost savings will be quantified after the completion of the focus study. It is to be noted that all projected savings in this report are conservative.

The testing requirements in the Technical Orders are succinct and when utilized with MDMSC expertise risks will be negligible.

The implementation of the focus study results will certainly withstand the impact of any known future workloads.

6.5.4.4 Duration and Level of Effort

MDMSC recommends a six month long focus study period of performance to:

- Assess all technical aspects, facilities, equipment, and fixtures necessary to provide the flexibility of testing individual items in multiple test cells.
- Research, establish, and provide standardized operation procedures to promote test operator flexibility. In addition, the resultant bench manual should appreciably reduce the training period for new operators.
- It is estimated that a total of $260,000 is required to successfully implement this recommendation. This number is an engineering rough order of magnitude estimate.
- Safety requirements will be noted in the bench book. The projected schedule of activities is shown in Table 6.5.4-3.

6.5.5 Recommended Focus Study: Develop and Implement a Quarterly Block Schedule System Based on Manpower and Equipment Capacity

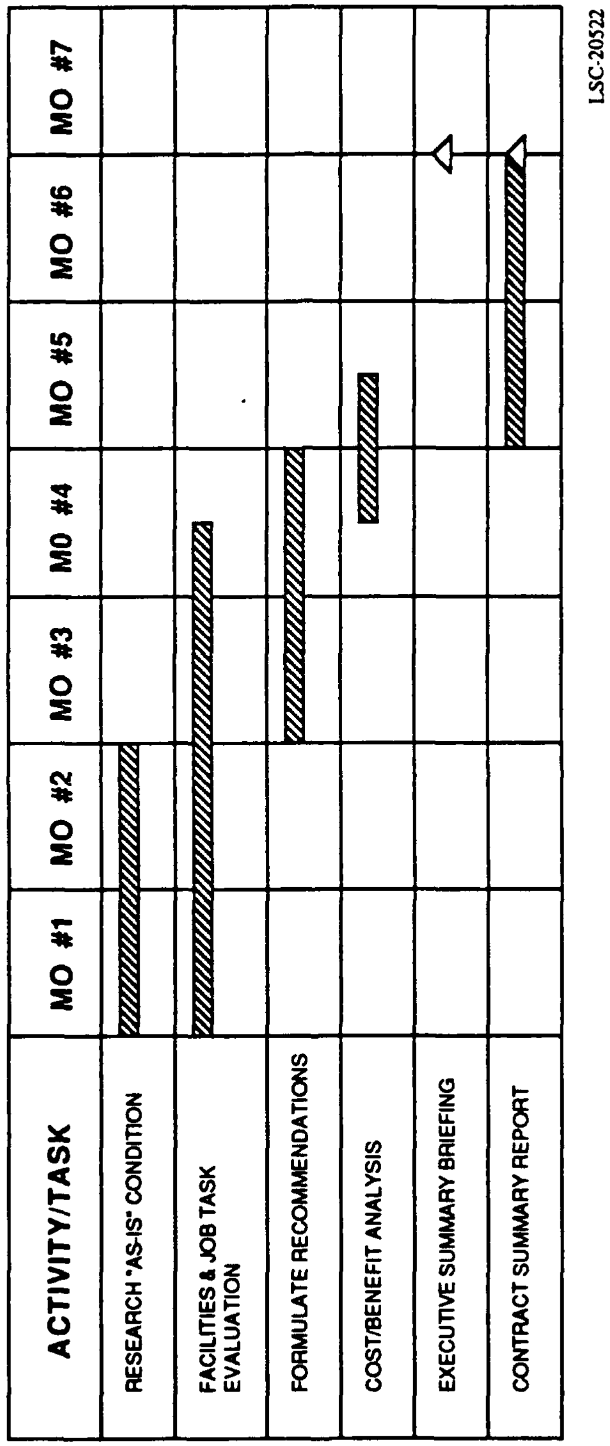
This focus study will provide a detailed analysis of the overall scheduling procedure in MATPAT. The objective of this focus study is to develop a block scheduling system that will appreciably reduce the number of set-ups per item and increase the length of item runs. To facilitate the study, a detailed analysis of manpower and equipment capacities will be developed and incorporated into the scheduling system. The effectiveness of the system will be evaluated through scheduling control reports.

This focus study was developed in part from the information contained in Table 6.5.5-1 which details the areas that will be affected by this focus study. Also shown is the MDMSC assessment of the level of effort required in the focus study to evaluate individual areas of analysis.

6.5.5.1 Rationale Leading to Change

In reviewing the scheduling system, it was found that the requirements are scheduled on a chronological basis, and manpower/equipment capacities are not addressed.

PROPOSED FSR NO. 1 SCHEDULE
TABLE 6.5.4-3



FOCUS STUDY CRITERIA CHECKLIST

TABLE 6.5.5-1 (SHEET 1 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Process/Material Flow	Block scheduling based on equipment and manpower capacity will produce longer production runs and reduced flow times.			X
Equipment/Work Place Layout	Fewer setups will be required due to the longer runs.			X
Facility Requirements	See test cell flexibility (see focus study paragraph 6.5.4).			
Labor Standards	Standards will be reviewed to account for reduced setups.			X
Manpower	Manpower will be evaluated due to reduced flow times.		X	
Task Assignments	Scheduling assignments will be delineated and categorized.		X	
Material Requirements	No change.			
Scrap Rates	No effect.			

LSC-20478

FOCUS STUDY CRITERIA CHECKLIST

TABLE 6.5.5-1 (SHEET 2 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Material Handling & Storage Methods	Additional storage space will be incorporated in the plant layout.		X	
Inspection Techniques	Non-applicable. Addressed in Focus Study No. 1.			
Equipment/Tools/Fixtures	Non-applicable. Addressed in Focus Study. (Reference Para. 6.5.4.)			
Process Delays	None expected.			
Part Identification	No change.			
Quality	The repetitiveness of longer runs will be quality assessed.			X
Personnel Safety	No changes.			
Environmental Assessments	No changes.			

LSC-20178

The days of each quarter are expressed as a percentage, and the items are spread over a ten day period based on the chronology of the specific days in the quarter.

The following is a typical example:

PCN 920414	May 1989									
Date	12	13	16	17	18	19	22	23	24	25
Schedule	1	0	0	2	0	1	2	0	2	0

Conclusion: Five set-ups for an eight piece run.

6.5.5.2 Potential Cost Benefit

An annual recurring cost savings of $75,452 occurs from the implementation of the recommended improvements as shown in Table 6.5.5-2. This cost savings is a result of 50% reduction in setup time.

The investment cost of the recommendations is estimated at $101,000. This cost includes the focus study effort and the implementation cost.

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 6.5.5-2 (SHEET 1 OF 2)

	CURRENT ANNUAL COSTS	PROPOSED CHANGE	
		INVESTMENT COSTS	ANNUAL COSTS
NONRECURRING COSTS (1)			
FOCUS STUDY	$0	$90,000 (2)	$0
FACILITIES			
LAND	$0	$0	$0
BUILDINGS	$0	$0	$0
SUPPORT EQUIPMENT			
DEVELOPMENT	$0	$0	$0
ACQUISITION	$0	$10,000 (3)	$0
INSTALL & CHECKOUT	$0	$0	$0
LOGISTICS SUPPORT			
INITIAL SPARES	$0	$0	$0
INITIAL TRAINING (DEV & PRESENTATION)	$0	$1,000 (4)	$0
TECHNICAL DATA	$0	$0	$0
TOTAL NONRECURRING COST	$0	$101,000	$0
RECURRING COSTS (1)			
TOUCH LABOR	$746,511 (5)	$0	$671,059 (6)
SUPPORT EQUIP MAINT	$0	$0	$0
SPARES AND SPARES MGMT	$0	$0	$0
TECHNICAL DATA	$0	$0	$0
MOD KITS	$0	$0	$0
CONFIGURATION DATA MGMT	$0	$0	$0
UTILITIES	$0	$0	$0
TOTAL RECURRING COSTS	$746,511	$0	$671,059
TOTAL COSTS	$746,511	$101,000	$671,059
ANNUAL COST SAVINGS	$75,452		

NUMBER OF MONTHS FOR FOCUS STUDY	4
NUMBER OF MONTHS TO IMPLEMENT CHANGES	2

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 6.5.5-2 (SHEET 2 OF 2)

NOTES:

(1) ONLY ITEMS THAT ARE SIGNIFICANTLY AFFECTED BY THE PROPOSED CHANGE HAVE BEEN ESTIMATED

(2) ENGINEERING ESTIMATE FOR USE IN ENGINEERING TRADE STUDIES ONLY, DOES NOT REPRESENT FIRM PRICING

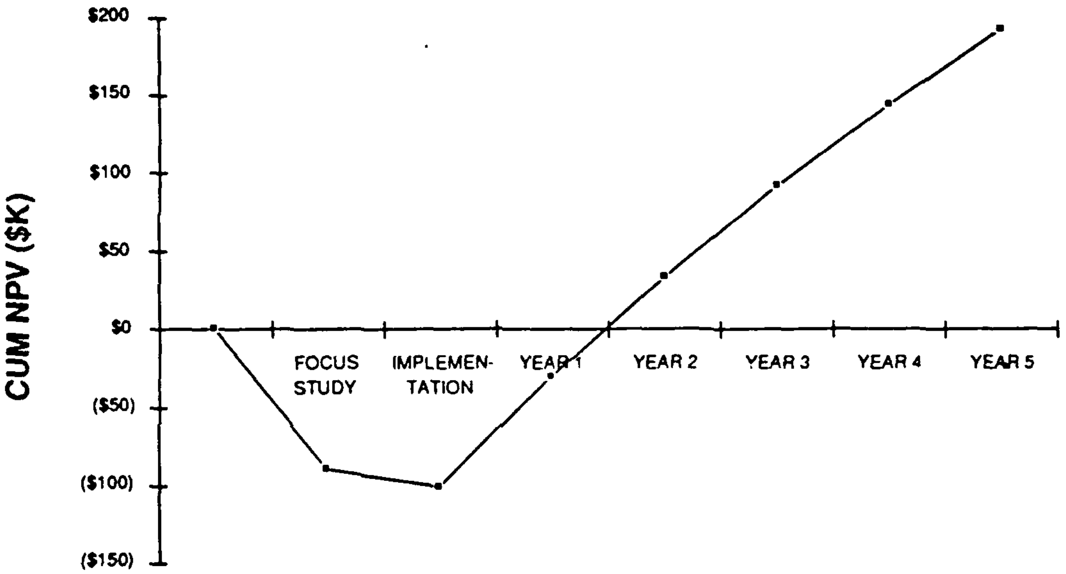
(3) SCHEDULING SOFTWARE (ESTIMATE PER OPT CORP.)

(4) INITIAL TRAINING
(10% OF SOFTWARE)

(5) BASED ON YEARLY LABOR HOURS (MODEL RUN)
24,992 HOURS X $29.87/HOUR

(6) BASED ON YEARLY LABOR HOURS WITH 50% REDUCTION IN SETUP HOURS (MODEL RUN)
22,466 HOURS X $29.87/HOUR

The Cost Benefit Analysis (CBA) shows an Internal Rate of Return (IRR) of 81% and a savings of $192,419 in terms of Net Present Value (NPV) using constant FY 89 dollars, see Figure 6.5.5-1. The CBA is in compliance with regulation AFR173-15, cost analysis procedures, dated 4 March 1988 and rates per AFLCR 78-3.



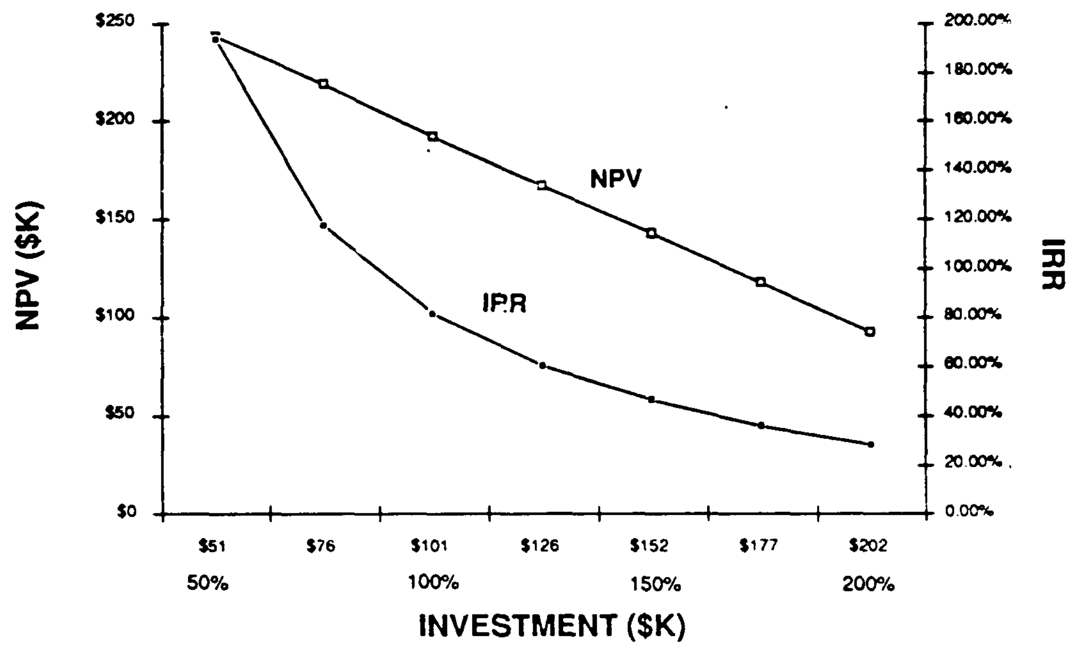
CUM NPV IN CONSTANT FY89 DOLLARS
FIGURE 6.5.5-1

The CBA covers the time frame starting with the focus study through five years after the completion of implementation. The recurring cost savings was assumed to start at the end of implementation.

The NPV takes into account the time value of money and is calculated by discounting a cash flow. The focus study cost, implementation cost, and the recurring savings were spread by fiscal year quarters and discounted back to the first quarter by using a mid-quarter discounting factor equivalent to an annual discount factor of 10%. Basically, this means a dollar that is earned in

FY 90 is worth $.91 in FY 89 terms ($1.00/1.1), due to the ability to borrow or lend at a positive interest rate.

A sensitivity analysis was performed in which the investment cost varied between 50% and 200% of the estimated costs, see Figure 6.5.5-2.



CBA SENSITIVITY ANALYSIS
FIGURE 6.5.5-2

6.5.5.3 Risk Assessment of Achieving Goals

The actual cost savings will be quantified after the completion of the focus study. It is to be noted that all projected savings in this report are conservative.

The application of block scheduling to the production requirements of the MATPAT RCC will negate any risks through the scheduling design expertise of MDMSC.

The implementation of this focus study will buffer any future workload impacts in a far superior manner than the current chronological system of scheduling.

6.5.5.4 Duration and Level of Effort

MDMSC recommends a four month long focus study period of performance to:

- Evaluate scheduling requirements on a quarterly basis.
- Determine manpower and equipment capacities in MATPAT.
- Establish a basic scheduling plan and the ancillary schedule controls.
- It is estimated that a total of $90,000 is required to successfully implement this recommendation. This number is an engineering rough order of magnitude estimate.
- Safety requirements will be noted in the bench book. The projected schedule of activities is shown in Table 6.5.5-3.

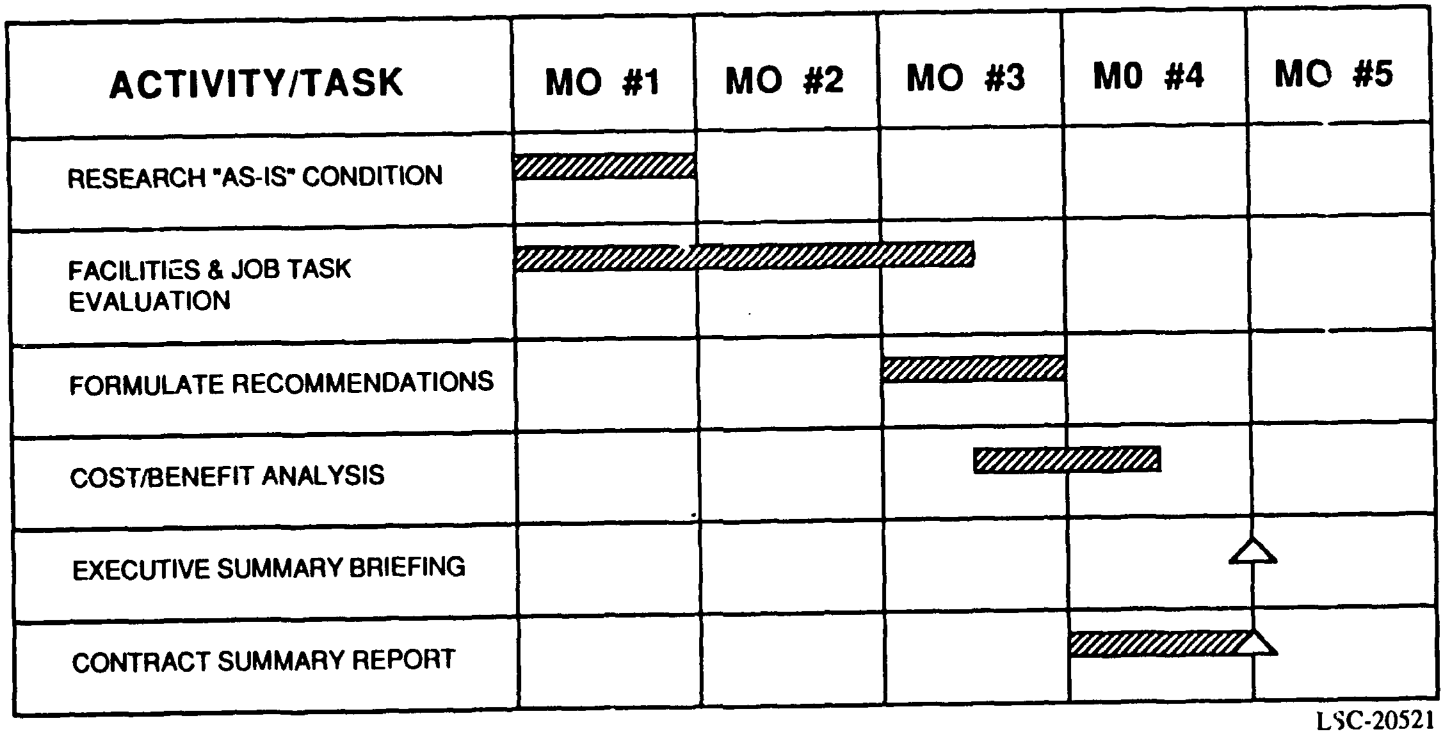
6.5.6 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact in the areas of quality, time, or cost. These observations were recorded to assist OC-ALC in developing ideas that will further enhance their repair operations.

The observations which follow were originally identified as quick fix or focus study improvement opportunities, and are detailed as such in the MATPAT DDB. After review by the MDMSC/Air Force team, it was determined that they should be pursued as other observations.

PROPOSED FSR NO. 2 SCHEDULE

TABLE 6.5.5-3



LSC-20521

Operational Improvements

- Development and Implementation of Quality Reject Definitions, Repair Procedures, and Intelligent Communications
  - Current Condition: The lack of reject definitions and immediate communications is perpetuating a "revolving door" posture of items that fail testing. These items are repaired, retested, and rejected several times, or put aside on the mechanic's bench if a similar item is available. Also, the mechanic may remanufacture the entire item when only one specific part, or just a few parts, are defective.
  - MDMSC Recommendation: A project should be initiated to develop a comprehensive list of quality definitions which would pin-point defect causes, repair approaches to these defects, and develop a communication system to eliminate the several trial and error cycles for one item.

- Provide Two Small Screw Type Compressors to Facilitate the Compressed Air Requirements for MATPAA and MATPAB
  - Current Condition: The air supply for MATPAA and MATPAB is siphoned off the main compressors used to supply air to the test cells in MATPAT. The requirements of MATPAA and MATPAB are relatively light. However, the length of piping that runs from the main compressors are lengthy and loss of air from line leakage is considerable.
  - MDMSC Recommendation: One or two (depending upon air flow measurement) small screw type compressors ($10,000 each) should be located closer to the point of usage. This will enhance the air supply to MATPAT and alleviate the air pressure drops in the test cells.

6.6 MATPCA ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

MATPCA is a repair and overhaul facility for several aircraft and aircraft engine electrical accessories. The primary task of MATPCA is to provide overhauled and repaired parts and assemblies to Air Force inventory, with secondary responsibility of supporting the OC-ALC engine overhaul facility on high priority parts. The repair responsibilities of MATPCA are more fully described in paragraph 6.6.1.

The MATPCA work force is viewed by MDMSC as being very experienced. They were quite helpful during our characterization activities. Throughput is based on how efficiently a given back shop provides the required support. In FY 88, all items were accomplished despite the various indirect activities found throughout the RCC. Also, experimentation revealed that the current resources within MATPCA are capable of processing all items in a surge condition.

Initial characterization of this RCC yielded a total of 25 potential improvement opportunities. This list of improvements was reviewed by the MDMSC/OC-ALC site team, and 15 items were selected for more detailed analysis. Of these, one quick fix proposal was found to provide the most significant cost savings. All remaining improvement opportunities are briefly discussed in paragraph 6.6.4 as other observations.

The improvement opportunity identified as a quick fix item is the repair of the amplifier assembly used in the control relay box (PCN 35113A), as opposed to replacement of this subassembly. This quick fix opportunity is described in detail under separate cover. Refer to TI-ES Task Order No. 1, Volume III Quick Fix Plan OC-ALC MATPCA, Quick Fix Opportunities section.

6.6.1 <u>Description of Current Operation</u>

The MATPCA RCC is an electrical accessories repair and overhaul unit within the Accessories Division Production Branch of OC-ALC. It is located in building 3001.

The primary responsibility of MATPCA is to overhaul, repair, and bench test motors, exciters, power supplies, and other aircraft and aircraft engine electrical accessories. The primary workload of MATPCA consists of both Maintenance Items Subject to Repair (MISTR) and Programmed Depot Maintenance (PDM) items.

MATPCA is divided into two sections, each having its own workload and personnel. The two sections share storage facilities and some testing equipment, but otherwise exist as separate entities. Each section has its own first line supervisor. Technicians in both areas display a high degree of proficiency and knowledge of their assigned tasks. Supervision is competent and the RCC is well administered. Workloads appear equitably distributed given the staffing of each unit.

A large part of the first section's workload consists of various aircraft electrical accessories, including ignition exciters, thermal probes, electrically actuated valves, and related electrical equipment. The second section's workload consists of temperature amplifiers, power supplies, servo-motors, and various other electrical accessories. Both areas have the facilities and manpower to handle larger workloads than now exist. It should be mentioned that workloads in this section have changed in the last several years. It appears that this is due to older aircraft being phased out of active service, with newer model aircraft being introduced to Air Force inventory. This is an important consideration in interpreting the utilization of resources in MATPCA at the present time.

Facility layout drawings were not current at the time of MATPCA's assessment by the Technology Insertion-Engineering Services (TI-ES) team. This RCC was affected by the formation of a new RCC (MATPCC) within the Accessories Division Production Branch, as well as new office space being created out of previous production space. Updated drawings are presently being prepared at OC-ALC. The TI-ES team prepared rough drawings for inclusion in the Data Base Documentation Book for this RCC.

Space utilization in this RCC is relatively well managed, with testing equipment and work areas in easy access of each other. No obvious areas of congestion or impeded flow were identified. Storage facilities consist of several 6 x 4 x 2 cabinets located throughout the RCC, which are well organized and appear adequate to the task, given present workload. The most readily identified storage problem dealt with the lack of a humidity controlled storage chamber in this RCC. As many electrical components worked by MATPCA have a high potential for moisture damage, this is considered a critical need. OC-ALC authorities have recognized this need, and the equipment is now on order.

Equipment presently utilized by MATPCA consists of a variety of electrical test stands, common electrical testing equipment, and both common and specialized hand tools. Much of the testing equipment is in excess of twenty years old. This has caused difficulties in obtaining parts for repair of these items.

In observing the repair processes occurring in MATPCA, the overall impression was favorable for efficiency and flow through in this RCC. The TI-ES team was impressed with the degree of knowledge and experience of the personnel assigned, and appreciative of the cooperation that technicians and supervisors gave during data collection and model validation.

One of the tasks assigned to the TI-ES team was comparing operations performed in RCCs, such as MATPCA, to that of private industry. While there are some companies that perform overhaul and repair processes on aircraft accessories, it is difficult to make such comparisons. The problems of supply and distribution, scope of diversity in functions performed, and overall responsibilities are very different for the Air Logistic Centers. Considering the diversity of operations performed within MATPCA we believe that they are operating on a par with comparable private industry shops.

The reason for the current success in production capability by MATPCA has much to do with the personnel assigned to this area. The average experience level for this RCC was twelve years per technician. Having a work force with this level of experience and expertise is what allows MATPCA to perform well.

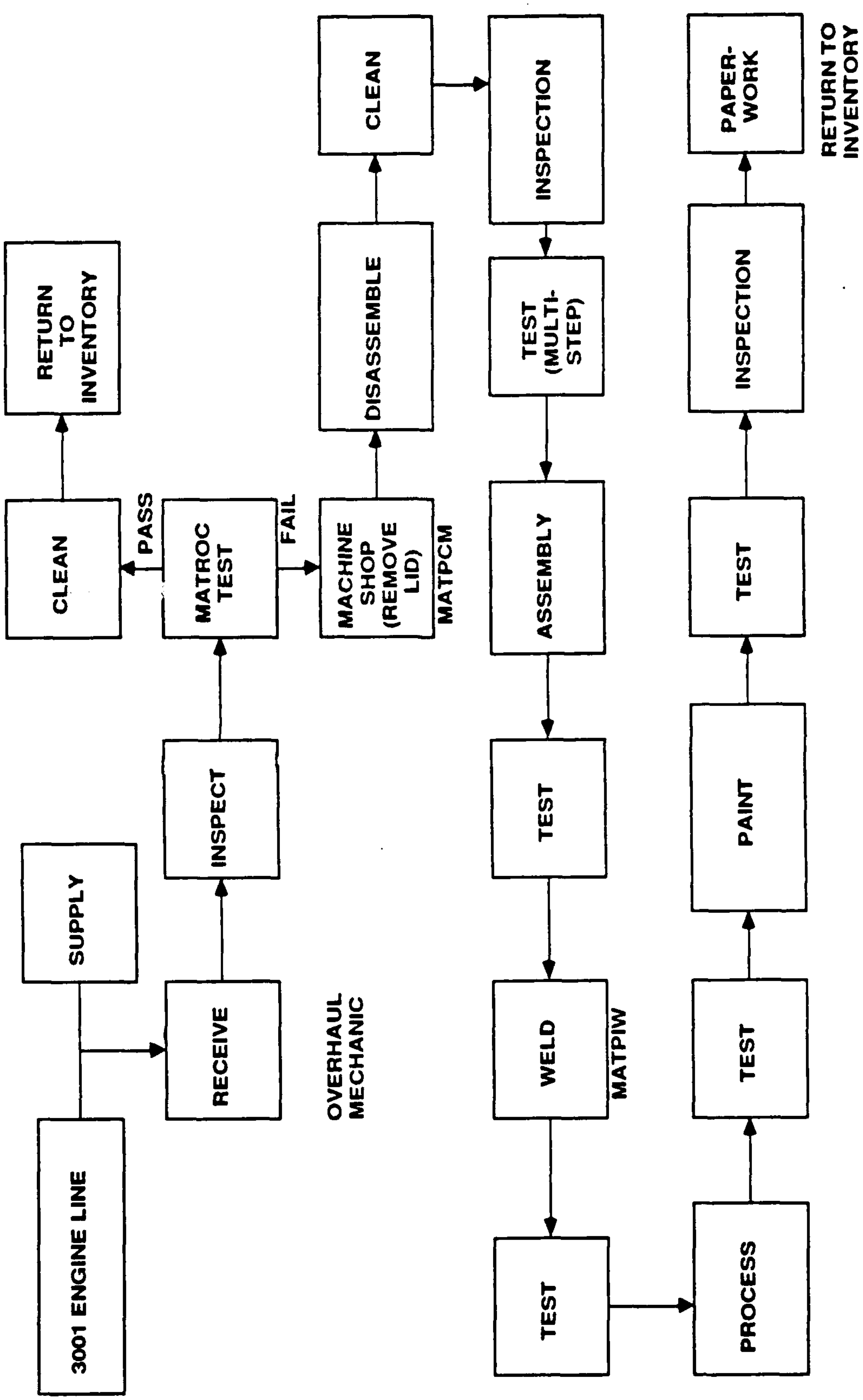
This is often in the face of adverse conditions, such as chronic parts shortages, dated equipment, reduced operating budget, and the normal bureaucracy found in large scale operations.

In regard to the size and complexity of the operations occurring in MATPCA, it is believed by the TI-ES team that production information management was an area of concern. The present system of Work Control Documents (WCD) was considered insufficient as a tracking tool, and was of questionable value as a historical record of work performed. Given the complexity of the processes accomplished in this RCC, a computerized tracking system such as DMMIS would be of great benefit. The accurate recording of in and out dates, manpower and equipment utilized, and stock consumed would all be more easily identified and planning would be enhanced with such a system. This might also assist in alleviating the chronic problems of supply and distribution.

Engineering and Planning should be more attentive to the WCDs and provide more detail for the methods of performing the various operations. Replies to AFLC Forms 103 (Problem Request Forms) are inconclusive, often leaving shop supervision with unresolved problems or insufficient information to work the problems. Engineering and Planning often address symptoms rather than causes to their problems.

Material flow (end items) into and out of MATPCA is variable and dependent on Air Force inventory needs, resource availability, and priority requirements. As stated above, any system that would assist in the scheduling of material flow, including repair parts and assemblies, would be of benefit. It is important to remember that several different types of aircraft and engine accessories are being worked in this RCC, and scheduling of these items and their support material is a arduous task. The process flow diagrams shown on Figures 6.6.1-1 and 6.6.1-2 are representative of the processes identified.

Many improvement opportunities exist which might prove beneficial to processes performed in MATPCA. A quick fix opportunity concerning the control relay box, PCN 35113A, was chosen for its low implementation cost and

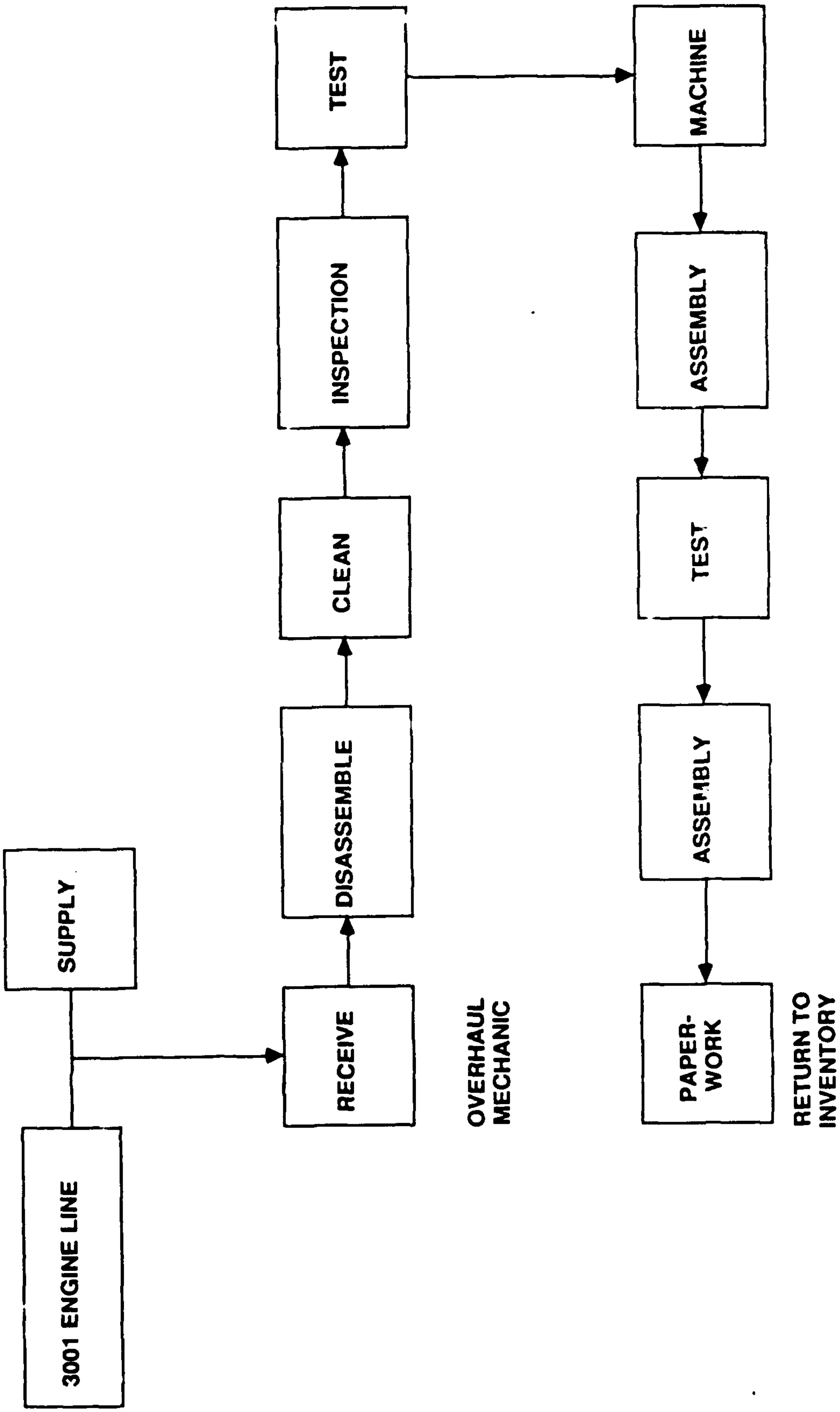


LSC-20325

FLOW DIAGRAM FOR OVERHAUL OF IGNITERS (MATPCA)

FIGURE 6.6.1-1

LSC-20333



FLOW DIAGRAM OF ELECTROMAG 3-WAY SELECT VALVES (MATPCA)
FIGURE 6.6.1-2

significant cost savings. Repair of this item is an example of the savings possible in repairing a subassembly as opposed to purchasing the component new. Specifically, the amplifier assembly for the control relay box can be repaired in many cases for an estimated cost of $14,000 per year, while replacement cost is listed as $113,000 per year. This item is estimated by technicians as having a failure rate of 80%. This should indicate the importance of identifying those cases where repair versus replacement should be considered.

For a more in-depth discussion of this quick fix item, refer to the Quick Fix Opportunities section of TI-ES Task Order No. 1, Volume III, MATPCA Quick Fix Plan. Other opportunities are listed in paragraph 6.6.4.

6.6.2 Statistical System Performance Measures

Validation of the UDOS 2.0 model simulation outputs for MATPCA was initiated on 10 July 1989. The validation process consisted mainly of a statistical comparison of historical throughput and flow times to the model generated simulations of these items for FY 88. Other criteria, such as utilization of manpower and equipment, were also used to assess the validity of the model results.

Several assumptions were made at the time of validation. These assumptions were considered to be both necessary and reasonable in interpreting model validity. The assumptions made were as follows:

- The 80/20 workload analysis was accurate and represented 80% of the workload. The workload may vary from 80% in cases where the MDMSC/OC-ALC team has decided on and jointly authorized deviations from the original 80/20 listing.
- Mechanics' estimates of process times are to be considered as statistically accurate.
- Induction quantity distributions are accurate and can influence throughput.

- Historical data, collected from the WCDs are not accurate. The reasons for the inaccuracies are influenced by the following:
  - WCD release practices (batch print)
  - Stamping practices on WCDs
  - Work schedules (priorities)
  - Lack of parts/high work in process
- Validation will be accomplished against engineering estimates.

The FY 88 80/20 list for MATPCA consisted of 26 end items. As previously stated, the criteria used to validate the UDOS 2.0 model simulation outputs was: 1) throughput, 2) simulated flow versus G019C estimated flow days, and 3) resources utilization (queues). These results are presented in detail in the DDB Experimental section.

The throughput statistical analysis done at the time of validation was to ascertain that the model simulated FY 88 production levels. As can be seen in DDB, Experimentation Section, the variance analysis for simulated throughput versus actual throughput for this RCC shows 2% difference. On the average, the model generated 7,308 end items versus 7,180 actual end items produced. A more detailed discussion by PCN number may be found in the DDB Experimental section.

The flow hours statistical comparison was performed against the G019C report. Historical data, once examined, was felt to contain too many inaccuracies for any meaningful analysis to be performed. The DDB contains the variance analysis for simulated flow hours versus G019C flow hours. On the average, the simulated flow hours reflect 17% higher than the G019C. A detailed discussion by PCN for this comparison is available in the DDB.

The brainstorming process for experimentation on MATPCA followed model validation. The prepositioning step is identification of the problem statement or objective of the brainstorming process. In the case of MATPCA, the problem statement read: "What effect would be seen by 1) adding one additional OC 3906 versus two additional OC 3906, using both the old and the new (1/2) processing times, 2) utilizing OC 4286 on second shift versus addition of a second or third OC 4286 (and combinations), 3) incorporating three versus four welders on first shift, or splitting four welders across two shifts, and 4) additional manpower loading across two shifts."

An orthogonal array was developed using the Taguchi process. The team identified four factors and established three levels for each factor. An L_9 (3^4) array is depicted in Table 6.6.2-1, with throughput (Δ) being selected as a quality characteristic. A discussion of the results of these experiments follows. Table 6.6.2-1 shows the average throughput of all experimental runs performed as being 100%. This precludes the use of throughput as an analysis factor for experimental results. It can also be seen that best and worst case analysis by PCN for each run shows little variance between end items worked. MATPCA appears very efficient across their entire workload.

Table 6.6.2-2 was developed using the simulated flow time averages from each experiment and performing a Taguchi analysis using this data. By selecting the Taguchi Optimum level for each factor, the most effective combinations of equipment, manpower, and skill were selected. It was seen that the addition of another OC 3906 Jet Ignition tester was an effective solution, while expenditure of additional capitol to purchase a third OC 3906 or one having a faster processing rate would not be justified. It also appears that adding two welders to both first and second shift is an effective solution.

The addition of one OC 4286 on first shift appears preferable to utilization of this equipment on the second shift, or purchase of a third OC 4286. It is also seen that addition of one more by skill to first shift is the most effective choice, with little or no benefit to be gained with additional manpower.

The FY 90 workload was used to determine MATPCA surge capabilities. Using the FY 90 surge information provided by AFLC, a throughput of 100% can be expected. It appears that present MATPCA resources are sufficient to meet projected surge conditions in 1990. The following MDMSC recommendations

MATPCA $L_9(3^4)$ TAGUCHI ORTHOGONAL ARRAY THROUGHPUT EXPERIMENTAL RESULTS - FY 90

TABLE 6.6.2-1

EXP #	EQUIPMENT QUANTITY	BACKSHOP	EQUIPMENT QUANTITY	MANPOWER ASSIGNED	NORMAL WORKLOAD		
					AVG	BEST	WORST
1	ADD 1 OC 3906	3 WELDERS ON 1ST SHIFT	ADD 1 OC 4286 ON 1ST SHIFT	ADD 1 CODE BY ON 1ST SHIFT	100%	34128A / 107%	49711A / 94%
2	ADD 1 OC 3906	4 WELDERS ON 1ST SHIFT	ADD 2 OC 4286 ON 1ST SHIFT	ADD 2 CODE BY ON 1ST SHIFT	100%	49315A / 109%	49711A / 96%
3	ADD 1 OC 3906	2 WELDERS ON 1ST SHIFT	USE OC 4286 ON 2ND SHIFT	ADD 4 CODE BY ON 1ST SHIFT	100%	49315A / 109%	49711A / 91%
4	ADD 2 OC 3906	3 WELDERS ON 1ST SHIFT	ADD 2 OC 4286 ON 1ST SHIFT	ADD 4 CODE BY ON 1ST SHIFT	99%	38643A / 104%	49711A / 90%
5	ADD 2 OC 3906	4 WELDERS ON 1ST SHIFT	USE OC 4286 ON 2ND SHIFT	ADD 1 CODE BY ON 1ST SHIFT	100%	49315A / 109%	49711A / 93%
6	ADD 2 OC 3906	2 WELDERS ON 1ST SHIFT	ADD 1 OC 4286 ON 1ST SHIFT	ADD 2 CODE BY ON 1ST SHIFT	100%	49315A / 107%	49711A / 95%
7	1 OC 3906 WITH 1/2 TIME	3 WELDERS ON 1ST SHIFT	USE OC 4286 ON 2ND SHIFT	ADD 2 CODE BY ON 1ST SHIFT	100%	49315A / 103%	49711A / 92%
8	1 OC 3906 WITH 1/2 TIME	4 WELDERS ON 1ST SHIFT	ADD 1 OC 4286 ON 1ST SHIFT	ADD 4 CODE BY ON 1ST SHIFT	100%	49315A / 109%	49711A / 103%
9	1 OC 3906 WITH 1/2 TIME	2 WELDERS ON 1ST SHIFT	ADD 2 OC 4286 ON 1ST SHIFT	ADD 1 CODE BY ON 1ST SHIFT	100%	49315A / 108%	49711A / 92%

LSC-20497

ANALYSIS OF EXPERIMENTAL FLOW TIME AVERAGES USING TAGUCHI METHOD (L_9)

TABLE 6.6.2-2

EXPERIMENTAL FLOW TIME AVERAGES -

EXP. 1	251.22
EXP. 2	239.08
EXP. 3	238.65
EXP. 4	275.43
EXP. 5	237.96
EXP. 6	232.85
EXP. 7	276.63
EXP. 8	247.76
EXP. 9	251.12

$L_9\ (3^4)$

NO	1	2	3	4
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
1	2	1	2	3
2	2	2	3	1
3	2	3	1	2
1	3	1	3	2
2	3	2	1	3
3	3	3	2	1

FACTOR	LEVEL	
1	1	242.98
	2	284.75
	3	258.50
2	1	267.76
	2	241.60
	3	240.87
3	1	243.94
	2	255.21
	3	251.08
4	1	246.77
	2	249.52
	3	253.95

LSC-20498

are offered to assist OC-ALC management in preplanning for future surge conditions:

- Purchase a second OC 3906 Jet Ignition Tester.
- Purchase a second OC 4286 Temperature Amplifier Test Stand.
- Addition of two welders each on first and second shift dedicated only to MATPCA workloads is needed.
- Run model simulation at surge conditions for a projected five year plan.

A more comprehensive discussion of surge analysis for MATPCA is found in the MATPCA DDB under the experimentation section.

6.6.3 Description of Process Problems

The intent of this paragraph is to expound on major process problems for which there are focus study recommendations. Since there are no major process problems identified for MATPCA at this time, the potential improvement opportunities discussed in paragraph 6.6.4 if classified as other observations, or as a quick fix in the Quick Fix Plan.

6.6.4 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact in the areas of time, quality, or cost. These observations are recorded to assist OC-ALC in developing ideas that will further enhance their operations.

The observations which follow were originally identified as Quick Fix and Focus Study improvement opportunities and are detailed as such in the MATPCA DDB. After review by the OC-ALC site personnel and the TI-ES team, it was agreed that they should be presented as other observations for future reference.

- Electromagnetic Three-Way Valve (PCN 97133A) Pneumatic Testing
  - Current Condition: No specific requirement exists to test this item with compressed air before placing it on the fuel transfer station in Building 3108. Testing with compressed air would indicate any leakage areas before item transport and set-up on test equipment.
  - MDMSC Recommendation: Testing with compressed air should be instituted to avoid lost time in unproductive transits and operations.

- Electromagnetic Three-Way Select Valve (PCN 97133A) Fuel Transfer Testing
  - Current Condition: Most of these items have one port blocked off. They are presently used for hot air bleed-off on aircraft engines. The third port was originally used for fuel transfer. Technical Orders presently utilized still require the fuel transfer test to be performed.
  - MDMSC Recommendation: Delete the presently required fuel transfer test procedure. This would free skilled technicians for other duties, allow testing equipment to be more effectively utilized, and otherwise reduce operating expenses.

- A3 Module Technical Specifications (PCN 38645A)
  - Current Condition: The A3 module is a component used in the temperature amplifier assembly. When this item fails, the replacement module must have an initial "select fit" test performed to determine the module's specifications. This same test is performed by the vendor as part of their quality assurance program.
  - MDMSC Recommendation: The vendor should be required to provide the specific select fit data values of each A3 module delivered. This would lower the repair time required for each temperature amplifier needing an A3 module replacement by approximately six hours.

- MATROC Designation of Ignition Exciters (PCN 61234A and 50217A)
  - Current Conditions: These ignition exciters are not presently designated as MATROC items.
  - MDMSC Recommendations: By designating these ignition exciters as MATROC approved, an estimated 40% of all inductions of these items could be returned to inventory in one to two hours.

- Flow Meter Power Supply (PCN 34252A) Repair
  - Current Conditions: Internal circuit boards for this item are repairable in many cases. Repair times are not coded to this item, and boards are replaced if failure occurs.
  - MDMSC Recommendation: Repair time should be assigned for the circuit boards in those cases where repair is possible.

- Repair of Automatic Ignition Actuator Housing (PCN 35111A)
  - Current Conditions: Presently, if the switch assembly contained in the cover housing fails, the entire housing is replaced. This is due to the unavailability of the potting compound used in anchoring the switch assembly. The same vendor who supplies the housing also produces the potting compound.
  - MDMSC Recommendation: Obtain vendor support in acquiring potting compound for repair of housing-switch assembly.

- Testing Equipment in MATPCA
  - Current Condition: Much of the present test equipment in MATPCA is outdated and exhibits long periods of downtime. Test results from this equipment are often of questionable reliability.
  - MDMSC Recommendation: A detailed study should be performed to identify and replace the equipment exhibiting unreliable operating characteristics. Items such as the Jet Cal Tester (No. OC #) and the Jet Ignition Testing equipment (OC 4929) should be replaced as soon as possible.

- <u>Humidity Control Storage Chamber Requirement</u>
  - Current Condition: There is presently no humidity controlled storage chamber in MATPCA. An old refrigerator, packed with desiccant, is being used to store those items susceptible to damage from moisture.
  - MDMSC Recommendation: Given the critical need to provide a moisture free storage area for many of the components used in MATPCA, the purchase of a humidity controlled storage chamber should be expedited.

- <u>Identification of Repairable Items</u>
  - Current Condition: Various items worked by MATPCA have components and subassemblies which appear repairable by existing skilled personnel. In many cases these components are not coded with any repairable time, which encourages replacement of these parts with new stock.
  - MDMSC Recommendation: Given current budget considerations, it is suggested that repairable items be identified and coded with appropriate repair times where feasible. Feasibility would depend on a simple economic analysis comparing the cost of new components versus repair of existing items. Availability of repair material would also need to be considered.

- <u>Quality Assurance of Replacement Stock</u>
  - Current Condition: Various components utilized in MATPCA repair processes were reported as having relatively high failure rates. Deficiencies in packaging and quality control by manufacturers were sited as underlying causes.
  - MDMSC Recommendation: Tracking procedures for replacement stock geared to be of use at the shop level should be implemented. These procedures should include ease of use, identification and origin of failed components. It should be assumed that action is then taken on parts noted as deficient.

- Back Shop Delay Times
  - Current Condition: Back shop delays are occurring for items worked by MATPCA. These delays are most significant in MATPIW.
  - MDMSC Recommendation: A detailed analysis of delivery schedules, operation times, and causes for delays should be performed for all back shop operations. This data should then be incorporated into some form of end item tracking system for back shop processes. This should be relatively easy to do since MATPIW has been characterized. A possible approach is to "chain" these two RCCs and run the model. Results could then be applied to alleviating delays in specific PCNs.

- Hand Tool Design
  - Current Condition: Many different hand tools currently in use in MATPCA do not conform to presently recommended occupational ergonomics standards.
  - MDMSC Recommendation: Replace incorrectly designed hand tools with ergonomically sound designs. This would increase worker efficiency while decreasing effort.

- Water Bath Temperature Control
  - Current Condition: The water bath in MATPCA is used to check ignition exciters for leakage. The water temperature must be elevated to perform this test. Personnel routinely reduce the water temperature to avoid evaporation and protect against inadvertent burns. The water temperature must be raised to required specifications for test purposes. This requires approximately 15 minutes.
  - MDMSC Recommendation: A cover should be installed on the existing water bath to slow evaporation and prevent burns. Water temperatures could then be maintained at test specifications.

- RTV Versus Potting Compounds in Ignition Exciters
  - Current Condition: Various ignition exciters presently use a thermoset potting compound which is very labor intensive to remove. An additional drawback is additional damage to internal components of the exciters due to mechanical stress induced during removal of the potting compound.
  - MDMSC Recommendation: An acceptable silicone based RTV compound should be identified and approval obtained for its use through engineering channels. The most significant factors influencing this choice are 1) compatibility with component materials of the exciter and its internal parts, and 2) the ability of the RTV to withstand operating temperatures without degradation or decomposition.

6.7 MATPCB ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

MATPCB is the RCC in the Accessories Division (MAT) which is responsible for repair, overhaul, and test of fuel nozzles, manifolds, pumps, and hydraulic pumps. The RCC is housed in two adjacent buildings (3001 and 3108). They are linked by a continuous overhead conveyor system. The extent of its operations is more fully addressed in paragraph 6.7.1.

The current resources within MATPCB are capable of processing all of the items under surge conditions. Throughput, however, can be enhanced with some reduction in indirect activities to better control all resources in value added work.

Initial characterization of the RCC resulted in the identification of 15 improvement opportunities specific to MATPCB. One of these was judged by the MDMSC/OC-ALC team to warrant focus study status and one other was judged a quick fix. The remaining 13 are discussed in paragraph 6.7.5, Other Observations.

The focus study "Tracking of Indirect Labor Hours" is intended to give management a tool for identifying the causes of non-productive paid manhours and controlling their impact on overall ALC operations. It is included here because an opportunity was seen to reap major benefits within this RCC. The full focus study is discussed in paragraph 6.7.4.

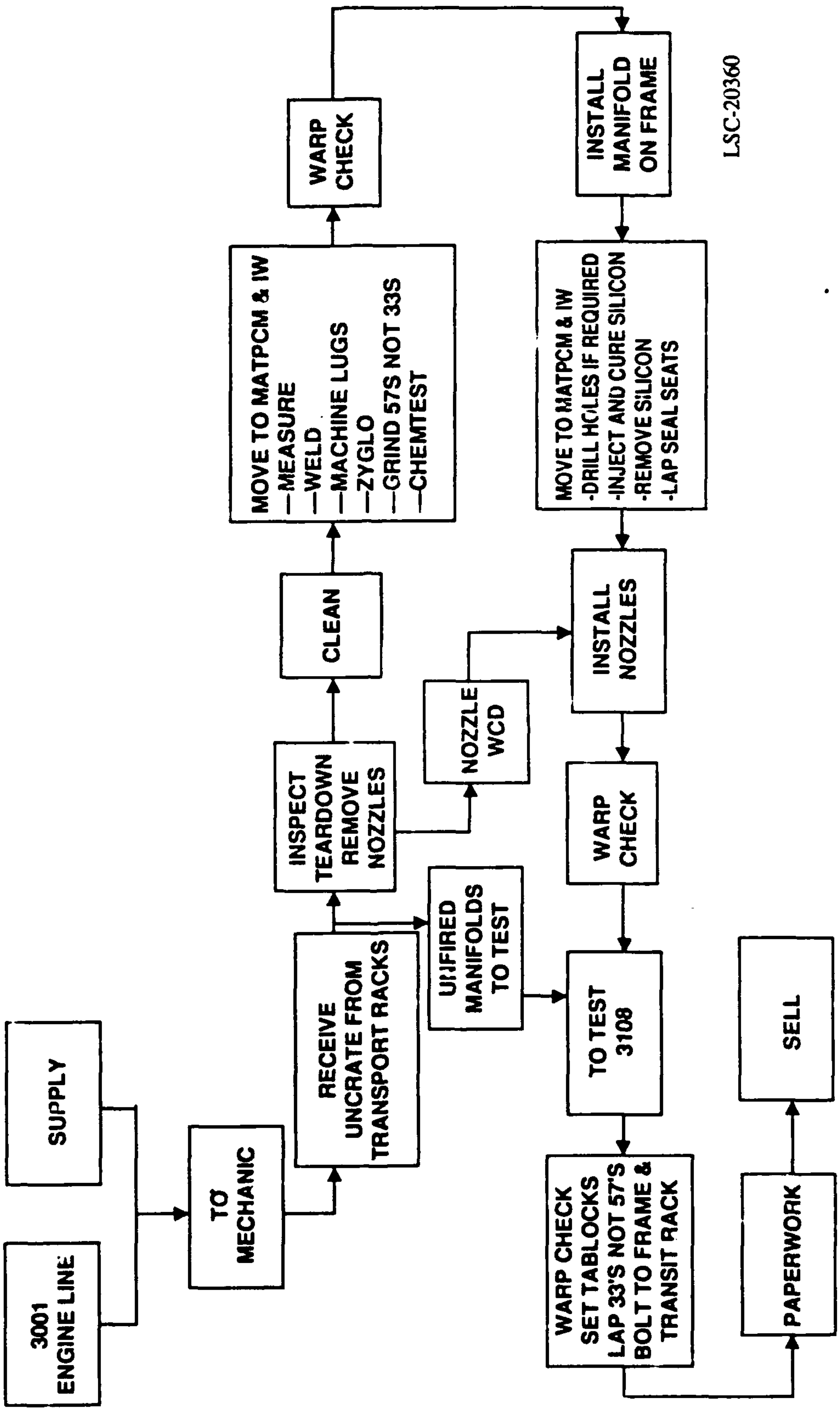
In the testing area, concerns have been identified in fuel spillage due to inadequate design of containment hoods on some test stands. This is primarily a health/safety concern and is discussed in the Quick Fix Plan for MATPCB.

6.7.1 Description of Current Operations

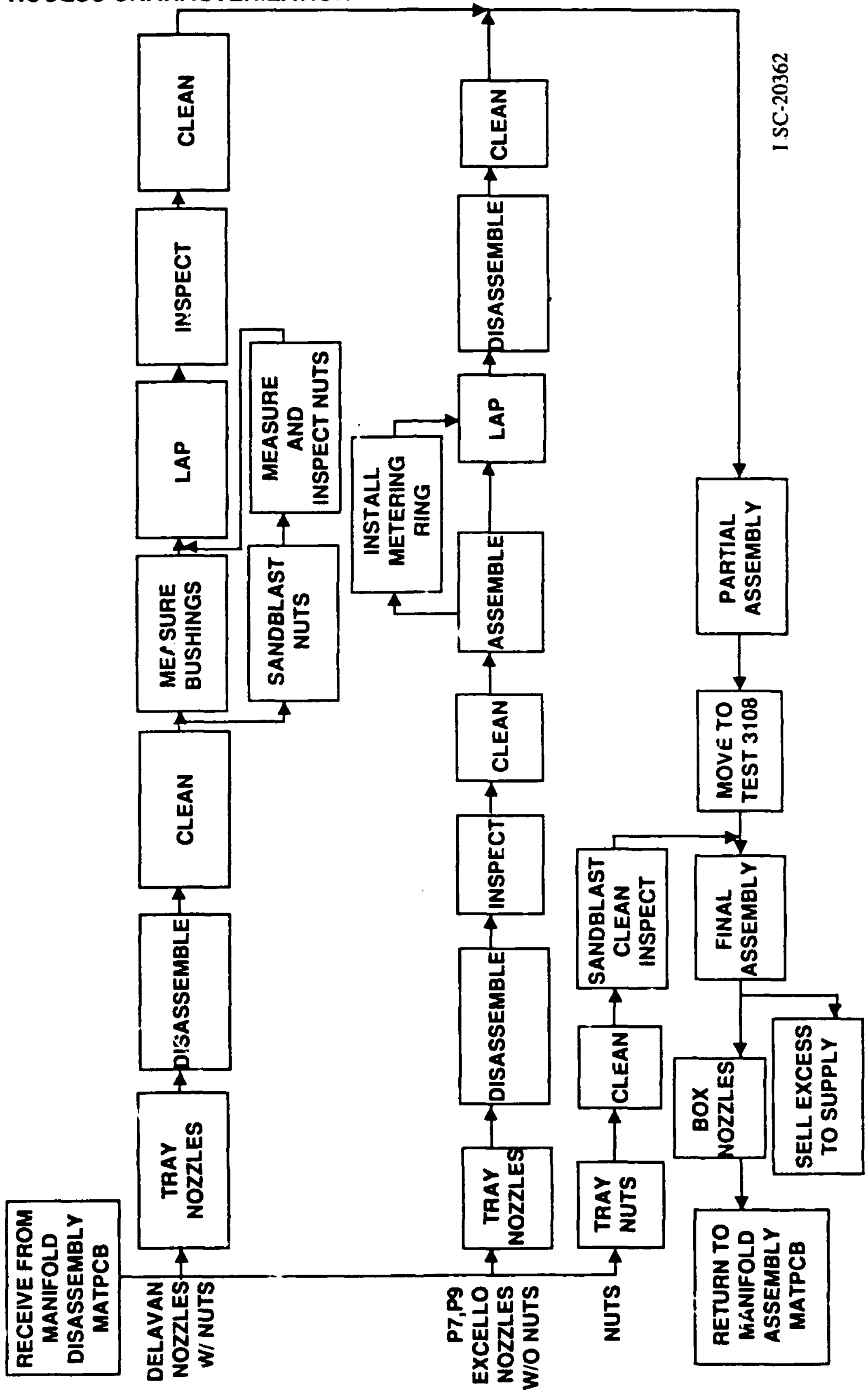
At OC-ALC, MATPCB is responsible for the overhaul and testing of jet engine fuel manifolds, fuel nozzles and various fuel and hydraulic pumps. The overhaul area is primarily located in contiguous shops in the south side of Building 3001. Leak and pressure testing is completed in Building 3108. The two work areas are linked via an overhead conveyor chain system, for transporting parts between shop areas. The total area of MATPCB covers approximately 16,481 feet for production and 7,799 feet for support. Workload in MATPCB consists of MISTR (Management of Items Subject to Repair), PDM (Programmed Depot Maintenance-Engine line assets) and temporary. The workload percent mix is approximately 45% MISTR, 50% PDM, and 5% Temporary.

The sub-unit overhauling and servicing manifolds is basically arranged according to the sequence of operations. The overall process flow for the overhaul of manifolds is shown in Figure 6.7.1-1. With the exception of required manifold welding (MATPIW) and machine shop (MATPCM) operations, all overhaul and test operations are performed by MATPCB. Although laid out in an orderly manner, the area is cluttered with parts stacked on the floor or on mobile shelf racks, awaiting processing. The work areas are normally small, with equipment and benches located in a somewhat cramped arrangement.

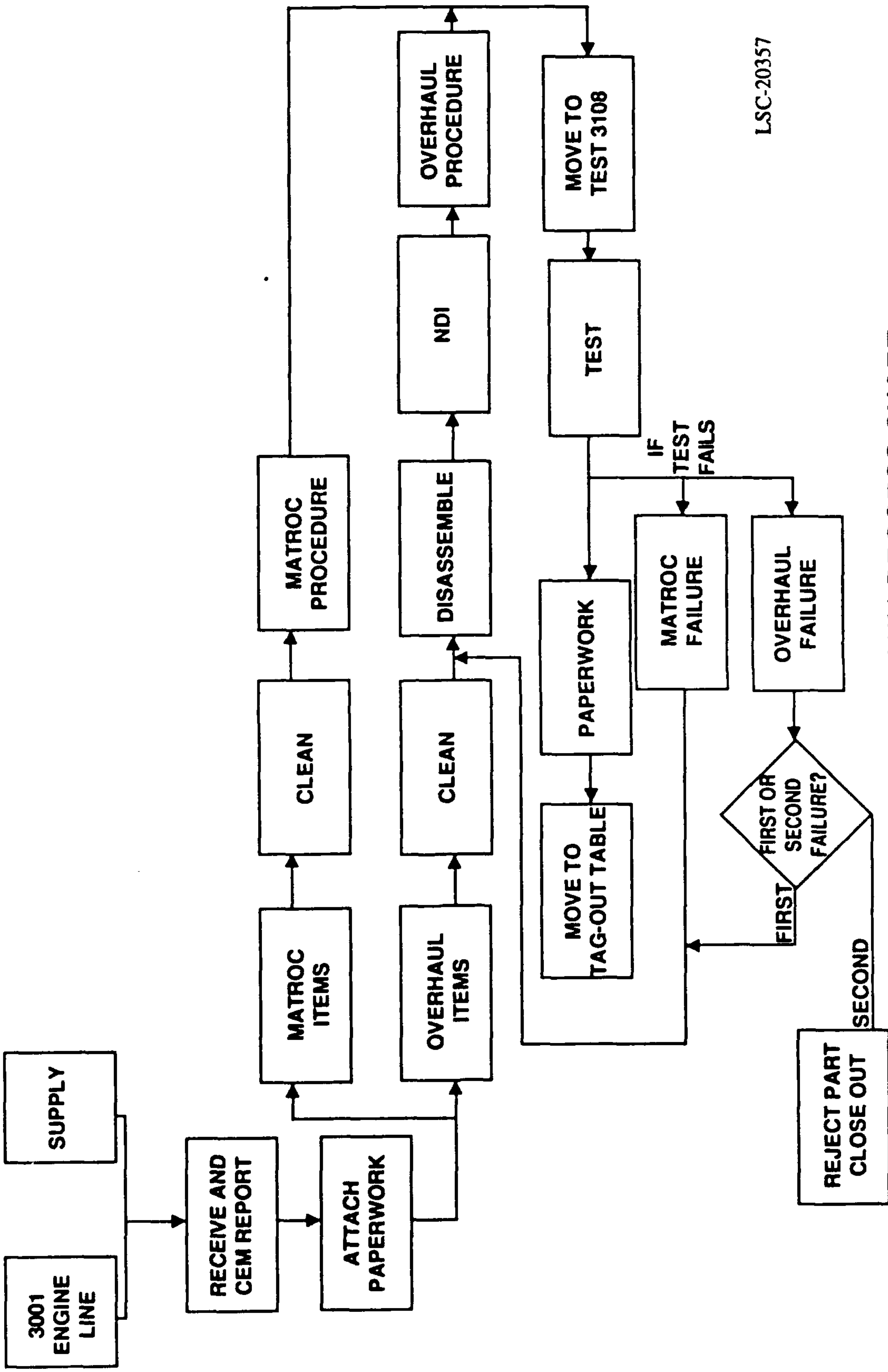
The fuel nozzle overhaul area is the smallest of the MATPCB areas. The general process flow for nozzle overhaul is presented in Figure 6.7.1-2. It is located immediately adjacent to the manifold area providing minimal transit distance and time. The workbenches are somewhat cluttered because the area is small and close-quartered. The low-smoke nozzle overhaul area is near the manifold final assembly area. The fuel and hydraulic pump sub-unit is arranged in an east/west orientation with activities located basically in-line. Since there are many types of pumps overhauled, there is no assembly line arrangement. All overhaul activities (as shown in Figure 6.7.1-3) are performed at single workstations except for cleaning, test, and machining. Some workstations (benches) have PCN unique fixtures attached to them. These workbenches are not arranged in categories of pumps, but are scattered throughout the overhaul sub-unit area. The cleaning tanks, in which work is performed by the overhaul mechanics, are located within the overhaul area. This reduces transit time. Non Destructive Inspection (NDI) on the pumps is performed by dedicated NDI personnel within the sub-unit overhaul area. Fluorescent penetrant and fluorescent magnetic particle methods are used in this RCC for NDI of parts.



MATPCB MANIFOLDS (OVERHAUL) PROCESS CHART
FIGURE 6.7.1-1



MATPCB NOZZLES (OVERHAUL) PROCESS CHART
FIGURE 6.7.1-2



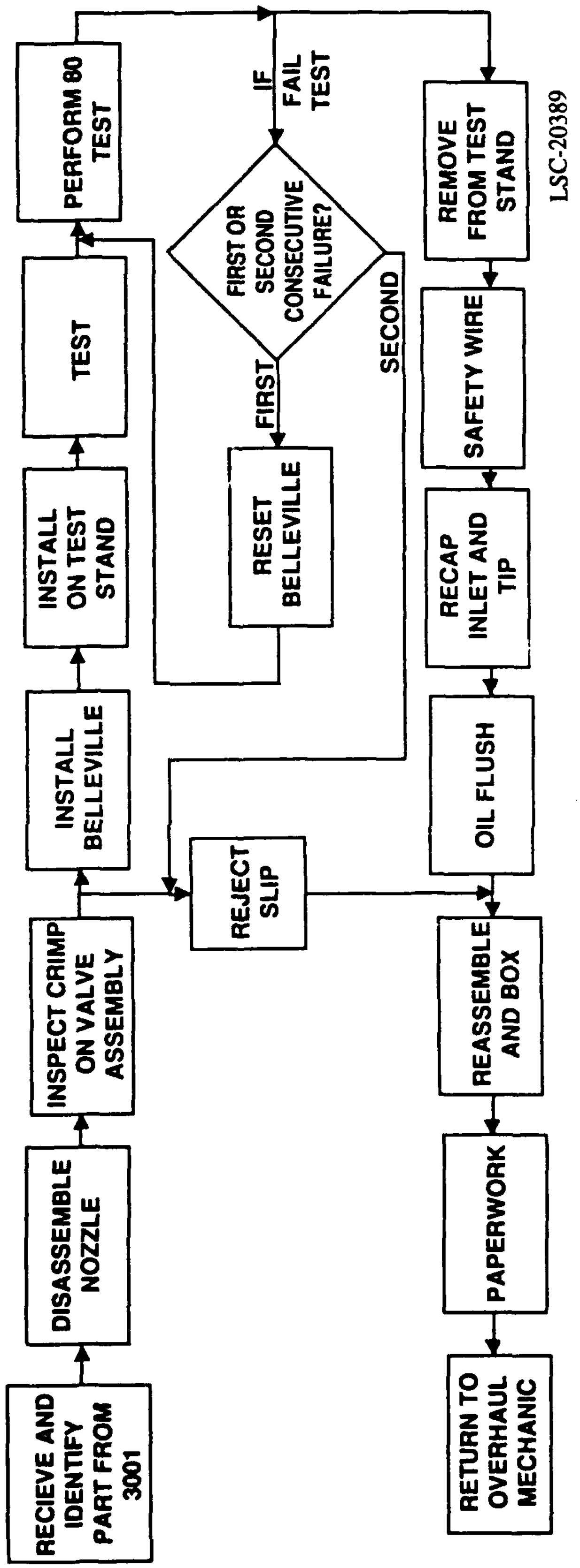
MATPCB PUMP (OVERHAUL) PROCESS CHART
FIGURE 6.7.1-3

The MATPCB test area is located in Building 3108 which is located adjacent to Building 3001, at the southwest corner. Building 3108 has increased safety and fire suppression systems. These added safety precautions are needed because of the nature of the test operations including the use of high pressure hydraulic fluids and fuel. The MATPCB product testing area of Building 3108 covers an aggregate area of 7,000 square feet. The testing area of Building 3108 that is dedicated to MATPCB actually exceeds this figure by several thousand square feet, but because this additional area is used for testing fuel controls (which were not part of the Task Order No. 1 workload), it was not considered. Both pumps and completed manifolds (with nozzles) are sent to and from the test area from the sub-units by way of a conveyor chain system. Pumps are placed in suspended trays (31/2 x 21/2'), but manifolds are suspended by two hooks.

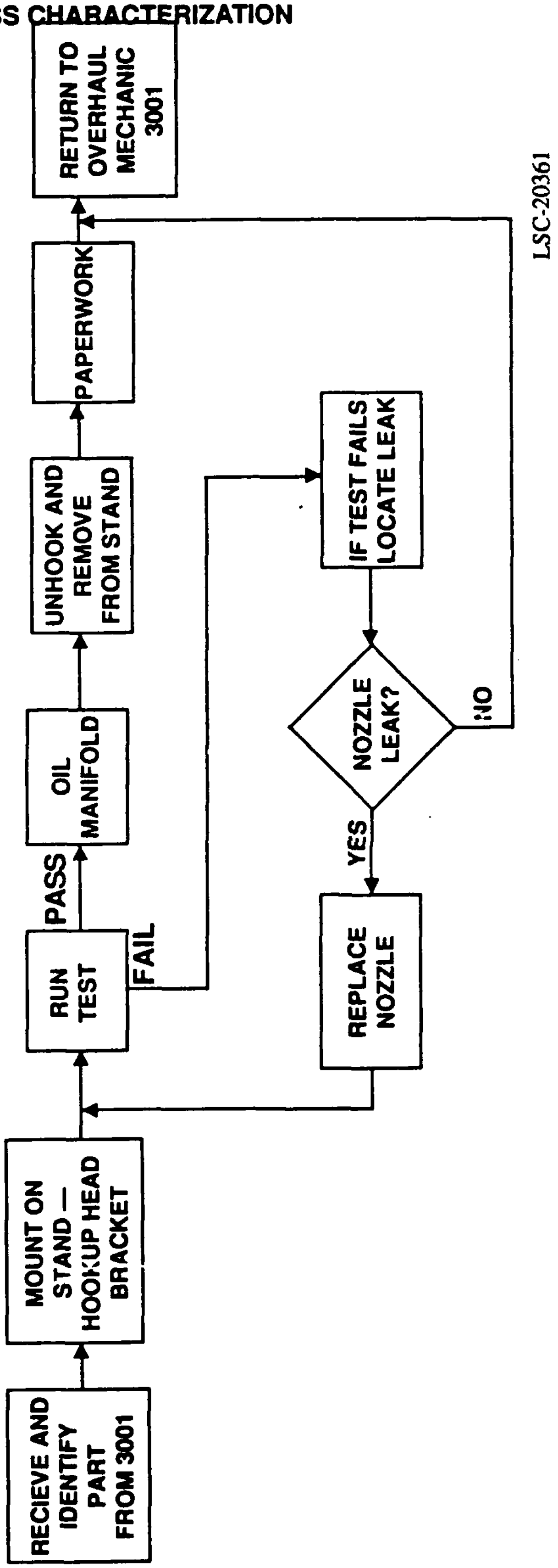
The test stations are widely scattered throughout Building 3108 and are interspersed with other RCC test stations. Figures 6.7.1-4, 6.7.1-5, and 6.7.1-6 show the process flows for the testing of nozzles, manifolds, and pumps, respectively. No family groupings of test stands were apparent. The conveyor is slow but effective. It takes from 15 to 45 minutes for parts to be conveyed between one station and another. If not picked off the line on arrival it may take up to 1.5 hours to complete the loop. The only communication system between stations is a phone line. It is used primarily for "hot" items only. Otherwise both ends "clear the line" daily at the beginning of first shift.

The equipment used in MATPCB varies from common and specialized hand tools to integrated tests stands. Most of the equipment is between five and 25 years old. Besides routine preventative maintenance there is very little down time due to machine breakdowns. A detailed listing of major equipment is detailed in the equipment profile section of the Database Documentation Book (DDB) for this RCC.

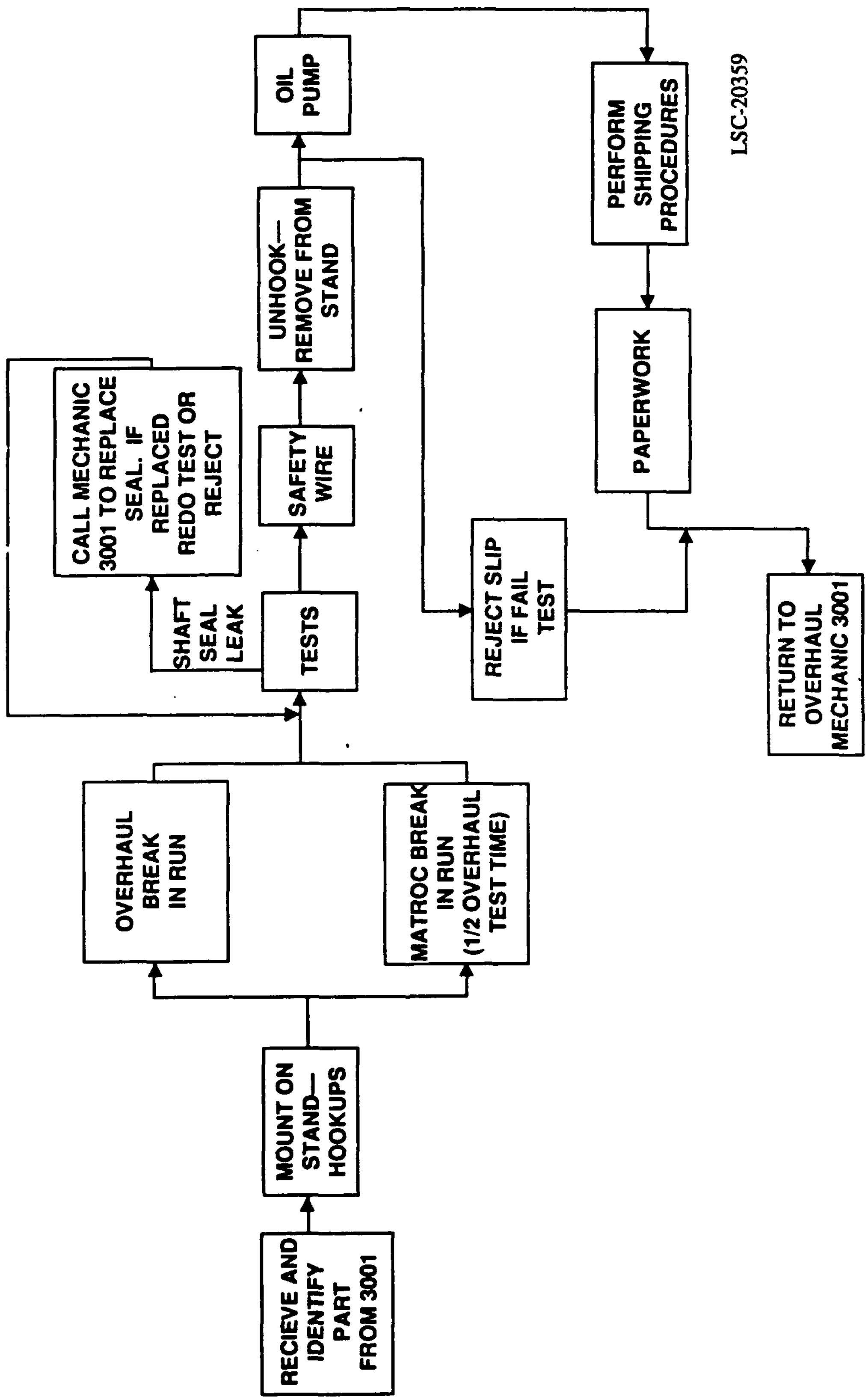
MATPCB has a stable work force consisting of direct and indirect labor. The direct labor is comprised of 63 mechanics and the indirect consists of six supervisors. All supporting RCCs are in Building 3001 and 3108.



MATPCB NOZZLE (TEST) PROCESS CHART
FIGURE 6.7.1-4



MATPCB MANIFOLDS (TEST) PROCESS CHART
FIGURE 6.7.1-5



MATPCB FUEL PUMPS (TEST) PROCESS CHART
FIGURE 6.7.1-6

End items overhauled in MATPCB are:

- Fuel Pumps
- Fuel Nozzles
- Fuel Manifolds

End items tested by MATPCB are:

- Fuel Pumps
- Fuel Nozzles
- Fuel Manifolds
- Regulators
- Cylinders
- Valves

The process technologies in MATPCB consist primarily of testing and repair of jet engine fuel manifolds, fuel nozzles and pumps. parts are inspected, tested for function and specification requirements and overhauled as required. Modifications are made to parts as required by technical order changes.

Engineering and Planning should be more attentive to the work control documents and provide more detail for the methods of performing the various operations. Also, Problem Request Forms (AFLC Form 103) are not always processed in a timely manner. In addition, replies are often inconclusive and leave shop supervision with unresolved problems or requires these supervisors to work the problems through trial and error within their expertise. Engineering and Planning often address symptoms rather than causes to their problems.

In MATPCB material handling is accomplished mostly by hand. A conveyor is used between the overhaul and testing areas of MATPCB as previously discussed. Parts are sent to and picked up from the overhaul mechanics' workbench by hand with the exception of one, two-stage fuel pump. This two-stage pump is transported on a push cart. Parts are carried by hand to and from NDI located within MATPCB. Eighty percent of manifold parts are received in quantities of 25 by a forklift truck. The other 20% comes directly from the engine tear-down shop usually by mechanized cart.

The storage areas for parts and spares are primarily located in bins near the maintenance workbenches. There are no designated storage areas in Building 3108 (items are received and tested one at a time). If two or more parts are received per test stand they remain on a workbench until they are tested.

6.7.2 Statistical System Performance Measures

Validation of the UDOS 2.0 model simulation outputs for MATPCB was initiated on 24 July 1989. The validation process consisted mainly of a statistical comparison of historical throughput and flow times to the model generated simulations of these items for FY 88. Other criteria, such as utilization of manpower and equipment, were also used to assess the validity of the model results.

Several assumptions were made at the time of validation. These assumptions were considered to be both necessary and reasonable in interpreting model validity. The assumptions made were as follows:

- The 80/20 workload analysis was accurate and represented 80% of the workload. The workload may vary from 80% in cases where the MDMSC/OC-ALC team has decided on and jointly authorized deviations from the original 80/20 listing.
- Mechanics' estimates of process times are to be considered as statistically accurate.
- Induction quantity distributions are accurate and can influence throughput.
- Historical data, collected from the WCDs are not accurate. The reasons for the inaccuracies are influenced by the following:
  - WCD release practices (batch print)
  - Stamping practices on WCDs
  - Work schedules (priorities)
  - Lack of parts/high work in process
- Validation will be accomplished against engineering estimates.

The FY 88 80/20 list for MATPCB consisted of 25 end items. As previously stated, the criteria used to validate the UDOS 2.0 model simulation outputs was:

1) throughput, 2) simulated flow versus G019C estimated flow days, and 3) resources utilization (queues). These results are presented in detail in the DDB Experimentation section.

The throughput statistical analysis done at the time of validation was to ascertain that the model simulated FY 88 production levels. As can be seen in DDB, Experimentation section, the variance analysis for simulated throughput versus actual throughput for this RCC shows .25% difference between these. On the average, the model generated 8,339 end items versus 8,318 actual end items produced. A more detailed discussion by PCN number may be found in the DDB Experimental section.

The flow hours statistical comparison was performed against the G019C report. Historical data, once examined, was felt to contain too many inaccuracies for any meaningful analysis to be performed. The DDB contains the variance analysis for simulated flow hours versus G019C flow hours. On the average, the simulated flow hours reflect 23% lower than the G019C. A detailed discussion by PCN for this comparison is available in the DDB Experimentation section.

The brainstorming process for experimentation on MATPCB followed model validation. The prepositioning step is identification of the problem statement or objective of the brainstorming process. In the case of MATPCB, the problem statement read: "What changes in throughput or process flow times will occur from (1) a 25% versus 35% reduction in cleaning times (from new robotic system), (2) a 25% versus 35% reduction in manifold lapping time, and (3) making the machining-welding back shop operations in-shop processes?"

An orthogonal array was developed using the Taguchi process. The team identified three factors and established two levels for each factor. An L_4 (2^3) array is depicted in Table 6.7.2-1, with throughput (Δ) being selected as a quality characteristic. A discussion of the results of these experiments follows.

MATPCB L_4 (2^3) TAGUCHI ORTHOGONAL ARRAY THROUGHPUT EXPERIMENTAL RESULTS - FY 88

TABLE 6.7.2-1

EXP #	A	B	C	NORMAL WORKLOAD		
				AVG	BEST	WORST
1	25% REDUCTION IN CLEANING TIME	25% REDUCTION IN LAPPING TIME	BACK SHOP AS-IS	100 %	50067A / 109%	38685A / 92%
2	25% REDUCTION IN CLEANING TIME	35% REDUCTION IN LAPPING TIME	MACH - WELD IN MATPCB	100 %	50067A / 109%	38691A / 90%
3	35% REDUCTION IN CLEANING TIME	25% REDUCTION IN LAPPING TIME	MACH - WELD IN MATPCB	100 %	49808A / 105%	38685A / 95%
4	35% REDUCTION IN CLEANING TIME	35% REDUCTION IN LAPPING TIME	BACK SHOP AS-IS	100 %	49808A / 107%	49810A / 94%

LSC-20489

Analysis of the four experimental runs indicates that average throughput is 100% for each. *This effectively precludes any evaluation of* throughput as a measure of change. Experimental flow times were then chosen as Δ, with the results as shown in Table 6.7.2-2.

The results of our analysis of the experimental interactions indicate that the most significant effects are obtained by having the back shop welding and machining operations performed in MATPCB. The reduction from 25% normal processing time to 35% normal processing time for both cleaning and lapping procedures are not particularly significant, and would not justify added implementation expenses.

Examination of percent throughput for each PCN yields the best and worst case analysis seen in Table 6.7.2-1. Again, with such a small range of difference from one PCN to another, it is difficult to draw any conclusions. It appears that there are no obvious problems with meeting present workload demands using

ANALYSIS OF EXPERIMENTAL FLOW TIME AVERAGES USING TAGUCHI METHOD (L_4)

TABLE 6.7.2-2

EXPERIMENTAL FLOW TIME AVERAGES -

EXP. 1	250.1
EXP. 2	224.1
EXP. 3	225.9
EXP. 4	248.5

FACTOR	LEVEL	
1	1	237.1
	2	237.2
2	1	238.0
	2	236.3
3	1	249.3
	2	225.0

$L_4 (2^3)$

NO	1	2	3
1	1	1	1
2	1	2	2
3	2	1	2
4	2	2	1

LSC-20493

any of the experimental conditions. A more detailed analysis is found in DDB Experimental section.

The FY 90 workload was used to determine MATPCB surge capabilities. The FY 90 workload was used to determine MATPCB surge capabilities. Using surge information provided by AFLC, a throughput of 100% can be expected for items listed on the present 80/20 list. The high percentage of throughput is most likely due to the efficiency and experience of the existing work force. MDMSC recommendations for preplanning to meet surge conditions are as follows:

- Do not reduce equipment or manpower (if possible) in the event of workload fluctuations.
- Locate machining and welding operation in MATPCB to reduce flow times.
- Install automated cleaning system in MATPCB for manifolds and nozzles.
- Install redesigned lapping equipment for use on manifolds. Target reduced processing times for these operations.
- Run model experimentation with a five year surge level workload forecast.

A more detailed discussion of MATPCB can be found in the experimental section of the DDB.

6.7.3 Description of Process Problems

Currently, there is no systematic approach to address non-value added activities at OC-ALC. Indirect labor accounts for over one third of the total time to repair, overhaul or manufacture a product. This focus study will allow management to better control all resources and their utilization.

6.7.4 Recommended Focus Study

This focus study recommends developing and installing a management control system to improve RCC efficiency by measuring and reducing non-value added activities. MATPCB, a direct labor environment was selected for a pilot study because of the various processes, product lines and department location. This focus study will define various types of indirect labor, after which a manual/semiautomatic tracking and control system will be recommended. A standard operating procedure will be developed before management receives the required instructional training for program administration. An analysis of performance and efficiency will be accomplished to show OC-ALC management the down side impact of non-value added activities has on overhaul, repair and test operations. A reduction in such activity will improve RCC effectiveness by an estimated 20 percent.

6.7.4.1 Rationale Leading to Change

During process characterization, it was learned that labor standards included a variety of indirect functions, which does not account for touch labor only. This makes it difficult to track either direct or indirect costs. Since no system is in place, we feel better control of the following items would enhance effectiveness and productivity.

Indirect Functions	Level of Opportunity
• Waiting for tools	Low
• House-keeping activities	High
• Trucking/moving parts or tools	High
• Waiting for equipment	Medium
• Waiting for support	Medium
-	Manufacturing engineering
-	Industrial engineering
-	Quality engineering
• Waiting for machine repair	Medium
• Other miscellaneous idle time	Medium
• Waiting for work	Medium
• Waiting for job assignment	Low
• Filling out excessive paperwork resulted from dekitting	High
• Waiting for parts/material	

The above functions create excessive flow times which has a direct impact on overall cost. Also, these activities are collected as "actual hours" and should be separated to fully understand touch labor effectiveness.

Other potential benefits of this system would facilitate implementation of DMMIS and/or MIL-STD-1567A.

6.7.4.2 Potential Cost Benefit

An annual recurring cost savings of $656,375 occurs from the implementation of the recommended improvements as shown in Table 6.7.4-1.

The investment cost of the recommendations is estimated at $588,188. This cost includes the focus study effort and the implementation cost.

The Cost Benefit Analysis (CBA) shows an Internal Rate of Return (IRR) of 108% and a savings of $1,827,715 in terms of Net Present Value (NPV) using constant FY 89 dollars, see Figure 6.7.4-1. The CBA is in compliance with regulation AFR173-15, cost analysis procedures, dated 4 March 1988, and rates per AFLCR 78-3.

The CBA covers the time frame starting with the focus study through five years after the completion of implementation. The recurring cost savings was assumed to start at the end of implementation.

The NPV takes into account the time value of money and is calculated by discounting a cash flow. The focus study cost, implementation cost, and the recurring savings were spread by fiscal year quarters and discounted back to the first quarter by using a mid-quarter discounting factor equivalent to an annual discount factor of 10%. Basically, this means a dollar that is earned in FY 90 is worth $.91 in FY 89 terms ($1.00/1.1), due to the ability to borrow or lend at a positive interest rate.

A sensitivity analysis was performed in which the investment cost varied between 50% and 200% of the estimated costs, see Figure 6.7.4-2.

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 6.7.4-1 (SHEET 1 OF 2)

	CURRENT ANNUAL COSTS	PROPOSED CHANGE INVESTMENT COSTS	PROPOSED CHANGE ANNUAL COSTS
NONRECURRING COSTS (1)			
FOCUS STUDY	$0	$260,000 (2)	$0
FACILITIES			
LAND	$0	$0	$0
BUILDINGS	$0	$0	$0
SUPPORT EQUIPMENT			
DEVELOPMENT	$0	$0	$0
ACQUISITION	$0	$0	$0
INSTALL & CHECKOUT	$0	$0	$0
LOGISTICS SUPPORT			
INITIAL SPARES	$0	$0	$0
INITIAL TRAINING (DEV & PRESENTATION)	$0	$0	$0
TECHNICAL DATA	$0	$0	$0
TOTAL NONRECURRING COST	$0	$260,000	$0
RECURRING COSTS (1)			
TOUCH LABOR	$3,281,877 (4)	$0	$2,625,501 (5)
SUPPORT EQUIP MAINT	$0	$0	$0
SPARES AND SPARES MGMT	$0	$0	$0
TECHNICAL DATA	$0	$0	$0
MOD KITS	$0	$0	$0
CONFIGURATION DATA MGMT	$0	$0	$0
UTILITIES	$0	$0	$0
TOTAL RECURRING COSTS	$3,281,877	$0	$2,625,501
TOTAL COSTS	$3,281,877	$588,188 (3)	$2,625,501
ANNUAL COST SAVINGS	$656,375		

NUMBER OF MONTHS FOR FOCUS STUDY	8
NUMBER OF MONTHS TO IMPLEMENT CHANGES	6

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)

TABLE 6.7.4-1 (SHEET 2 OF 2)

NOTES:

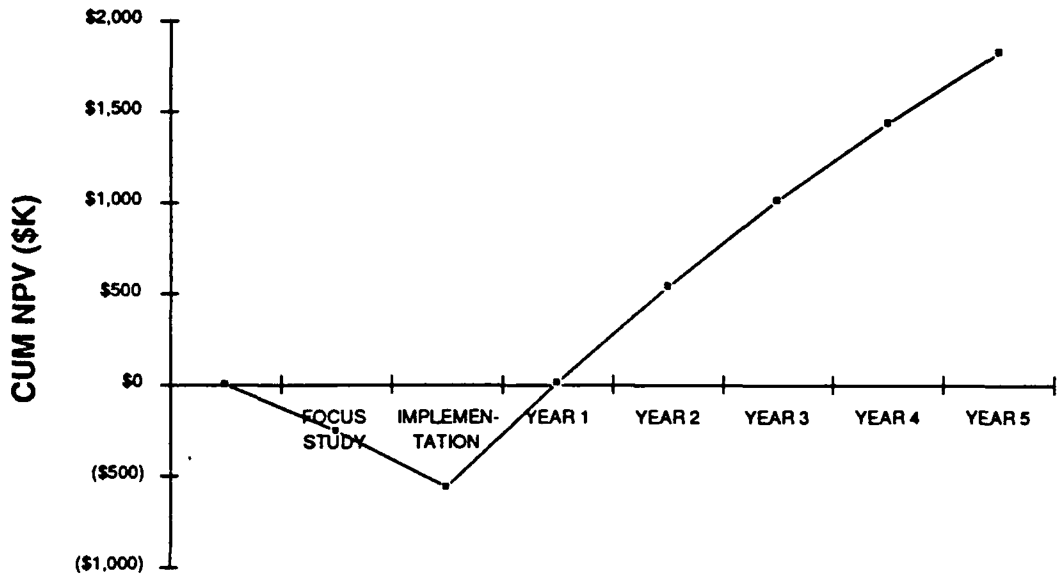
(1) ONLY ITEMS THAT ARE SIGNIFICANTLY AFFECTED BY THE PROPOSED CHANGE HAVE BEEN ESTIMATED

(2) ENGINEERING ESTIMATE FOR USE IN ENGINEERING TRADE STUDIES ONLY, DOES NOT REPRESENT FIRM PRICING

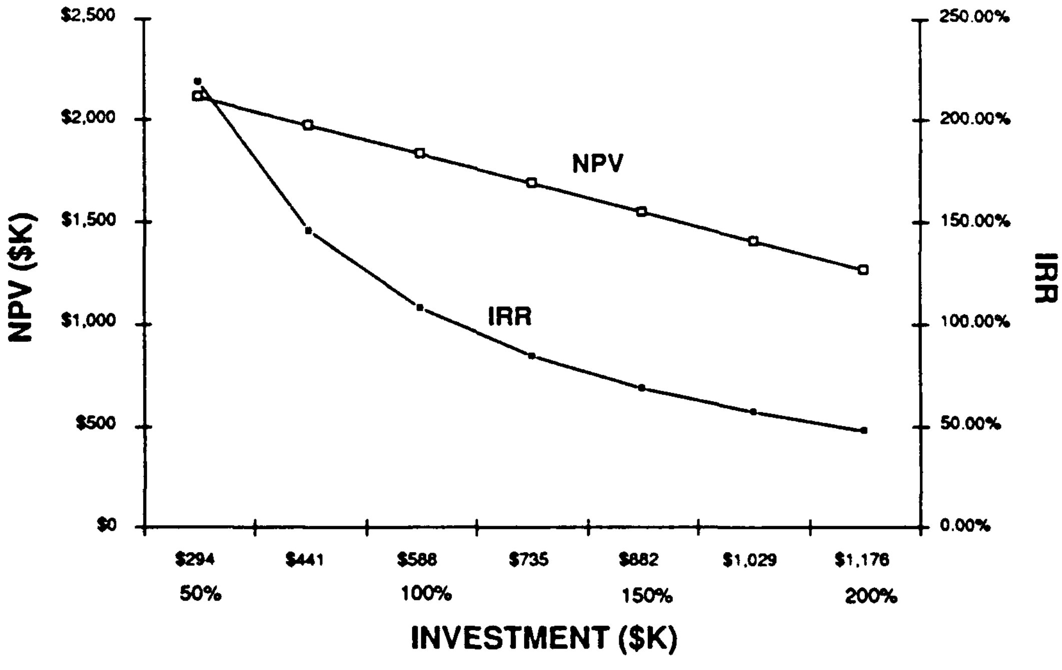
(3) TOTAL INVESTMENT COST INCLUDES 50% OF THE ANNUAL COST SAVINGS AS AN ESTIMATE OF IMPLEMENTATION COST.

(4) BASED ON CURRENT STAFFING
63 PEOPLE X 1,744 HOURS/YEAR X $29.87/HOUR

(5) BASED ON 20% IMPROVEMENT IN LABOR EFFICIENCY
63 PEOPLE X 1,744 HOURS/YEAR X .8 X $29.87/HOUR



CUM NPV IN CONSTANT FY89 DOLLARS
FIGURE 6.7.4-1



CBA SENSITIVITY ANALYSIS
FIGURE 6.7.4-2

6.7.4.3 Risk Assessment of Achieving Study Goals

There are some risks associated with increasing output, while not having additional work to keep employees actively employed. This perception may cause resistance to change. It is recommended that management make a firm commitment of no lay-offs, to overcome resistance, and work toward transfers. (Reassign employees to other RCCs). Also, increase workload by cancelling orders for purchased work.

6.7.4.4 Duration and Level of Effort

MDMSC recommends a nine month long focus study period of performance to:

- Research "As-Is" condition and develop project guidelines.
- Provide required instructions.
- Develop indirect functions and a data collection form.
- Develop computer program for data analysis.
- Initiate and complete four months of data collection and analysis.
- Formulate recommendations.
- Initiate and complete Contract Summary Report.
- It is estimated that a total of $328,188 is required to analyze and implement (most, if not all) recommendations.

The applicable criteria, their impact, and an estimated level of effort are presented in Table 6.7.4-2, and the resulting focus study schedule is found as Table 6.7.4-3.

6.7.5 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact in the areas of time, quality, or cost. These observations are recorded to assist OC-ALC in developing ideas that will further enhance their operations.

The observations which follow were originally identified as Quick Fix and Focus Study improvement opportunities and are detailed as such in the MATPCB DDB. After review by the OC-ALC site personnel and the TI-ES team, it was agreed that they should be presented as other observations for future reference.

FOCUS STUDY CRITERIA CHECKLIST

TABLE 6.7.4-2 (SHEET 1 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Process/Material Flow	Analyze model outputs and compare results with floor observations. Determine high cost/excessive flow hours by product line. Develop indirect function(s).			X
Equipment/Work Place Layout	Analyze equipment and work place layout. Determine causes for indirect activities. Document findings.		X	
Facility Requirements	No changes anticipated.	X		
Labor Standards	Verify labor standards that show variations of up to 25%.			X
Manpower	Set up table to analyze performance. Set up table to analyze efficiency. Compare with current method.			X
Task Assignments	Task assignments will include training, short interval scheduling, and establishment of RCC operating baseline. Some revision may be required to confirm RCC As-is condition.			X
Material Requirements	No changes anticipated.	X		
Scrap Rates	No changes anticipated.	X		

LSC-20492

FOCUS STUDY CRITERIA CHECKLIST

TABLE 6.7.4-2 (SHEET 2 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Material Handling & Storage Methods	Material handling and storage will be analyzed to establish indirect functions. Recommendations to reduce those functions.		X	
Inspection Techniques	No changes anticipated.	X		
Equipment/Tools/Fixtures	Storage and transportation of tools and fixtures will be reviewed to develop indirect codes for tracking. Recommendations to reduce those functions.		X	
Process Delays	Major process delays will be analyzed for indirect activities.		X	
Part Identification	No changes anticipated.	X		
Quality	Quality costs will be grouped where applicable.			X
Personnel Safety	No changes anticipated.	X		
Environmental Assessments	No changes anticipated.	X		

LSC-20492

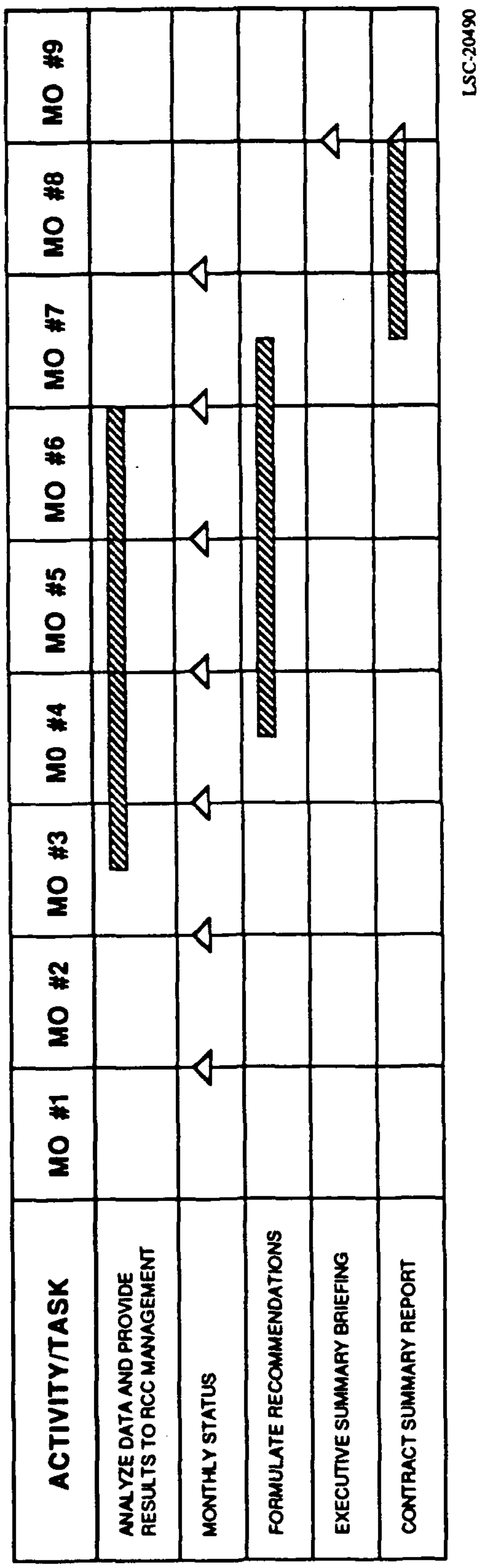
PROPOSED FSR NO. 1 SCHEDULE
TABLE 6.7.4-3 (SHEET 1 OF 2)

ACTIVITY/TASK	MO #1	MO #2	MO #3	M0 #4	MO #5	MO #6	MO #7	MO #8	MO #9
RESEARCH "AS-IS" CONDITION	▨								
DEVELOP AND ISSUE PROCEDURAL GUIDELINES		▨							
PROVIDE INSTRUCTIONS FOR MANAGEMENT AND EMPLOYEES		▨	▨						
DEVELOP INDIRECT FUNCTIONS BY PRODUCT AND/OR REPAIR TECHNOLOGIES			▨	▨					
CONSOLIDATE FUNCTIONS AS NECESSARY			▨	▨					
DEVELOP A STANDARD DATA COLLECTION FORM			▨	▨					
WRITE COMPUTER PROGRAM TO FACILITATE: - INDIRECT LABOR ANALYSIS -PERFORMANCE ANALYSIS - EFFICIENCY ANALYSIS			▨	▨					
ADMINISTRATE/COORDINATE DATA COLLECTION PROCESS WITH RCC SUPERVISION			▨	▨	▨	▨	▨		

LSC-20490

TASK ORDER NO. 1
PROCESS CHARACTERIZATION

PROPOSED FSR NO. 1 SCHEDULE
TABLE 6.7.4-3 (SHEET 2 OF 2)



Operational Improvements

- Test Stand Layout, Building 3108
  - Current Condition: Test stands for pressure, flow, and leakage of fuel pumps and manifolds are located in seemingly random areas of Building 3108. This causes excessive test time and is more difficult to supervise.
  - MDMSC Recommendation: Co-locate test cells by "family" groups to increase efficiency.

- J-57/TF-33 Shipping Fixture Identification
  - Current Condition: There is currently no easy method of distinguishing between J-57 and TF-33 manifold shipping fixtures. Use of incorrect fixture may cause deformation or damage to manifold during shipping.
  - MDMSC Recommendation: Uniquely identify each type of shipping fixture to avoid shipping damage to manifolds.

- Human Factors - Test Stands OC 4743 and OC 1277
  - Current Condition: It is difficult for the operator of the test stand to repeatedly install/remove nozzles and heavy fittings from chamber that is well above normal reach. A portable step stool is required. Control panel is also split into two panels remote from each other. (Operator cannot reach both simultaneously.)
  - MDMSC Recommendation: Ergonomic study to determine if test stand can be modified to provide for less strenuous and time consuming operation.

- J-57/Excello Nozzle Testing Stand
  - Current Condition: Nozzle fuel flow test stands (OC 0702, -0703, -0704, and -0705) allow only limited visibility of nozzle under test. The spray patterns are difficult to distinguish because fuel hitting view plate further obscures vision.
  - MDMSC Recommendation: Install higher candle power light inside test chamber and a wiper device for the inside surface of the view plate.

- Test Stand Downtime
  - Current Condition: Some test stands in Building 3108 can be down for a matter of months if a major component fails.
  - MDMSC Recommendation: Coordinate with maintenance contractor/ vendor to have sufficient parts on hand to return test stand to operation in a timely manner.

- Test Equipment Downtime - Airflow Control and Regulator Pac
  - Current Condition: Test stand OC 2735 in Building 3108 frequently malfunctions causing bottlenecks, reducing output and efficiency. This is also common to test stand OC 0918 and other test stands to a lesser extend.
  - MDMSC Recommendation: Accurately record usage and failure rate on OC 2735. Once obtained, contact the vendor to repair or replace machine at vendor cost if possible. OC 2735 is a relatively new machine and should be covered by a warrantee. Other test stands may have reached the end of their useful life and be more expensive to maintain than to replace.

- Manifold Leak Test Stands
  - Current Condition: Hood on test stand leaks fuel outside of test chamber. Stand is sometimes operated with hood open to improve visibility. These factors result in fuel spilled on floor.
  - MDMSC Recommendation: Improve design and/or operation of test chamber hood. Improve view plate for enhanced visibility.

- Oil Flush Stand - South End of Building 3108
  - Current Condition: Procedures for fuel pump tests require a high pressure oil flush after testing in fuel. There is no oil flush stand near the fuel pump test stands. Operators are substituting a manual oil flush which does not force all the fuel out of internal passages in the pumps.
  - MDMSC Recommendation: Provide an oil flush stand at the south end of Building 3108 to service fuel pump test stands in that area.

- J-57 Manifold Braze Identification
  - Current Condition: A chemical test is required to determine whether Au/Ni (Gold/Nickel) brazing metal is used on J-57 manifold assemblies. This requires time which may not be necessary.
  - MDMSC Recommendation: That ALC engineering evaluate the use of the two different braze metals in the overhaul procedure. Where possible, etch or otherwise identify joints requiring each of the braze metal alloys.

- Discontinue 97150A J-57 Fuel Pump by Attrition
  - Current Condition: Both 97150A and 97178A fuel pumps are presently being overhauled. Operator indicates that these pumps are interchangeable. The 97150A takes ten hours longer to overhaul and test. The pump body itself is $2,800, $600 more than that of the 97178A pump body.
  - MDMSC Recommendation: Let 97150A fuel pumps work out of the system by forced attrition, being replaced by the less expensive 97178A.

Reliability Improvements

- J-57 Manifold Assembly Inspection
  - Current Condition: Flex mount mounting brackets of J-57 manifolds are not required to be inspected, yet many are found to be cracked, particularly at clusters three and six.
  - MDMSC Recommendation: Institute fluorescent penetrant inspection of flex mount mounting brackets for J-57 manifolds.

Sourcing/Inventory Improvements

- Hydraulic Pump S/N Identification
  - Current Condition: In a recent batch of hydraulic pumps, five had identical serial numbers, making SIMS tracking impossible.
  - MDMSC Recommendation: Insure pumps ordered from vendors are given unique serial numbers.

- O-Rings Out of Date
  - Current Condition: O-Rings issued from stock are older than stated shelf life.
  - MDMSC Recommendation: Institute First In First Out (FIFO) inventory controls on O-Rings. Periodically review O-Ring stocks and discard expired items.

6.8 MATPCC ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

The MATPCC RCC does the repair on electro-mechanical accessories, and a wide variety of items are processed through it. A detailed description of the activities which take place in MATPCC is given in paragraph 6.8.1 of this report.

The MATPCC RCC contains a number of factors which work together to allow the RCC to produce high-quality items on schedule. The main factor behind the RCC's success appears to be the work force, which is very motivated and experien ed. The workers are genuinely committed to producing a quality product, and this commitment is reflected in the high number of suggestions for improvements submitted by this group. The workers also are conscientious in their work habits, as reflected in the clean and organized appearance of the work areas within the RCC.

However, the RCC's operations are hurt by a severe problem with vendor-supplied items. A substantial number of items which are received into MATPCC do not conform to specifications and are reworked to make them usable. The RCC should not have to devote its manpower to correcting the mistakes of its suppliers. This situation results in the delay of those defective items going through the repair process. Delays also result from the hand delivery of individual items by the highly skilled workers. This takes them away from their repair work and results in the underutilization of the workers' talents.

The RCC seems to have some equipment which is not calibrated correctly which also causes problems. The repaired or tested items which come off this equipment do not always function properly when installed. The equipment, as a whole, is kept well-maintained and has relatively little downtime.

The throughput in MATPCC is very good, with items being processed without any major bottlenecks. The throughput under the predicted surge (refer to paragraph 6.8.2 of this document) is expected to be high, with no additional resources being required.

The repair technology used in MATPCC is similar to that used in private industry by companies which do electro-mechanical repair work on a variety of low volume items. The relatively low number of individual PCNs repaired in MATPCC prevent the RCC from purchasing specialized equipment which could speed up the repair process. The RCC has an advantage over private industry in that the workers are capable of reworking bad vendor items without causing a serious delay in getting the required throughput. The RCC also benefits from high levels of work-in-process being available. This keeps the throughput high, because workers who run into difficulties when repairing one item can switch over to repairing another item. Afterwards, when the time demand slackens for these items, they return to working the problem item. The workers are aware of the importance of producing a high-quality item to guarantee aircraft safety. Because of this, the workers seem more quality conscious than those in private industry.

During the initial characterization of the MATPCC, a total of ten improvement opportunities were identified (reference the Potential Improvements section of the Database Document Book (DDB) for MATPCC). After review of the original set of opportunities by the MDMSC/Air Force team, three opportunities were selected to be pursued as the focus of the TI-ES program activities relating to MATPCC.

The three major improvement opportunities, the Bulk Transporting of Items, the Repairing of the Impeller Unit Rather Than Buying It, and the Automation of the Harness Cable Thermostat Tester, are quick fix opportunities and are described in detail under separate cover. Refer to the Quick Fix Plan report for MATPCC for their descriptions.

The balance of original MATPCC improvement opportunities are described in paragraph 6.8.4 of this document.

6.8.1 Description of Current Operations

The MATPCC RCC is responsible for the overhaul, repair, and testing of electro-mechanical components. It is subdivided into the following subunits:

- Servo and miscellaneous subunit
- Actuator subunit
- Fuel flow instrument subunit
- Cable and harness manufacture and repair subunit and the battery shop

MATPCC's unit chief reports to the MATPCC section chief. Each subunit is staffed with a supervisor and an average of 15 to 20 mechanics except for the battery shop, which is staffed by four operators who report to the supervisor of the Servo subunit. MATPCC is located in Building 3001 (reference floor layout drawing - MATPCC Database Documentation Book). The work force is not stable, causing workers to be loaned out when the work volume is low.

There is a planned increase for the cable and harness manufacturing and repair subunit. It is estimated that 275,000 hours over the next four years will be needed to manufacture harnesses for the KC-135. The planned increase of 55 new employees will almost double the manpower of MATPCC. The repair portion of MATPCC is responsible for the overhaul, testing, and repair of harnesses, cables, switches, and other electro-mechanical components. The battery shop personnel are responsible for keeping ground vehicle and aircraft batteries charged and ready for use. The battery shop is located in Building 3123.

The remaining three subunits of MATPCC perform the repair of different electro-mechanical components. The process begins with an incoming test so the operator will have some idea of what is wrong with the unit, then the unit is disassembled. The individual parts are cleaned by hand, inspected, tested, adjusted, and replaced or repaired. The unit is then reassembled. The Servo subunit operators test their own units on test equipment within their area. The actuators are tested within the area by a test operator. The fuel flow instruments are tested in Building 3108 which is a short distance from Building 3001.

The operators in MATPCC are very involved in the suggestion program and most have submitted at least one suggestion. Cooperation is good between the supervisors and operators. Both groups are very knowledgeable and want to produce good products. Parts shortages and bad vendor parts cause flow time delays in the repair processes, resulting in increased costs and operator frustration.

The repair areas are organized and clean. There is a problem when it rains because the roof leaks. Plastic sheets are draped to protect the workers and equipment from the water. The overall lighting level in the RCC is poor, but this situation has been remedied by equipping the work stations with individual fluorescent lights.

The area in MATPCC is fairly congested, but is sufficient for the work being done. There is a large quantity of work-in-process stored on racks in MATPCC, but the small size of the items prevents this from being a serious problem.

The workers in MATPCC seem to have a great deal of control over how items get repaired. The workers themselves pick the items that are to be repaired and do the complete repair process with a minimum of supervision. On the items which must have processes performed on them outside of MATPCC, the worker often carries the items to the appropriate RCC by hand, without any logs being kept or receipts being issued.

The individual worker who repairs an item is responsible for the quality of the item under repair. A variety of items are worked in MATPCC, such as actuators, fuel flow transmitters, torque motors, clutches, and cable and harness assemblies. The worker who repairs an item will inspect the item and its components during the repair process to insure that the item will have no defects when completed.

The majority of equipment in MATPCC consists of test stands and other testing-related equipment. Most of the equipment and tooling has been in use for at least 15 years, but is still quite reliable. The equipment in general is well-maintained and serviceable and the test stands show a very little downtime. Two new test stands are scheduled to be brought in to replace two of the older stands that are used to test the fuel flow transmitters, and it is expected that the new stands will be more efficient and safer. The readouts on the stands will be digital, which will eliminate the "judgement calls" that have to be made with the analog gauges now in use. The benefits of the new stands are: (a) they will be adaptable to handle different part configurations, and (b) it will be easier to load parts onto them.

The equipment in MATPCC is calibrated under the PME program, but there seems to be problems with the calibration of certain test stands. For example, one of the servo assemblies that is repaired often fails upon its installation into the next higher assembly. However, the vast majority of items that are repaired in MATPCC function correctly.

A major problem that many workers commented on was the high percentage of parts that they receive from supply which do not function properly. No receiving inspection is done on the items which come into MATPCC, so a defective component is not found until it has been installed into another item. Many of these defective components are reworked because of the amount of paperwork required to reject an item, and because of the long lead time required to receive a replacement item into the RCC. The general opinion is that it is less complicated to just repair the item. This problem of bad vendor parts is very pervasive, and quite a few workers in MATPCC are kept busy just repairing vendor items. This situation has existed for a long time and many people in MATPCC now consider it normal procedure. Aside from this, there is the associated problem that items that should be replaced according to the instructions in the Technical Orders are instead being repaired.

The items worked in MATPCC are moved within the RCC manually because no powered material handling equipment is available. The items are either hand carried or transported using a push cart; however, the workload in the RCC consists of small items that require no special packaging. Items that have been repaired are usually set on "pickup" tables, where they are picked up by material handlers.

The existing situations where the mechanics are having to transport items is bad because high-skill labor is being used to do low-skill work. Valuable time that could be used by the mechanics to repair items is being lost and this problem is expanded upon in paragraph 6.8.1 of the Quick Fix Plan.

The storage capacity of each of the subunits in MATPCC is sufficient, with the capability of expanding, if necessary. The items which come over from supply are stored in a large area which has been nicknamed "the barn." At fairly regular intervals, MATPCC mechanics are sent to bring items over, which are stored on the racks which are located within each subunit. These items are taken by the mechanics as the need to repair them arises.

Two processes were spotted by the MDMSC team as being ideal candidates for quick fix improvements. The first quick fix would be to develop a method to rework the impeller units of the fuel flow transmitters rather than to replace each one with a new unit. The second quick fix concerns automating the testing equipment that is used for checking the thermostats on the transmission cables. These two ideas are described in the Quick Fix Plan for MATPCC, paragraphs 6.8.2 and 6.8.3 respectively.

Most of the workers and supervisors have been in the MATPCC for a long time. The processes and equipment have remained constant over the years. This is beneficial in that most mechanics are extremely familiar with their work. Unfortunately, this allows many incorrect WCD procedures to remain incorrect and unchallenged.

6.8.2 Statistical System Performance Measures

The OC-ALC Technology Insertion Team met with ALC representatives during the week of 26 June 1989 to perform a statistical comparison of the UDOS 2.0 Model Simulation Outputs for RCC MATPCC to the historical throughputs and flow times for FY 88. Other criteria, such as the utilization of manpower and equipment, were also used to assess the validity of the database. A detailed discussion of this validation process for MATPCC is included in the Experimentation section of the DDBs for each RCC. The joint validation team concluded that the statistics generated by the simulation model were within an acceptable range when compared to the As-Is condition. This model database represents the As-Is condition for FY 88 and can be used as a baseline for comparison purposes.

The throughput of items in MATPCC under the FY 88 workload averaged 100%. The throughput on all PCNs was high with no PCN averaging less than 95% throughput for FY 88.

A comparison of the average simulated flow hours against the average actual hours, taking into account the workload weight, revealed a difference of 21% between the values. The percentage difference by PCN falls within a fairly small range and excluding the top two variances (due to PCNs 34512A and 48451A) from the calculation only drops the overall difference to 19%.

The utilization of the equipment in MATPCC was generally low. Equipment such as the OC 1944 generator test stand (2%), the clutch pack test stand (2%), and the OC 2698 torque motor tester (2%) show very low usage, as do many of the other pieces of equipment that were profiled. The only two pieces of equipment that show a utilization factor better than 40% were the PO0325 actuator tester and the OC 1522 fuel flow tester.

The manpower within MATPCC shows low utilization. The overall utilization of manpower of all skill codes during the first shift is only 49%. The workers of skill code DY (electrical equipment repair) are the most underutilized. This situation was examined during model experimentation.

The majority of items went through the process flow with few delays other than the initial queue, while the worker needed to perform the repair is being found. There were some isolated instances of parts being delayed because of a lack of availability of equipment, such as PCN 34512A which sometimes waits on the PO0325 tester and PCN 48451A which also has trouble getting onto the tester.

During the brainstorming process, the ALC personnel expressed a desire to see what effect changing the levels of manpower and equipment in MATPCC would produce. The RCC currently has two test stands (71374 and 71375) which show low utilization and it was requested that the model be used to examine the effect of using a single test stand rather than two. It was also requested that the effect of adding another piece of equipment similar to the OC 1522 fuel flow tester be examined. The low utilization of the workers of skill code DY was noted during the validation process and a reduction in the amount of manpower of this code was requested as an experimental factor.

The L_4 Taguchi array that was constructed for the factors and levels that were chosen is shown in Table 6.8.2-1. The use of this array reduced the number of experimental runs needed to test these factors from eight to four. The table also shows the overall throughput percentages for the PCNs that were profiled (refer to the Experimentation section of the MATPCC DDB for a detailed report of the results produced for the individual PCNs). The table also lists the individual PCNs which showed the best and worst throughput under each experimental run.

The results produced by the experimentation showed that under the FY 90 workload, all experimental conditions were equally capable of producing high throughput. To further investigate the effect of the different factors, the average flow time of an item being repaired in MATPCC under each experimental run was examined. Refer to Table 6.8.2-2 for the comparison of the times.

This analysis showed that the average flow time needed to process an item was almost identical under all of the combinations of experimental conditions. This indicates that the RCC has no need for another fuel flow tester. The results also prove that one of the existing test stands (either the 71374 or the 71375) can be removed from the RCC without impacting productivity.

MATPCC $L_4(2^3)$ TAGUCHI ORTHOGONAL ARRAY THROUGHPUT EXPERIMENTAL RESULTS - FY 90

TABLE 6.8.2-1

EXP #	EQUIPMENT QUANTITY	MANPOWER ASSIGNED	EQUIPMENT QUANTITY	NORMAL WORKLOAD		
				AVG	BEST	WORST
1	71374 & 71375 TEST STANDS	AS-IS	(1) OC 1552 FUEL FLOW TESTER	100 %	48563A / 106%	34522A / 95%
2	71374 & 71375 TEST STANDS	REDUCE "DY" LABOR BY 10	(2) OC 1552 FUEL FLOW TESTER	100 %	35097A / 104%	34510A / 92%
3	71375 TEST STAND	AS-IS	(2) OC 1552 FUEL FLOW TESTER	100 %	95086A / 106%	34510A / 89%
4	71375 TEST STAND	REDUCE "DY" LABOR BY 10	(1) OC 1552 FUEL FLOW TESTER	100 %	95086A / 106%	34510A / 92%
RECOMMENDED	71375 TEST STAND	REDUCE "DY" LABOR BY 10	(1) OC 1552 FUEL FLOW TESTER			

LSC-20474

LSC-20473

MATPCC $L_4(2^3)$ TAGUCHI ORTHOGONAL ARRAY FLOW TIME EXPERIMENTAL RESULTS - FY 90

TABLE 6.8.2-2

EXP #	EQUIPMENT QUANTITY	MANPOWER ASSIGNED	EQUIPMENT QUANTITY	NORMAL WORKLOAD
				AVERAGE FLOW HOURS
1	71374 & 71375 TEST STANDS	AS-IS	(1) OC 1552 FUEL FLOW TESTER	135.1
2	71374 & 71375 TEST STANDS	REDUCE "DY" LABOR BY 10	(2) OC 1552 FUEL FLOW TESTER	137.0
3	71375 TEST STAND	AS-IS	(2) OC 1552 FUEL FLOW TESTER	137.0
4	71375 TEST STAND	REDUCE "DY" LABOR BY 10	(1) OC 1552 FUEL FLOW TESTER	139.0

The reduction in manpower of ten workers resulted in only a slight increase in the average flow time, which indicates that the RCC has excess manpower. The experimentation demonstrated that a reduction of ten workers is possible without producing any negative impact on the flow of items through the RCC and MDMSC recommends that OC-ALC management continue to experiment using the model to determine the least number of workers required to meet the production requirements of the RCC.

MDMSC believes that the recommended combination of levels for the factors examined during experimentation is as follows:

Recommended Configuration

Factor:	No. of test stands	Amount of Manpower	Amount of Equip. (OC 1552)
Level:	1	10 less workers of skill code DY	As-Is

To evaluate MATPCC's ability to respond to surge conditions, the resource usage report was analyzed to determine whether the present levels of manpower and equipment are sufficient to meet the additional demand. The FY 90 workload was increased by the surge percentages that were provided to MDMSC by AFLC Headquarters and run in the simulation model. This indicated that not only is the RCC capable of processing the surge workload with the existing manpower and equipment, but has excess capacity even at surge. Around-the-clock coverage was provided by putting the workers on 12-hour shifts and working them seven days a week to simulate surge conditions.

6.8.3 Description of Process Problems

The intent of this paragraph is to expound on major process problems for which there are focus study recommendations. Since there are no major process problems identified for the MATPCC RCC, potential improvement opportunities discussed in paragraph 6.8.1 are classified as other observations in this report or quick fixes in the Quick Fix Plan.

6.8.4 Other Observations

The other observations in this section were not considered as focus studies or quick fixes because they had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist OC-ALC in developing ideas that will further enhance their repair operations.

The following observations were originally identified as Quick Fix and Focus Study improvement opportunities, but after review by the MDMSC/ALC team. it was agreed that they should be presented as other observations.

Environmental Improvement Opportunities

- Safety/Health Opportunities
  - Current Condition: Some of the signs in MATPCC are hung at heights which make it inconvenient or difficult to read.
  - MDMSC Recommendation: Hang all signs at eye level so they will be noticed and read. At each entrance to this RCC, hazard warning signs should be posted to identify protective gear to be worn, such as when the use of safety glasses is required.

General Area Improvement Opportunities

- Adopt stricter guidelines regarding the disposition of vendor items that do not conform to specifications
  - Current Condition: The majority of vendor items that come in defective are being reworked by the MATPCC mechanics because they do not want to bother with the paperwork required to get an item classified as defective, and they do not want to wait until a good item gets brought into the RCC to make the repairs. Most items have a very limited inventory kept on them, and the time delay to requisition out-of-stock items into the RCC is lengthy. This repair time for new parts could be eliminated if efforts were made to require vendors to consistently deliver nondefective items. The mechanics' time is being spent repairing items that theoretically should not need repair. This situation is made worse when a mechanic has to "repair"a defective vendor part that later is found to have other defective components.

This "repaired" part is then removed and further "repaired" and reinstalled. This, in effect, will usually double the repair time normally required.

- MDMSC Recommendation: The price paid for a vendor part is supposed to guarantee that the part will perform its function. The TQM approach is based on first time quality. The ALC should closely monitor the performance of their vendors over time, and those that are incapable of delivering a consistently good item in a timely manner should be dropped as a business partner. During the transition of the ALC to an "accept no defects" philosophy, incoming inspection procedures also need to be established to determine the depth of this problem.

An example of three specific vendor items with which the mechanics in MATPCC have had problems in the past include the springs used in the slip clutch type actuators, and two items related to the fuel flow transmitters. The springs have a history of being too long, and using them in the actuator causes damage to the gears and gear shafts. The transmitters use a gearplate assembly (P/N 405-05-001) that sometimes has uneven legs, while another vendor problem is that the transmitters supplied by Gull Airborn sometimes have loose compensator blocks.

The MDMSC team was unable to get figures on how much the "fix it and use it" philosophy is costing the ALC, but based on our observations in MATPCC, this cost is significant. The switch to a "use only good vendor parts" philosophy will be a difficult and lengthy one to make, but the savings that would occur make it an effort that deserves very high priority.

- <u>Establish Some Documentation For Items Which Leave MATPCC For Processing in Other RCCs</u>
  - Current Condition: A large percentage of items that are repaired in MATPCC go outside for back shop processes such as painting, grit blasting, fluorescent dye penetrant inspection, magnetic particle inspection, etc. The mechanics in MATPCC take the items to the appropriate back shop RCC and return for them after the required operations have been completed. This disrupts the repair cycle on an item by taking the mechanic away from his work area. It also creates a situation where the RCC is not assigned ownership of the item, so that if it is lost, the back shop RCC is not held accountable. Each mechanic must also keep track of where and when he must retrieve the items. This additional distraction keeps him from concentrating on his work.
  - MDMSC Recommendation: Set up a process whereby a log is kept to show when an item is moved out of MATPCC and when it is returned. A log entry should contain certain information, such as the PCN, serial number, operator's name, the back shop RCC to which the item goes, the date and time the item is moved, and the projected time the item should be returned. The date and time when the item is actually returned to MATPCC should also be logged. This log system would help MATPCC personnel identify, track, and resolve work flow problems with other RCCs in a timely manner.

Operational Improvement Opportunities

- Update the Work Control Documents (WCDs)
  - Current Condition: Many of the WCDs used in MATPCC are obsolete or difficult to interpret. Due to the high experience level of the workers, the RCC still seems to function well despite the inaccuracy of the WCDs. If workers who are unfamiliar with the repair processes in MATPCC were asked to work items covered by certain WCDs, this documentation problem would quickly become critical.
  - MDMSC Recommendation: Make the WCDs reflective of the actual processes as they now exist so that they can be used in conjunction with the Technical Orders to help guide the newer workers through the repair processes with which they may not be familiar.

Inventory/Sourcing Opportunities

- Increase inventory level on actuator motors
  - Current Condition: Some of the actuators being repaired become delayed because motors are needed which are unavailable. The actuators then must be set aside until a supply of motors arrive, and this can take up to three weeks. This situation creates an unnecessary delay in the repair flow times.
  - MDMSC Recommendation: Keep a floating stock of two motors in MATPCC to prevent the delays currently being caused by unavailable parts.

Quality Improvements

- Improve the Recordkeeping of the RCC on Items Which are Condemned
  - Current Condition: Production operations generate scrap through a variety of causes. This scrap is ordinarily removed from the RCC for disposal, along with the accompanying WCDs.

- MDMSC Recommendation: Each RCC should maintain a scrap logbook that lists each part as it is scrapped and the cause for scrapping the part. A periodic review of an RCC's scrap logbook could be used to determine how to reduce excessive scrap by implementing methods to eliminate, or reduce, the repetitive causes for scrapping parts. By cutting down on the amount of items presently being scrapped, the RCC will increase the productivity of its manpower and equipment, and reduce the amount of material being wasted.

6.9 MATPCD ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

MATPCD, the Governor and Miscellaneous Engine Accessories Overhaul and Test Unit, is responsible for overhaul of J-57, J-79, TF-30, TF-33 and TF-41 engine accessories. The specific repair responsibilities and organizational details of MATPCD operations are provided in paragraph 6.9.1.

The MATPCD work force is experienced and motivated and therefore produce high quality items on schedule. This is accomplished despite the various indirect activities found throughout the RCC. Also, under surge conditions, the current resources within MATPCD are capable of meeting surge.

During process characterization of MATPCD, a total of 33 improvement opportunities were identified. (Refer to MATPCD Database Documentation Book, Potential Improvements Section.) During review and analysis of these opportunities, the MDMSC/OC-ALC TI-ES Team concluded that similar observations should be combined and that observations of limited utility should be dropped from further consideration. Team review and analysis also resulted in the conclusion that none of the observed opportunities qualified as a focus study, and only one opportunity could be classified as a quick fix. Several of these remaining opportunities were found to have OC-ALC general applicability (see paragraph 6.0 for discussion of these). The remaining 21 improvement opportunities are classified as other observations and described in paragraph 6.9.4 of this document.

The single Quick Fix recommendation resulting from characterization of MATPCD addresses rework, where possible, of Control Assembly (PCN 96571A) components muscle valves and covers. It is estimated that implementation of this Quick Fix will result in annual real dollar savings of $99,938.

6.9.1 <u>Description of Current Operations</u>

MATPCD performs remanufacture, rework, and test of various aircraft engine accessories. The work load is a mix of PDM (55%), MISTR (40%) and Temporary (5%) work. This RCC occupies 21,225 square feet of Tinker Air

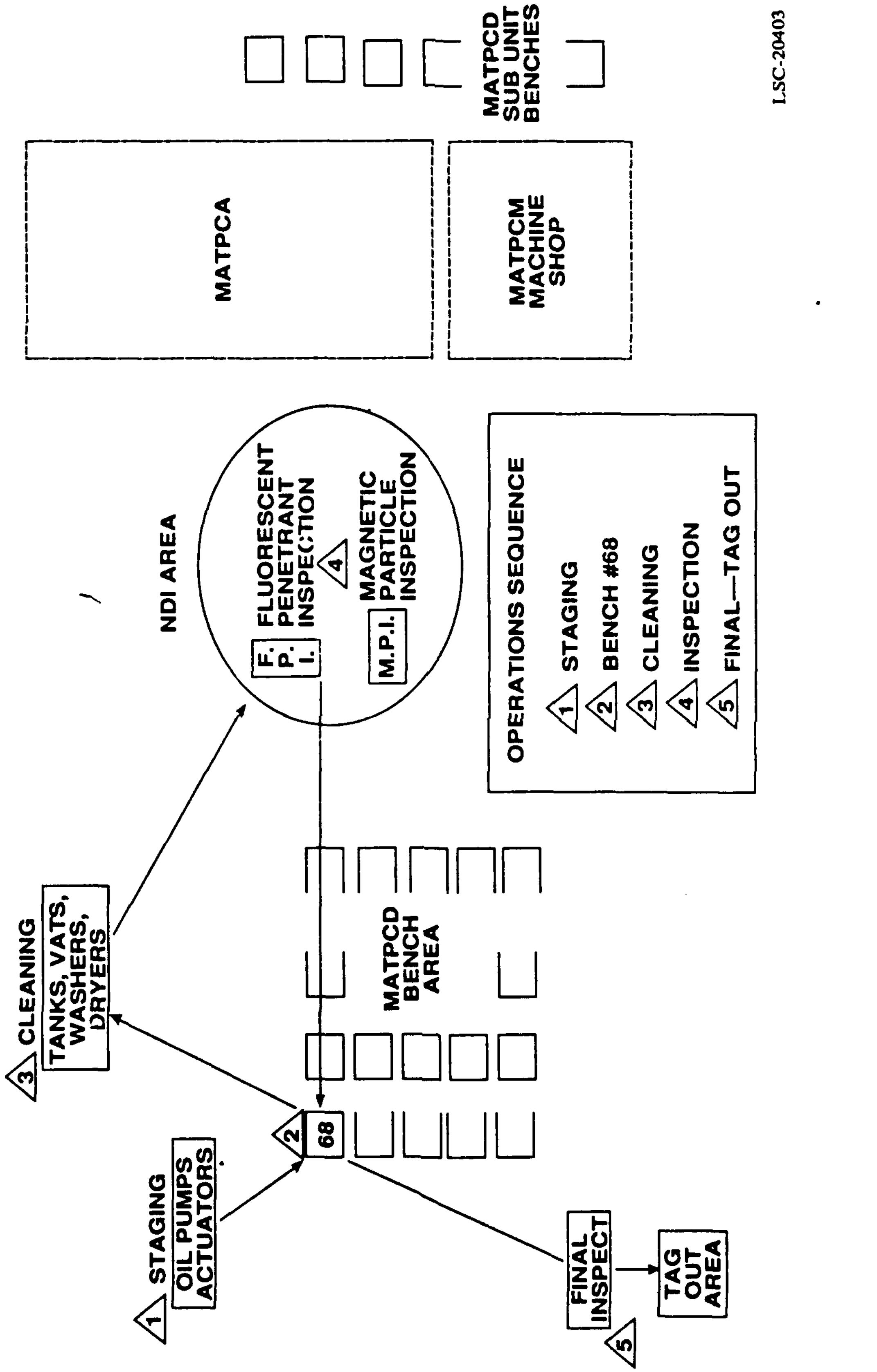
Force Base Building 3001 and employs a staff of 69: one Chief Supervisor, four first-line Foreman and 64 Mechanics. Allocated floor space, staffing level and organization are appropriate for performance of the RCC's mission.

The repair technologies employed by MATPCD consist of cleaning/degreasing, disassembly/assembly, and testing operations. Major rework (machining, welding, grinding, and plating), some testing operations and specialized (Fluorescent Penetrant and Magnetic Particle)inspections are performed by back shops. Figure 6.9.1-1 provides an example of floor layout and product flow for MATPCD. Aside from small hand tools utilized in disassembly/assembly operations, the primary equipment employed by this RCC consists of cleaning systems, drying ovens, and test stands. All MATPCD equipment is in good operating condition requiring minimum unscheduled maintenance.

During the base period for characterization of this RCC (FY 89), the total quantity of 80/20 workload end items processed was 11,576. (Refer to MATPCD Database Documentation Book, Data Collection Section, for details pertaining to the 80/20 workload.) The types of components overhauled by MATPCD are as follows:

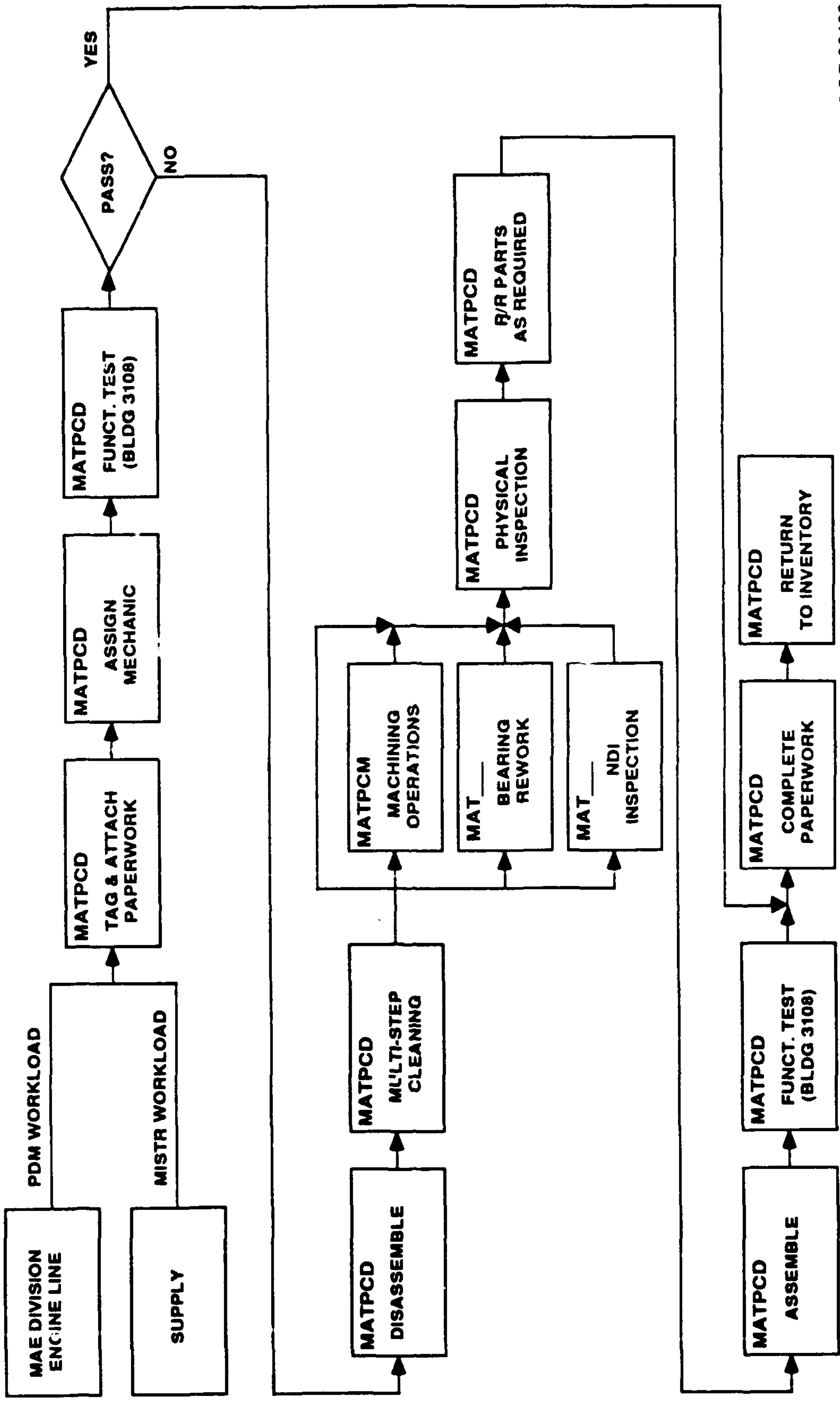
- Governors
- Filters
- Oil Pumps
- Nozzle Controls
- Actuators
- Valves
- Regulators
- Cylinders
- Fuel Valves
- Water Injection Pumps

Although this RCC processes a wide variety of end items, there is considerable commonality in process flow and technology. The process flow diagrams for governors (Figure 6.9.1-2), filters and oil pumps (Figure 6.9.1-3), and nozzle controls and actuators (Figure 6.9.1-4) are provided as examples of the major process flow schemes utilized by this RCC. These three process flow diagrams present all processes and technology required for MATPCD to accomplish its mission.



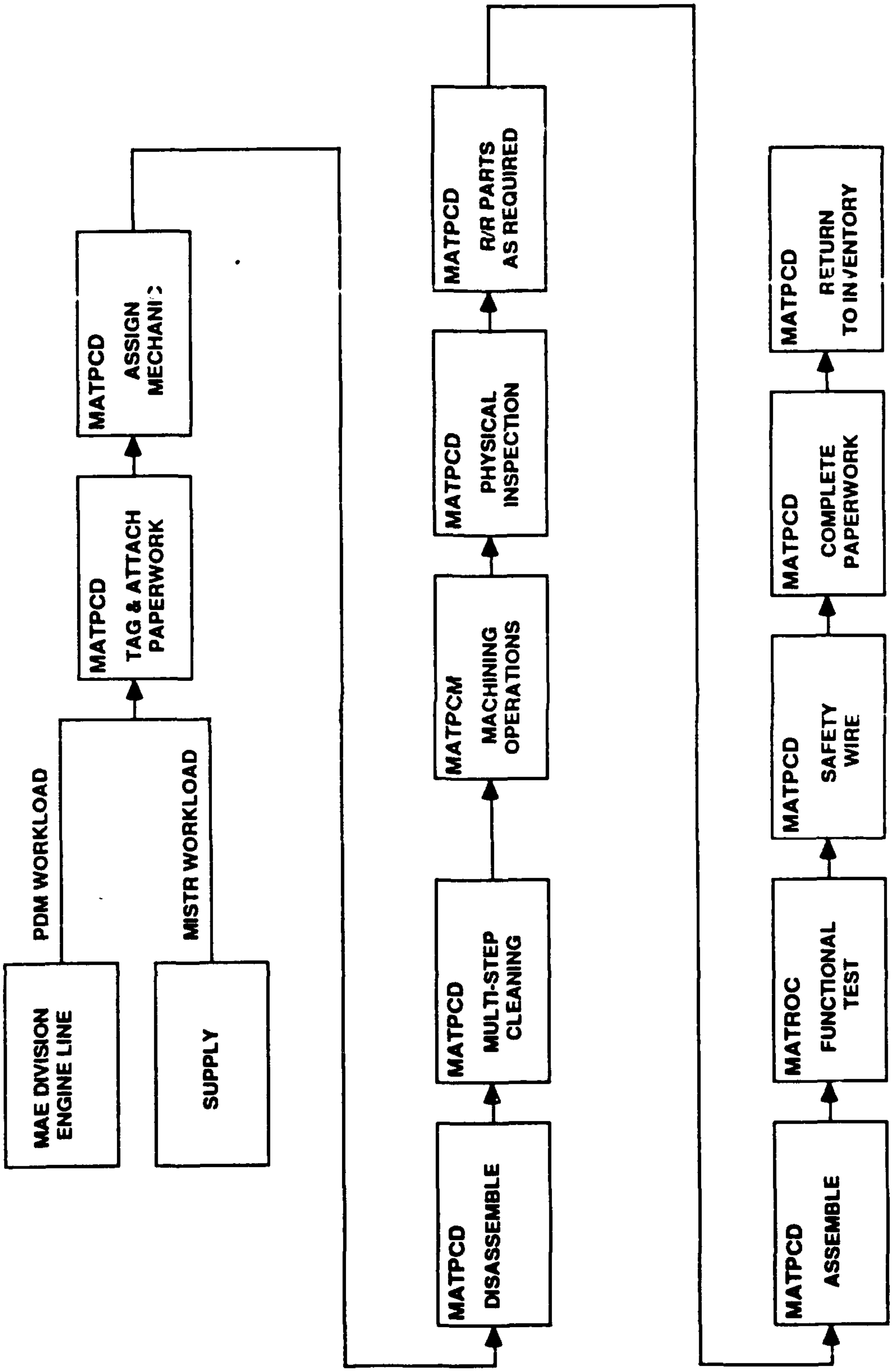
WORK AREA LAYOUT AND WORK FLOW FOR PCN 38680A (CONTROL BOX ASSEMBLY)
FIGURE 6.9.1-1

LSC-20400

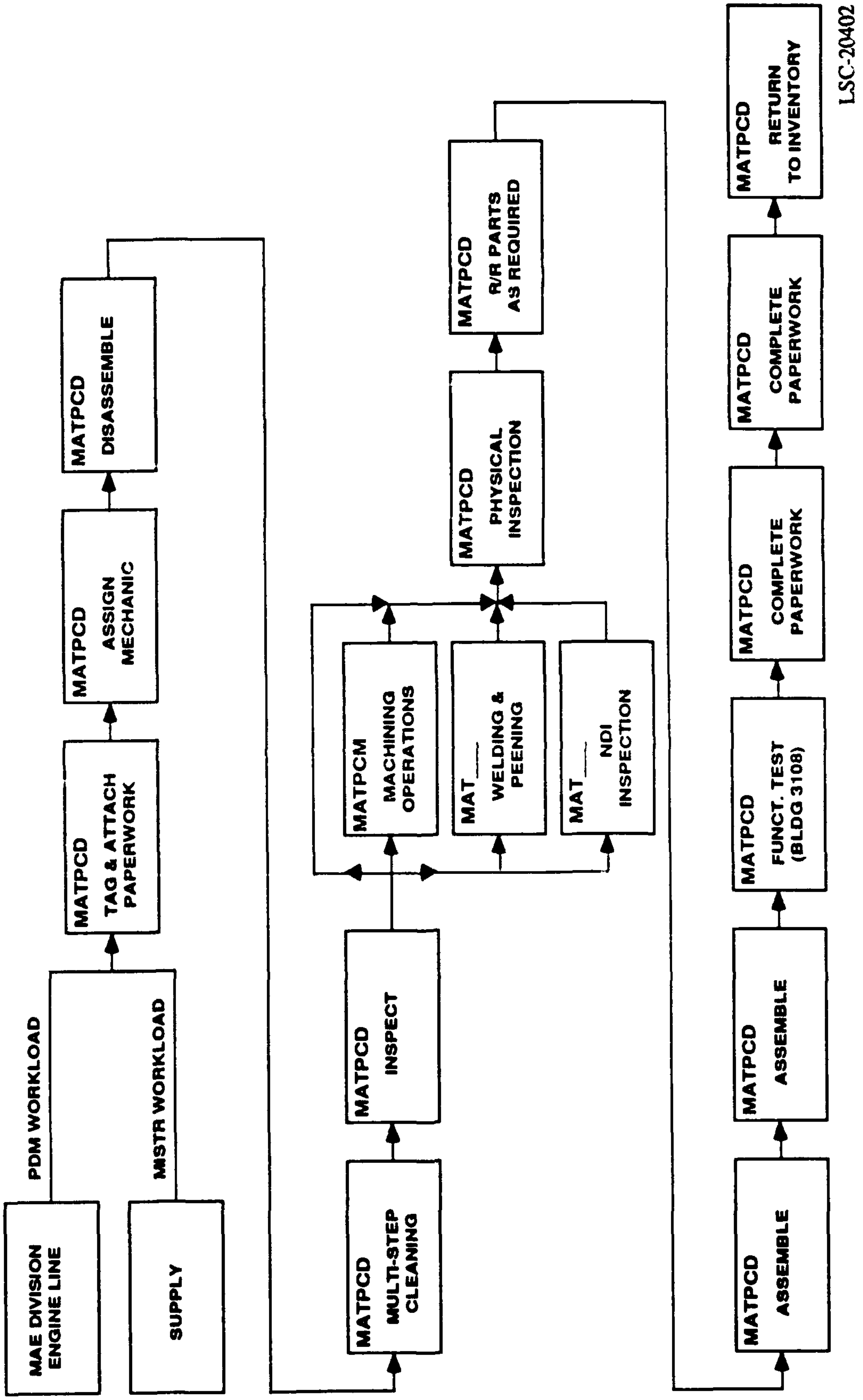


MATPCD ENGINE ACCESSORIES PROCESS CHART (GOVERNORS)
FIGURE 6.9.1-2

LSC-20401



MATPCD ENGINE ACCESSORIES — FILTERS, OIL PUMPS
FIGURE 6.9.1-3



MATPCD ENGINE ACCESSORIES — NOZZLE ACTUATOR
FIGURE 6.9.1-4

Engineering and planning should be more attentive to the work control documents and provide more detail and methods on performing the various operations. Also, Problem Request Forms (AFLC Form 103) are not always processed in a timely manner. In addition, replies are often inconclusive and leave shop supervision with unresolved problems or requires these supervisors to work the problems through trial and error within their expertise. Engineering and planning often address symptoms rather than causes to their problems. This seems to be a general concern affecting many RCCs at OC-ALC.

6.9.2 Statistical System Performance Measures

Validation of the UDOS 2.0 model simulation outputs for MATPCD was initiated on 10 July 1989. The validation process consisted mainly of a statistical comparison of historical throughput and flow times to the model generated simulations of these items for FY 88. Other criteria, such as utilization of manpower and equipment, were also used to assess the validity of the model results.

Several assumptions were made at the time of validation. These assumptions were considered to be both necessary and reasonable in interpreting model validity. The assumptions made were as follows:

- The 80/20 workload analysis was accurate and represented 80% of the workload. The workload may vary from 80% in cases where the MDMSC/OC-ALC team has decided on and jointly authorized deviations from the original 80/20 listing.
- Mechanics' estimates of process times are to be considered as statistically accurate.
- Induction quantity distributions are accurate and can influence throughput.

- Historical data, collected from the WCDs are not accurate. The reasons for the inaccuracies are influenced by the following:
  - WCD release practices (batch print)
  - Stamping practices on WCDs
  - Work schedules (priorities)
  - Lack of parts/high work in process
- Validation will be accomplished against engineering estimates.

The FY 88 80/20 list for MATPCD consisted of 41 end items. As previously stated, the criteria used to validate the UDOS 2.0 model simulation outputs was: 1) throughput, 2) simulated flow versus G019C estimated flow days, and 3) resources utilization (queues). These results are presented in detail in the DDB Experimental section.

The throughput statistical analysis done at the time of validation was to ascertain that the model simulated FY 88 production levels. As can be seen in the DDB Experimentation section, the variance analysis for simulated throughput versus actual throughput for this RCC shows 1% difference between these. On the average, the model generated 11,527 end items versus 11,361 actual end items produced. A more detailed discussion by PCN number may be found in the DDB Experimental section.

The flow hours statistical comparison was performed against the G019C report. Historical data, once examined, was felt to contain too many inaccuracies for any meaningful analysis to be performed. The DDB contains the variance analysis for simulated flow hours versus G019C flow hours. On the average, the simulated flow hours reflect 12% lower than the G019C. A detailed discussion by PCN for this comparison is available in the DDB Experimental section.

The brainstorming process for experimentation on MATPCD followed model validation. The prepositioning step is identification of the problem statement or objective of the brainstorming process. In the case of MATPCD, the problem statement read: "The effect that would be seen by (1) eliminating kitting versus performing kitting operations on second shift, (2) addition of a second OC 4081 test stand on first shift versus utilization of existing OC 4081 on second shift, and (3) adding one additional OC 0574 on first shift versus utilization of existing OC 0574 on second shift."

An orthogonal array was developed using the Taguchi process. The team identified three factors and established two levels for each factor. An L_4 (2^3) array is depicted in Table 6.9.2-1, with throughput (Δ) being selected as a quality characteristic. A discussion of the results of these experiments follows.

Examination of the experimental simulated throughput for each run indicates that on the average, 100% of inductions are being processed. This effectively precludes the use of throughput for any meaningful analysis of experimental conditions.

Table 6.9.2-2 shows the result of a Taguchi analysis using the stated experimental conditions. Based on these results, it is observed that while all of the experiments showed a reduced average simulated flow hours when compared to the As-Is (276.05 hours), there was little individual variation between them. The Taguchi optimal conditions were found to be:

- Utilize second shift kitting.
- Utilize existing OC 4081 on second shift.
- Utilize existing OC 0574 on second shift.

A more detailed discussion may be found in the DDB Experimental section.

MATPCD EXPERIMENTAL SIMULATED FLOW TIME ANALYSIS

TABLE 6.9.2-1

EXPERIMENTAL FLOW TIME AVERAGES -

EXP. 1	231.53
EXP. 2	229.63
EXP. 3	230.23
EXP. 4	229.03

FACTOR	LEVEL	
1	1	233.3
	2	229.63
2	1	230.88
	2	229.05
3	1	230.28
	2	229.65

$L_4 (2^3)$

NO	1	2	3
1	1	1	1
2	1	2	2
3	2	1	2
4	2	2	1

LSC-20511

$L_4 (2^3)$ TAGUCHI ORTHOGONAL ARRAY THROUGHPUT EXPERIMENTAL RESULTS - FY 88

TABLE 6.9.2-2

EXP #	A	B	C	NORMAL WORKLOAD		
				AVG	BEST	WORST
1	ELIMINATE KITTING	ADD 1 OC 4081 ON 1ST SHIFT	ADD 1 OC 0574 ON 1ST SHIFT	100 %	98022A / 109%	97102A / 95%
2	ELIMINATE KITTING	USE EXISTING OC 4081 ON 2ND SHIFT	USE EXISTING OC 0574 ON 2ND SHIFT	100 %	97021A / 114%	38692A / 94%
3	2ND SHIFT KITTING	ADD 1 OC 4081 ON 1ST SHIFT	USE EXISTING OC 0574 ON 2ND SHIFT	100 %	50280A / 95%	97138A / 93%
4	2ND SHIFT KITTING	USE EXISTING OC 4081 ON 2ND SHIFT	ADD 1 OC 0574 ON 1ST SHIFT	100 %	50280A / 95%	97138A / 93%

LSC-20519

The FY 90 workload was used to determine MATPCD surge capabilities. Using surge information supplied by AFLC, a throughput of 100% can be expected. This RCC appears to have sufficient resources and expertise to meet forecasted surge conditions. The following MDMSC recommendations are made to assist OC-ALC preplanning for surge production:

- Utilization of kitting on second shift for MATPCD is effective for lowering average processing times for affected items. This would be an important consideration for surge production.
- Perform a five year simulation experiment using surge conditions.

6.9.3 Description of Process Problems

The intent of this paragraph is to provide detailed description of major process problems for which there are focus study recommendations. Since none of the observed MATPCD improvement opportunities could be addressed by a focus study, they are addressed as either quick fixes or other observations.

6.9.4 Other Observations

The MDMSC/OC-ALC TI-ES Team consider the following observations , which could not be significantly quantified in terms of quality, cost, or time, to offer MATPCD opportunities for further enhancing RCC operations.

General Area Improvement

- PA System
  - Current Condition: When an individual is needed, a person must walk to find the individual or attempt a phone call.
  - MDMSC Recommendation: Install a localized PA System in discrete areas of the shop.

Operational Improvements

- Valve Assy-Parts Going to Strip & Blast Area
  - Current Condition: Components of PCN 53856A require stripping and blasting operations in RCCs MABPSC and MABPSH. Flow time can sometimes be as long as three weeks.
  - MDMSC Recommendation: Examine the MABPSC and MABPSH RCCs to determine how this flow time can be reduced.

- Pneumatic Tools for Pump Operations
  - Current Condition: Manual ratchets and sockets are used for assembly/disassembly operations.
  - MDMSC Recommendation: Utilize pneumatic tools whenever possible.

- Steel Corrosion Removal
  - Current Condition: Sometimes steel components return from corrosion removal with contaminated surfaces causing mechanics to have to repeat the cleaning process (noted for PCN 97103A, Water Injection Control.)
  - MDMSC Recommendation: Examine the process of corrosion removal to determine why parts are returning to MATPCD contaminated.

- Airflow Control and Regulator
  - Current Condition: Although the o-ring vendor for the airflow control part was changed in order to reduce cost, it appears that the new o-rings are causing a leakage problem resulting in extra rework.
  - MDMSC Recommendation: Review total cost/benefits of the new o-rings versus the cost of reworking the airflow controls due to o-ring failure.

- Torque Booster (PCN 38659A)
  - Current Condition: The shaft assembly on the torque booster is not tested until the unit is "built-up." Failures at this point require disassembly and rework, then retesting.
  - MDMSC Recommendation: Devise a shaft assembly test which does not require build-up of the unit in order for the shaft assembly to be installed.

- Control Activator Assembly Reset
  - Current Condition: Reset kits are transported to MATPCD magnetic particle inspection one at a time.
  - MDMSC Recommendation: Combine operations and transport several reset kits to magnetic particle inspection at the same time.

- Scavenge Pump (PCN 38688A) Shaft Keys
  - Current Condition: Two small keys need to be installed in the shaft, but the unit can be assembled without these two keys.
  - MDMSC Recommendation: Insert a caution note for any operator performing this assembly operation advising him to verify that the installation of the keys has been accomplished.

- Bearings on Valve Inlet
  - Current Condition: Approximately 5% of the 97175A fuel pressure pumps do not have the bearings attached on the inlets. The mechanic must take the entire valve assembly to the machine shop to have the bearings attached resulting in a one to three day delay.
  - MDMSC Recommendation: Have all 97175A fuel pressure pumps checked while still in inventory. Pumps could be worked at this point eliminating delay time in the repair cycle.

- Maintain O-Ring Inventory
  - Current Condition: Inventory levels of all types of o-rings are often low.
  - MDMSC Recommendation: Maintain an inventory level of all types of O-rings. Set up a min/max system and assure FIFO management to prevent lapsing of shelf life.

- Bearing Packs
  - Current Condition: After disassembly of the oil pump, the bearings are sent to the bearing bay for cleaning, measuring and packaging. These parts can have as much as a 30 day turn around.
  - MDMSC Recommendation: An analysis of the bearing bay should be made to determine reasons for the excessive flow time.

- Select Fit of Thermophial
  - Current Condition: The Technical Order calls for a select fit for the reinstallation of the thermophial into the original assembly. Because of a lack of a practical method to mark the units for rematch of original components, this is difficult to accomplish.
  - MDMSC Recommendation: To comply with the Technical Order requirements, increase airflow control reliability, and reduce cost, a method for marking and rematch of the original thermophial and base unit should be devised so as to allow for a select fit reassembly.

- WCD Info
  - Current Condition: Many WCDs appear to be inaccurate such as lacking info, missing operations, operations out of seq., etc.
  - MDMSC Recommendation: Update the WCD system to reflect the actual shop floor conditions.

- Spare Parts at Test Stand
  - Current Condition: The current floor layout requires the operator to leave the test stand, and walk to the rear of the stand for spare parts.
  - MDMSC Recommendation: Modify layout relocating spare parts to a bench behind operator.

Sourcing/Inventory

- Purchase Seal Rings
  - Current Condition: The seal rings on the 96571A control assy are currently "home-made" in-house on lathes and are not to "Spec." As a result, the "home-made" seal rings are either out of round, too long, too wide, and often too thin.
  - MDMSC Recommendation: Until rings can be made to spec on site, purchasing should continue to buy the seal rings from a reliable vendor.

Material Handling

- Bar Code - Inventory Control
  - Current Condition: Inventory control of small and large parts (utilizing bins for small parts) is accomplished by a manual system.
  - MDMSC Recommendation: An electronic scan (bar code) system for labeling and controlling items would improve inventory control and material handling procedures.

- Bins at Workstations for Small Parts
  - Current Condition: Operator spreads approximately 19 small parts out on his bench during assembly/disassembly operations.
  - MDMSC Recommendation: The use of small bins or containers for each small part would help prevent loss and would reduce the chance of small parts being inadvertently interchanged.

- Scanner
  - Current Condition: Jobs are signed-off using rubber stamps, pens, etc.
  - MDMSC Recommendation: Sign off jobs using Electronic "wands" or scanners. These machines read the bar codes on work orders and reduce the amount of time spent on paperwork. An electronic system could form the beginning of a historical data collection system that would be more accurate than that currently used.

- Stock Bin Identification
  - Current Condition: Stock bins are not properly identified and stocked with the designated part.
  - MDMSC Recommendation: Identify stock bins with their appropriate part numbers and part name or description.

- Material Handling Operators
  - Current Condition: Operators are responsible for obtaining and transporting their own material to the workstations.
  - MDMSC Recommendation: Designate full-time material handlers either within the RCC or ALC wide.

Technology Development

- Fixture Usage
  - Current Condition: Mechanics are having to support parts by hand during assembly operation.
  - MDMSC Recommendation: Develop holding fixtures to be kept at the workstations which aid in assembly operations.

6.10 MATPCM ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

The Resource Control Center (RCC) identified as MATPCM is a machine shop which performs standard machine operations for parts and assemblies requiring rework and repair. These parts and assemblies are received from other RCCs in MATP. Once the items are repaired and reworked by MATPCM, they must be picked up by the respective RCC. The detailed responsibilities of MATPCM are described in paragraph 6.10.1.

Surge condition will be enhanced when modifications of outdated equipment is accomplished. However, the current resources within MATPCM are capable of processing the surge workload. Throughput to a large degree is based on the talent of a given machinist and/or machine operator.

During initial characterization of the MATPCM RCC, three improvement opportunities were identified (reference MATPCM Database Documentation Book, Potential Improvements section). Upon further review of this original set of opportunities by the MDMSC/Air Force Team, one improvement opportunity was selected to be pursued as the focus of the TI-ES program activities relating to MATPCM. This improvement opportunity is a quick fix to add Acu-Rite III digital readouts to the engine lathes, horizontal and vertical milling machines. This Quick Fix Opportunity is described in detail under separate cover. The remaining two MATPCM improvement opportunities are considered as other opportunities and are described in paragraph 6.10.4.

6.10.1 <u>Description of Current Operations</u>

The MATPCM machine shop will perform standard machining operations for several overhaul RCCs in MAT. The typical machining operations are drilling, boring, reaming, threading, tapping, facing, cutting, grinding, and lapping. These operations will be worked on a wide variety of parts such as actuators, manifold assemblies, nozzles, fuel support assemblies, pumps, hinges, engine parts, thermostats, and miscellaneous small parts. The equipment utilized in the processes are manual engine lathes, milling machines, radial drill presses, standard drill presses, arbor presses, a tapping machine, an oven, and a grinder. As mentioned in section 6.10, MATPCM personnel will work incoming parts on a FIFO basis unless a part is specially designated as a priority by the responsible unit or a higher authority. The machine operators will perform the necessary operations as called out on the WCD for the item or on the AFLC Form 945 (Routed Work Order). Once the operations are completed for the part, the operator will place it on an outgoing tray located on the tables next to the main aisle. The main RCC responsible for the item will be notified and would then pick up the part.

The work force consists of 14 machine tool operators, one machinist, and a unit chief. There is one foreman who is currently on leave. All of the operators are cross-trained on all operations performed in the unit but have various levels of experience. The work force of MATPCM is fairly stable. Although the WG-09's are described as machine tool operators, they often perform work on the same level as a WG-10 (machinist) in the same unit. The WG-09's are cross-trained to perform nearly all operations of the shop and have skills similar to a WG-10.

The area layout is such that similar type machines are positioned together in one section of the shop. A problem exists for the lathe group in that the spacing between machines is sometimes not sufficient for working some parts requiring large fixtures on the lathes. However, adequate space exists for the other equipment in the area.

The square footage for MATPCM consists of 3900 square feet of assigned production area for MATPCM and 1450 square feet allocated in MATPCB for the J-57 and TF-33 manifold assembly operations. Given the current workload requirements, there appears to be an adequate amount of equipment, work space, and personnel. It is noted that the current MATPCM RCC will be integrated into a complete machining complex which has been proposed by AFLC management. The detailed layout configuration for the new area has not been developed.

This machine shop will typically work control numbers and WCDs from MATPCA (servo control and engine igniter subunits), MATPCB (accessories, fuel pumps, manifold-nozzle subunits), and MATPCD (engine accessories, governor/misc.

overhaul, and regulator-control subunits). Of these three, MATPCB supplies the majority of the workload to MATPCM. Work will arrive at the machine shop in various ways. If a part is considered a "rush" priority by the home RCC, then the machine shop will work on the one part as soon as possible. Otherwise, any other part or group of parts which arrive at the shop will be worked on a FIFO basis.

There are many parts which require considerable set-up time on either the engine lathes or the milling machines. In this case the home RCCs will take a bin of several parts to the machine shop at a time in order to reduce setup frequencies, especially if the machining time for the part is minimal. The machine operator will do all the necessary rework, return the parts to the traveling bin, and place the bin on the finished parts table for the home RCC group to pick up.

Engineering and Planning should be more attentive to the work control documents and provide more detail for the methods of performing the various operations. Also, Problem Request Forms (AFLC Form 103) are not always processed in a timely manner. In addition, replies are often inconclusive and leave shop supervision with unresolved problems or requires these supervisors to work the problems through trial and error within their expertise. Engineering and Planning often address symptoms rather than causes to their problems.

Volume of work for the unit will vary and is typical of a job-shop unit. The workload will primarily depend upon the conditions of the inducted parts

The specific engine models which are primarily worked are the J-57, TF33, J79, TF41, and TF3. All control numbers worked are MISTR items.

There is no special material handling equipment required in MATPCM since it is a job-shop environment and no large assemblies are worked in the area requiring unique handling. The parts to be worked will be transported to the appropriate work station in a bin which can be carried by the operator, large fixtures which have considerable weight can be moved with small carts which are available in the area.

Work tools, fixtures and miscellaneous hardware are the only items stored in MATPCM. The glass-front cabinets will contain the fixtures and the small cabinets with drawers will contain the small interchangeable parts and miscellaneous hardware. Each drawer is labeled as to what type of part or hardware it contains. Incoming and outgoing parts are stored on benches and tables next to the main shop aisle.

The quick fix identified addresses increased productivity as a result of outfitting machine tools with digital readouts. There is one digital readout being utilized on a manual engine lathe in MATPCM. A preliminary study on the use of the digital readout versus machining without the readout, indicated that a significant amount of machining time can be reduced. This modification would increase machine capacity and improve ability to meed surge requirements.

The remaining two improvement opportunities have been judged as other opportunities and are discussed in paragraph 6.10.4. They address machining of small parts to finish tolerance by the vendor and implementation of a priority scheduling system.

A bushing which is installed in the inlet guide vane actuator (PCN 38677A) is received from the vendor not machined to specifications. The machinist in MATPCM must perform a facing operation on the bushing which requires one to two hours of machining time. Although it is currently required that the machinist face the bushing, the vendor should have no difficulty finishing the part to specifications.

Generally, parts which arrive at the machine shop will be worked on a FIFO (first-in first-out) basis. However, some parts which are sent to the machine shop from an RCC will be designated as a "Priority" item either by the home RCC or by a higher authority. A problem occurs when either MATPCM does not know which items are priority in what order or what to do if a conflict of items arises.

6.10.2 Statistical System Performance Measures

Validation of the UDOS 2.0 model simulation outputs for MATPCM was initiated on 24 July 1989. The validation process consisted mainly of a statistical comparison of historical throughput and flow times to the model generated simulations of these items for FY 88. Other criteria, such as utilization of manpower and equipment, were also used to assess the validity of the model results.

Several assumptions were made at the time of validation. These assumptions were considered to be both necessary and reasonable in interpreting model validity. The assumptions made were as follows:

- The 80/20 workload analysis was accurate and represented 80% of the workload. The workload may vary from 80% in cases where the MDMSC/OC-ALC team has decided on and jointly authorized deviations from the original 80/20 listing.
- Mechanics' estimates of process times are to be considered as statistically accurate.
- Induction quantity distributions are accurate and can influence throughput.
- Historical data, collected from the WCDs are not accurate. The reasons for the inaccuracies are influenced by the following:
    - WCD release practices (batch print)
    - Stamping practices on WCDs
    - Work schedules (priorities)
    - Lack of parts/high work in process
- Validation will be accomplished against engineering estimates.

The FY 88 80/20 list for MATPCM consisted of 26 items. As previously stated, the criteria used to validate the UDOS 2.0 model simulation outputs was: 1) throughput, 2) simulated flow vs. G019C estimated flow days, and 3) resources utilization (queues). These results are presented in detail in the Database Documentation Book (DDB) Experimental section.

Since MATPCM is a back shop to several RCCs, the reported G019C flow hours are not applicable to processes performed there. The G019C tracks end items, which may spend only a short period of time in MATPCM. For this reason, there is no valid comparison between average simulated flow hours and G019C reported hours. In the case of historical flow hours, it was felt that the historical data contained too many inaccuracies to be of use in comparative analysis. For these reasons, no statistical comparisons were performed for simulated flow hours in the RCC. Validation of model generated flow hours for each PCN was confirmed using the combined knowledge of shop foreman, planners, schedulers, and engineering staff.

The throughput statistical analysis for items worked in MATPCB may be found in the DDB Experimentation Section. This analysis indicates that 100% of the inducted items were processed. On the average, the model generated a throughput of 11,031 items compared to actual throughput of 11,026 items. A more detailed analysis by PCN is contained in the DDB Experimentation section.

The brainstorming process for experimentation on MATPCM followed model validation. The prepositioning step is identification of the problem statement or objective of the brainstorming process. In the case of MATPCM, the problem statement read: "What effects would be seen from (1) comparing As-Is manpower conditions to reduction by six AJ09s, (2) reduction in set-up times of 30% using new digital equipment versus As-Is set-up times, and (3) reduction of processing times by 2% using new digital equipment as compared to As-Is processing times."

Examination of the experimental results for MATPCM throughput averages indicates that all experimental conditions allowed 100% throughput of inducted items. Best and worst case throughput by PCN indicates that very little variance occurs from one experiment to the next.

Table 6.10.2-1 shows the results of analysis of experimentally generated flow time averages. The average simulated flow hours under presently existing conditions is 90.84 hours. As can be seen, there is little benefit received from any of the proposed changes.

An orthogonal array was developed using the Taguchi process. The team identified three factors and established two levels for each factor. An L_4 (2^3) array is depicted in Table 6.10.2-2, with throughput (Δ) being selected as a quality characteristic. A discussion of the results of these experiments follows.

It must be concluded that MATPCB is a very robust RCC, having a well trained and efficient work force. More detailed discussion of these facts may be found in the DDB Experimentation section.

The FY 90 workload was used to determine MATPCM surge capabilities. Using the FY 90 workload factors provided by AFLC, a throughput of 100% can be expected. Since it was observed that manpower was sufficient to meet both normal and surge conditions, it might be advisable to have the existing AJ09 machine tool operators cross-trained to work in other machining areas. The machine tool operators in MATPCM appeared very knowledgeable and proficient at their assigned tasks, and could possibly be integrated into other machine shop areas during surge conditions as needed. MDMSC also recommends running a five year simulation experiment using projected surge conditions. This would indicate any long range consequences of operating under extended surge production rates.

6.10.3 Description of Process Problems

The intent of this paragraph is to expound on major process problems for which there are a focus study recommendations. Since there are no candidate focus studies identified for MATPCM at this time, potential improvement opportunities discussed in paragraph 6.10.1 are classified as other observations in this report or quick fixes in the Quick Fix Plan.

MATPCM EXPERIMENTAL
FLOW TIME AVERAGES STATISTICAL COMPARISON
TABLE 6.10.2-1

EXPERIMENTAL FLOW TIME AVERAGES -

EXP. 1	90.04
EXP. 2	89.83
EXP. 3	92.24
EXP. 4	92.82

FACTOR	LEVEL	
1	1	89.94
	2	92.53
2	1	91.14
	2	91.33
3	1	91.43
	2	91.04

$L_4\ (2^3)$

NO	1	2	3
1	1	1	1
2	1	2	2
3	2	1	2
4	2	2	1

LSC-20514

L_4 ORTHOGONAL ARRAY
EXPERIMENTAL RESULTS FOR MATPCM
TABLE 6.10.2-2

EXP #	A MANPOWER	B SET-UP REDUCTION	C PROCESS TIME REDUCTION	NORMAL WORKLOAD		
				AVG	BEST	WORST
1	AS-IS	AS-IS	AS-IS	100 %	98034A / 102%	98057A / 93%
2	AS-IS	30% REDUCTION	2% REDUCTION	100 %	98034A / 102%	98057A / 94%
3	6 LESS AJ09s	AS-IS	2% REDUCTION	100 %	98034A / 102%	98057A / 94%
4	6 LESS AJ09s	30% REDUCTION	AS-IS	100 %	98034A / 102%	98057A / 95%

LSC-20512

6.10.4 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist OC-ALC in developing ideas that will further enhance their operations.

The observations which follow were originally identified as quick fix and focus study improvement opportunities and are detailed as such in the MATPCM DDB. After review by the MDMSC/OC-ALC TI-ES team, it was mutually agreed that they should be presented as other observations for future reference.

- Small Parts Which Can be Machined to Tolerance by Vendor
  - Current Condition: A bushing (PN 111952) which is installed in the inlet guide vane actuator (CN 38677A) is sent from the vendor not machined to specifications. The machinist in MATPCM must perform a facing operation on the bushing which requires one to two hours of machining time. Although it is currently required that the machinist face the bushing, the vendor should have no difficulty finishing the part to specifications. According to the senior machinist and other machine tool operators, there are many such parts which require extra machining the vendor could have done.
  - MDMSC Recommendation: Identify, with the help of production operators, parts which should be finished/upgraded before purchase from vendors. Successful re-negotiation of such purchased parts can result in significant savings in manpower and production time.

- Priority Scheduling System
  - Current Condition: Generally, parts which arrive at the machine shop will be worked on a First In First Out (FIFO) basis. However, some parts which are sent to the machine shop from an RCC will be designated as a "Priority" item either by the home RCC or by a higher authority. A problem occurs when either MATPCM does not know which items are priority in what order or what to do if a conflict of items arises.
  - MDMSC Recommendation: Determine the feasibility of implementing an integrated scheduling system (such as MRP II) ALC wide.

6.11 MATPFA ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

The MATPFA RCC is responsible for the repair of the PB60, FC-11, and AJB7 integrated flight panels, as well as the ASA-32 and E-4 automatic pilot systems. A detailed description of the activities that take place in MATPFA is given in paragraph 6.11.1 of this document.

The RCC MATPFA has a number of assets which allow it to meet the demands placed upon it. The workers in this RCC are well-trained and most have been working in the area for a long time. This high experience level results in the workers getting to know the repair procedures extremely well and because of this, high quality items are produced. The workers, as a whole, display good skills and high motivation. The workers appear to enjoy the type of work that they do and are very conscientious in seeing that the items repaired have no defects. The working environment seems to be enjoyed by the workers and a good relationship exists between the workers and the supervisors. The supervisors in MATPFA do a good job of monitoring the activities within the RCC and providing the workers with assistance when it is needed.

The RCC benefits from having a relatively small percentage of one of a kind equipment. Most processes have backup equipment that can be used when the primary equipment is not available. However, the potential for line shutdown is expected to increase significantly as more dedicated Automated Test Equipment (ATE) is introduced into the RCC. The combination of a highly skilled work force with adequate equipment results in good throughput. The RCC is capable of maintaining good throughput under war time surge provided that one additional worker is added to the work force and that the workers are spread over 12-hour shifts and work seven days a week.

The main problem which MATPFA suffers from is the high turnover of the work force because of discontent with the compensation rates. This problem is compounded by a lack of cross training among the workers. Aside from these manpower problems, the RCC functions smoothly and effectively.

The process of electronic repair in the RCC is very similar to the process used in private industry, though private companies usually benefit from economies of scale because they repair large volumes of like items. Some of the automated equipment in MATPFA is as state of the art as anything which the MDMSC team has seen in use in private industry. The workers in the RCC are very aware that the quality of their work has an effect on aircraft safety and this awareness contributes to a very low defect rate on repaired items. Because of this emphasis on quality, MDMSC would rate the quality of the electronic repair work done in MATPFA superior to that done in private industry.

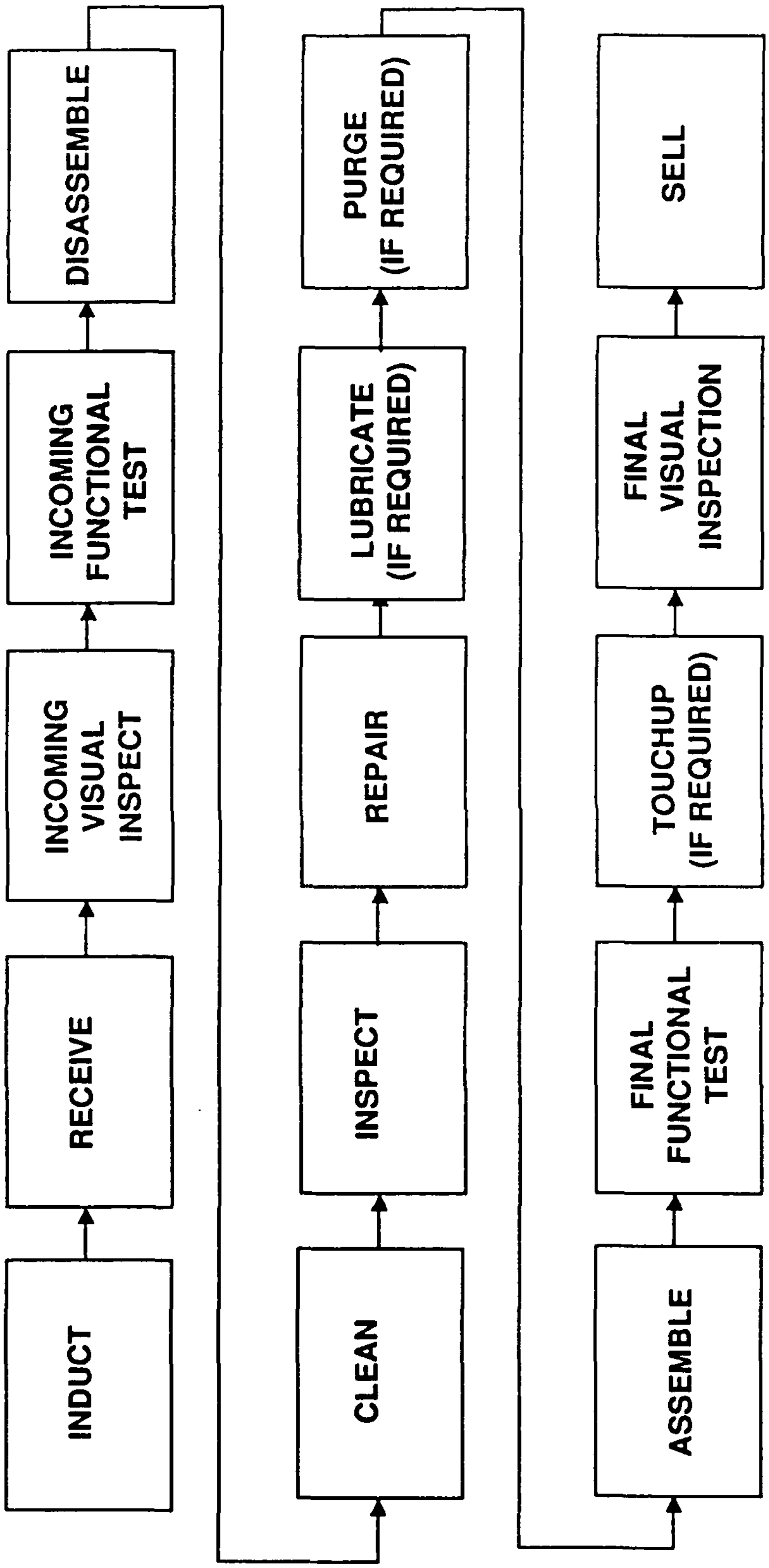
During initial characterization of the MATPFA RCC, a total of 25 improvement opportunities were identified (reference MATPFA Database Documentation Book (DDB) Improvements section). After review of this original set of opportunities by the MDMSC/ALC team, two improvement opportunities were selected to be pursued as quick fixes for the TI-ES program activities related to MATPFA.

These first two improvement opportunities deal with reducing the flow time of items repaired in MATPFA by (a) reducing the turnover in skilled mechanics, and (b) utilizing a work leader. They are described in detail under separate cover. Refer to paragraphs 6.11.1 and 6.11.2 of the Quick Fix Plan for their descriptions.

The balance of the original MATPFA improvement opportunities are described in paragraph 6.11.4 of this document.

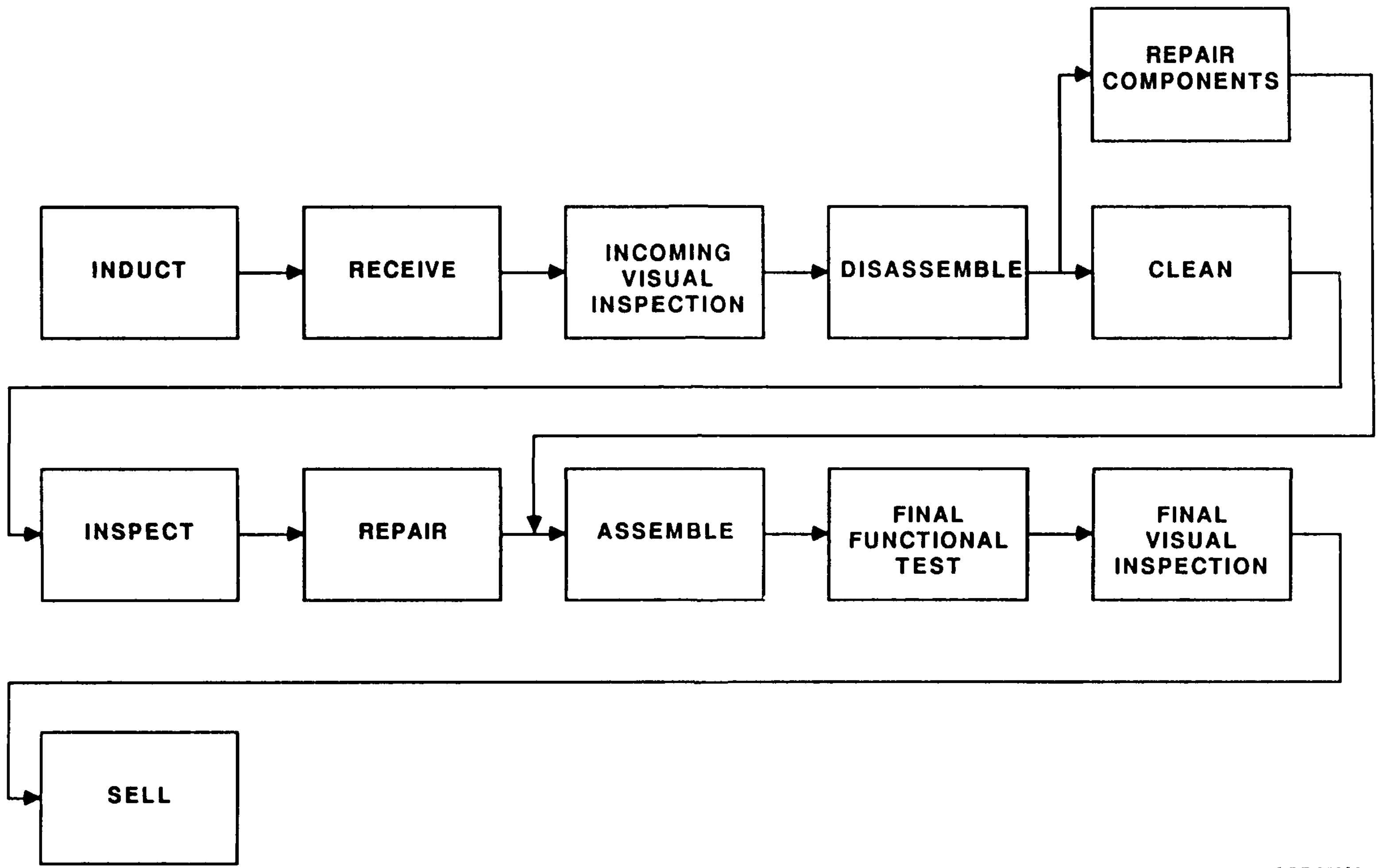
6.11.1 <u>Description of Current Operation</u>

The operations in MATPFA are typical of those used in commercial electronics repair, except that the repair procedure at OC-ALC usually calls out for only one person to be involved in the repair process from beginning to end. The basic flow of an item going through the repair process consists of testing the incoming item to determine what is wrong with it, repairing the item, and testing the repaired item to see that it functions properly. The items that are repaired in the autopilot unit (MATPFA) vary widely in their size and complexity. Generic flow diagrams showing the flow of typical items through MATPFA are shown in Figure 6.11.1-1 and Figure 6.11.1-2. In addition, the workload in this RCC is highly variable, with significant changes in the quarterly requirements for a PCN fairly



LSC-20428

OC-ALC MATPFA PROCESS FLOW CHART
FIGURE 6.11.1-1



LSC-20323

OC-ALC MATPFA PROCESS FLOW
(FOR ITEMS WHERE COMPONENTS ARE WORKED SEPARATELY FROM THE END ITEM)
FIGURE 6.11.1-2

common. It is the nature of the electronics industry to continuously make improvement and design changes; therefore, the workload in the MATPFA RCC is constantly in a state of change as new items are introduced and old items become obsolete.

Many of the items that are worked in these RCCs require a lengthy troubleshooting procedure to identify which component items are malfunctioning. The flow of an item is sometimes impacted because the mechanic doing the repair encounters a problem that he cannot solve. When this situation arises, a lengthy delay often occurs as the mechanic attempts to define the cause of the problem and what action can be taken to correct it. The mechanic often has to call over his supervisor or another mechanic for assistance, which adds to the delay. Because of the unpredictable condition the items are in when brought into the RCC, there are numerous instances where unique problems arise that nobody has dealt with before. These out-of-the-ordinary problems lengthen the time that it takes to repair an item, which inflates the repair cost for that item. The MDMSC team believes it would be beneficial to promote a mechanic in each RCC to the position of work leader, where this leader can help the other mechanics troubleshoot and repair items that do not respond when worked using the established repair procedures. This idea is addressed in paragraph 6.11.1 of the Quick Fix Plan for this RCC and applies also to RCCs MATPFE and MATPFF.

The electronics RCCs sometimes suffer a productivity loss when a mechanic transfers out because there is usually not another mechanic available who can step in and do the job. The supervisor in MATPFA operates under the theory that the greatest productivity can be achieved by assigning a mechanic to work a limited number of items, which allows him to become very proficient at repairing them. This system has a major drawback in that when a mechanic leaves the RCC, there is a drop in productivity while another mechanic learns the job. Unfortunately, the MATPFA RCC has a history of high turnover in manpower, which usually takes place because the mechanics can transfer out of the RCC to a higher paying position. The MDMSC team believes that a thorough evaluation of the labor grades specified for the jobs in the MATPFA RCC needs to be undertaken to insure the mechanics are being adequately compensated for the work they are doing relative to workers in other RCCs. It is our belief that a substantial investment has been made by OC-ALC to train the mechanics in the analysis techniques and repair processes used and that this investment should be protected by seeing that the mechanics receive a rate of pay that is compatible to that which is received in other RCCs. This idea is developed further in paragraph 6.11.2 of the Quick Fix Plan and also applies to RCCs MATPFE and MATPFF.

The MDMSC team believes that the operations within the RCC are successful in that high quality items are being produced on schedule. A main reason for this success is that the workers are trained well. They are sent to classes to insure that they remain current on the repair procedures to be used on the items processed through the RCC. The ever-changing nature of electronics demands a highly skilled work force that is knowledgeable and the MDMSC team believes that OC-ALC does an excellent job in keeping its workers trained in the state of the art repair methods that have been developed.

The success of the RCC can also be contributed in part to the relaxed working atmosphere within the RCC. The MDMSC team observed that the workers were not pressured by the supervisors. The supervisors made sure that the workers under them knew their assignments and then they left the workers on their own to complete those assignments. The workers were free to consult with other workers or the supervisor if they ran into problems. The workers are self-motivated and seem to like the challenge of troubleshooting and repairing an item on their own. The supervisors make themselves readily available to the workers, but the supervisors are often called away to meetings or are unavailable to the workers because of other reasons. The MDMSC team believes that a work leader is needed in the RCC and this situation is described in paragraph 6.11.1 of the Quick Fix Plan for MATPFA.

The success of the RCC's operations is also due to the commitment of the workers to turn out nothing less than a high-quality item. The workers that were interviewed by the MDMSC team showed a great deal of pride in what they do and emphasized the amount of care that they use to guarantee that the items which they work go out defect-free. The workers' pride and feeling of ownership are contributing factors to why the RCC has proven they are capable of getting high-quality items which they repair out in a timely manner, despite a constantly changing workload.

The equipment being used in the MATPFA RCC varies in age, but much of it is over 15 years old. The MATPFA, PFE, & PFF RCCs have a lot of common test equipment, such as voltmeters and oscilloscopes, as well as pieces of specialized test equipment that can only handle a family of like items, or in some cases, just a single item. The MDMSC team observed instances where bottlenecks were occurring because a piece of specialized equipment lacked a backup and this was causing queues to develop at the equipment. The MDMSC team will address those operations where we believe that additional equipment will reduce the repair flow time during the model experimentation process.

The MATPFA RCC has good storage capacity and many cabinets and racks are available for the storage of items. The present method of manually transporting parts works well, given the fairly small size of the items and the short distances involved. All of the work which is assigned to MATPFA takes place in Building 230. These facilities are adequate, though water stains on the ceiling of the MATPFA area indicate that there has been a problem with the roof leaking. The MATPFA RCC is scheduled to be moved out of Building 230 in the future.

A comparison of the existing RCC layout to the ALC -supplied blueprints was made by MDMSC. The blueprints were found to be outdated. The prints were marked up to reflect the As-Is floor layout and these corrected prints can be found in the brown folder included in the General Information section of the DDB. The items worked in the RCC are generally small which reduces the importance of utilizing the space within the RCC efficiently. The MDMSC team believes that the area allocated to the RCC is too big for its needs. In particular, the aisles in the RCC are much wider than they need to be. The workbench area given to each worker also appears to be excessive in most cases. The utility islands that exist between workbenches could be largely eliminated by running the utilities up from the floor or down from the ceiling for each individual workbench. The poor utilization of space in the RCC does not negatively affect its productivity, but the MDMSC team believes that when the RCC is moved out of Building 230, it can be moved into a substantially smaller area than what is allowed for it now.

Aside from the use of racks and shelves, very little utilization of vertical space takes place in the RCC. There does not appear to be a need to make more use of vertical storage given the present workload conditions within the RCC. Many mechanics have been supplied with storage bins which they use to store small, frequently used items. The RCC should wait until the workload becomes fairly stable before making any decisions concerning the purchasing of equipment to allow better utilization of vertical space.

The management structure used in the RCC during first shift seems to work well, with a section chief overseeing the activities taking place in MATPFA, as well as those in MATPFE and MATPFF. The RCC has a unit chief assigned to it, who supervises three first-line supervisors who are assigned to each of three subunits within the RCC. The MDMSC team believes that this structure is ideal for handling the day-to-day activities of the RCC because it allows the first-line supervisor to keep in close contact with the mechanics working under them and to assist them when it is required. There is also a section chief assigned to the swing shift who is responsible for over seeing the activities in MATPFA (as well as in MATPFE and MATPFF).

In addition to the supervision within the RCC, there are personnel assigned to support the RCC's operations in such areas as planning, scheduling, and engineering. The MDMSC team came away with the following impressions concerning the effectiveness of the support groups' activities relative to the operations in the RCC.

The planners seemed very involved in the day-to-day activities in the RCCs, but more interaction needs to take place between the planners and the workers to insure that incorrect or redundant information does not get out to the floor. The workers as a whole felt that they would benefit from the WCDs being more detailed. The workers also complained about the wordiness of some of the Technical Orders and the MDMSC team believes that more extensive use should be made of schematics and logic flow diagrams (refer to paragraph 6.11.4 for more information).

Scheduling appeared very good and most items are inducted in a manner which maintains a smooth flow of items through the repair process. The items come through the repair process in fairly consistent intervals and this helps to cut down on the amount of storage space that is needed in the RCC.

Engineering needs to improve their responsiveness to the workers' requests for changes. The workers that MDMSC interviewed pointed out several instances where improvements could be made in the methods used to repair an item, yet engineering had not yet responded to their requests for a review. There were also cases where worker suggestions to implement a design change on a component or an end item in order to make the repair process easier or quicker were not being acted upon in a timely manner. These delays may be due in part to the number of steps that have to be gone through to get a design change approved.

Material support in the RCC causes numerous process delays. There are delays being caused by components not being available when they are needed, but a much more common problem is that vendor supplied items are found to be defective after the repair process has been completed. The problem that plagues the RCC is not so much that items are not on hand when needed, but that good items are not available. The reworking of an item in order to get the repair activity completed is commonplace and results in increased flow times for the items in the RCC. This situation is addressed further in paragraph 6.11.4 of this document.

The tracking of items in the RCC is simplified by the fact that on most items, a single worker will work on the item from start to finish to repair it. The tracking of items is also made easier because the items do not leave the general area where the repair work is done. The items do sometimes leave the worker's control to have processes such as sealing or painting performed, but everything which is done to the items during repair takes place within a confined area of Building 230. This situation greatly enhances the ability of the supervisors to keep track of the progress of the items that are being repaired.

The tracking of items in the RCC is complicated by the use of supplementary WCDs which enables some work a worker would normally do to be assigned to another worker. The use of supplementary WCDs fluctuates depending upon the demand for certain items and the workers usually are allowed to make the decision as to whether they will work an item solely by themselves or send some of the component work out to be performed by others. The use of supplementary WCDs not only makes the tracking of an item more difficult, but also compounds the difficulty of entering archive WCD data into a simulation program such as the one developed by MDMSC. This is because the code used to identify the component work is often the same as that used for the end item work, resulting in the intermingling of the data. The supplementary WCD system gives the RCC flexibility in adapting its manpower to the work needing to be done, but more emphasis must be placed upon getting the workers to fill out the paperwork correctly so that the RCC's ability to track the processing of items accurately is not sacrificed.

6.11.2 Statistical System Performance Measures

The OC-ALC Technology Insertion Team met with ALC representatives during the week of 17 July 1989 to perform a statistical comparison of the UDOS 2.0 Model Simulation Output for RCC MATPFA to the historical throughputs and flow times for FY 88. Other criteria, such as the utilization of manpower and equipment, were also used to assess the validity of the database. A detailed discussion of this validation process for the RCC is included in the Model Validation section of the DDB. The joint validation team concluded that the statistics generated by the simulation model were within an acceptable range when compared to the As-Is condition. This model database represents the As-Is condition for FY 88 and can be used as a baseline for comparison purposes.

The throughput of items in MATPFA under the FY 88 workload averaged 99%. This figure is even more impressive when one considers that only three PCNs (48401A, 50254A, and 50274A) showed less than 94% throughput and these items were all low volume jobs that had a high fourth quarter induction rate.

The utilization of certain pieces of equipment in MATPFA was very low. Such infrequently used pieces of equipment as the temperature bath, the heat induction machine, and the servo amp tester only showed a utilization factor of 2%. The utilization of certain pieces of equipment, such as the PL0023 test panel (66%) and the T100855 alignment tool (61%) was high, but the utilization of most of the equipment (with the exception of the automatic test equipment) was below 25%.

The manpower within MATPFA is heavily utilized. If the manpower which is dedicated to the PL9911 temperature chamber and the P49933 test computer is not considered, the average utilization of manpower of all skill codes during the first shift is approximately 82%. The model shows the manpower on second shift being fully utilized.

The large queue on PCN 48396A can be attributed to the high utilization of the PL0023 test panel because 93% of the items end up having to wait for the use of this piece of equipment. The PL0023 panel also is partially responsible for the queues that delay the repair process on PCN 48426A. This item is first delayed during the assembly process because of the difficulty of gaining access to the T100855 tool, which hangs up almost 7% of the items being repaired. Another queue also develops on the subsequent testing operation, where 59% of the items are held up because the PL0023 panel is unavailable.

During the brainstorming process, ALC personnel expressed a desire to see what effect the amount of equipment and manpower would have upon the flow of items in MATPFA under the FY 90 workload. The pieces of equipment that were most heavily utilized were chosen as factors in the experimentation. The equipment selected to be evaluated was the P49933 testing computer and a set of equipment (the E107 pneumatic test set and the 704 controller sensor test set that are used in conjunction with each other). The utilization of manpower was high enough that the consensus of the validation group was that experimentation should be done with additional manpower to examine whether some queues might be reduced as a result of more manpower being available. Three additional workers of each skill code were added for this factor.

The L_4 Taguchi array constructed for the factors and levels chosen is shown in Table 6.11.2-1. The use of this array reduced the number of experimental runs needed to test these factors from eight to four. The table also shows the overall throughput percentages for the PCNs that were profiled (refer to the Experimentation section of the MATPFA DDB for a detailed report of the results produced for the individual PCNs). The table also lists the individual PCNs which showed the best and worst throughput under each experimental run.

MATPFA $L_4 (2^3)$ TAGUCHI ORTHOGONAL ARRAY THROUGHPUT EXPERIMENTAL RESULTS - FY 90

TABLE 6.11.2-1

EXP #	EQUIPMENT QUANTITY*	EQUIPMENT QUANTITY	MANPOWER ASSIGNED**	NORMAL WORKLOAD		
				AVG	BEST	WORST
1	(1) E107 (1) 704	(1) P49933 TEST CMPTR	AS-IS	99 %	50250A / 115%	50273A / 87%
2	(1) E107 (1) 704	(2) P49933 TEST CMPTR	ADD 9 MECH (3 EA CODE)	99 %	50250A / 115%	50273A / 87%
3	(2) E107 (2) 704	(1) P49933 TEST CMPTR	ADD 9 MECH (3 EA CODE)	99 %	50250A / 115%	50273A / 90%
4	(2) E107 (2) 704	(2) P49933 TEST CMPTR	AS-IS	99 %	50250A / 115%	50273A / 90%
RECOMMENDED	(1) E107 (1) 704	(1) P49933 TEST CMPTR	AS-IS			

NOTE: * EQUIPMENT E107 IS A PNUEMATIC TEST SET AND EQUIPMENT 704 IS A CONTROLLER SENSOR TEST SET. BOTH ARE USED CONCURRENTLY.

** ADDITIONAL MANPOWER ADDED TO FIRST SHIFT ONLY.

LSC-20476

The results produced by experimentation were surprising because the throughput produced by the different experimental runs were identical to that produced under the As-Is condition. The runs also showed the same PCNs producing the best and worst throughputs under each run. The difference in throughput percentages between the best and worst conditions seem to be attributable to the differences in the way the items were inducted during the two quarter experimental simulation period.

Since the throughput was identical between runs, further analysis was performed to determine how the different factors affected the average flow time for an item being repaired. See Table 6.11.2-2 for the array showing the flow time values for each run. Surprisingly, the flow times showed very little deviation from each other. Increases in manpower and equipment produced only minor improvements in flow time, indicating that there is presently sufficient resources to process the FY 90 workload through MATPFA. Considering the expense involved in buying more equipment or hiring additional workers, MDMSC believes that the As-Is condition is the recommended combination of levels for running the items. The recommended levels of the experimental factors that MDMSC believes will yield the best results when considering the investment involved is as follows:

<u>Recommended Configuration</u>

Factor:	Equipment (E107 plus 704)	Equipment (P49933)	Manpower
Level:	As-Is	As-Is	As-Is

To evaluate the RCC's ability to respond to surge conditions, the resource usage report was analyzed to determine whether the present levels of manpower and equipment were sufficient to meet the additional demands. Around-the-clock coverage was provided by putting the workers on 12-hour shifts and working them seven days a week to simulate surge conditions. To determine the workload under surge, the FY 90 workload was increased by the surge percentages that AFLC Headquarters provided to MDMSC.

MATPFA $L_4(2^3)$ TAGUCHI ORTHOGONAL ARRAY FLOW HOURS EXPERIMENTAL RESULTS - FY 90

TABLE 6.11.2-2

EXP #	EQUIPMENT QUANTITY	EQUIPMENT QUANTITY	MANPOWER ASSIGNED	NORMAL WORKLOAD
				AVERAGE FLOW HOURS
1	(1) E107 (1) 704	(1) P49933 TEST CMPTR	AS-IS	277.5
2	(1) E107 (1) 704	(2) P49933 TEST CMPTR	ADD 9 MECH (3 EA CODE)	273.3
3	(2) E107 (2) 704	(1) P49933 TEST CMPTR	ADD 9 MECH (3 EA CODE)	276.1
4	(2) E107 (2) 704	(2) P49933 TEST CMPTR	AS-IS	274.9

LSC-20479

The model shows that the equipment resources within MATPFA are sufficient to meet the requirements of war time surge conditions with the addition of a single worker. The work force would need to work 12-hour shifts, 7 days a week, to meet the surge demand.

6.11.3 Description of Process Problems

The intent of this paragraph is to expound on major process problems for which there are focus study recommendations. Since there are no major process problems identified for the MATPFA RCC at this time, improvement opportunities discussed in paragraph 6.11.1 are classified as other observations in this report or quick fixes in the Quick Fix Plan.

6.11.4 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist OC-ALC in developing ideas that will further enhance their repair operations.

The following observations were originally identified as Quick Fixes and Focus Study improvement opportunities, but after a review by the MDMSC/Air Force team, it was mutually agreed that they should be presented as other observations.

Environmental Improvement Opportunities

- Noise Abatement
  - Current Condition: Constant background noise makes it hard for mechanics to concentrate on their work.
  - MDMSC Recommendation: Use damping materials to cut down on the noise levels.

General Area Improvements

- Space Consolidation
  - Current Condition: The layout of the RCC takes up more space than is necessary.
  - MDMSC Recommendation: Allow the mechanics only as much workbench area as is necessary to do the job. Eliminate the island between workbenches if possible and reduce the width of the aisles.

- Ergonomic Seating
  - Current Condition: Mechanics are working while seated in desk-type swivel chairs, which usually results in the mechanic being too low relative to the height of the workbench. Many mechanics have used cushions to try to raise themselves up, but this seldom resolves the problem of the mechanics being in an uncomfortable working position.
  - MDMSC Recommendation: Purchase adjustable-height stools like those commonly used in the commercial electronics industry.

Operational Improvements

- Accuracy of Floor Documents
  - Current Condition: The Work Control Documents (WCDs) do not always accurately reflect the operations that are being done to an item to repair it.
  - MDMSC Recommendation: Review the WCDs on all items currently being repaired and correct them until they are true representations of how the items are being processed.

- Improvement of Repair Procedure Documentations
  - Current Condition: Many of the Technical Orders related to the repair of electronic components are very wordy, which often makes it difficult for a mechanic to find a specific repair procedure.
  - MDMSC Recommendation: Check all Technical Orders to see that they contain schematic diagrams. On complicated repair procedures, utilize logic flow diagrams similar to those used in computer programming to make the steps involved in the repair process easier to follow.

- Equipment Study
  - Current Condition: The RCC contains equipment that is not being utilized very much.
  - MDMSC Recommendation: Do a study of the equipment in the RCC to see if it is possible to eliminate some of it by modifying certain pieces so that more than a single part can be run on them. Examine whether it would be worthwhile to replace some of the older equipment with more modern equipment.

- Tooling Study
  - Current Condition: Some mechanics lack the proper tools to do the job, which inflates the flow time needed to repair the item.
  - MDMSC Recommendation: Study the RCC and determine what the tooling requirements are for the jobs that are in it. Make sure that the proper tools in sufficient amounts are provided to the mechanics. Examine whether the tools currently being used are the best suited to the task, paying particular attention to areas where power tools can be used in place of hand tools.

- Utilization of Board Turners
  - Current Condition: Mechanics who work on circuit boards position them manually during the repair process. The flipping and rotating of the board sometimes results in damage being done to some of the components on the board. The mechanic also requires extra time during the repair process because he has to hold onto the board with one hand while he works with his free hand.
  - MDMSC Recommendation: Supply the workers with board turners that will allow the worker to have freer use of his hands during the repair process. The turners should also reduce of damage done to the components on the board and reduce the time needed to repair the board.

- Eliminate the Reworking of Vendor Items
  - Current Condition: Mechanics who, during the course of their repair work, run into a defective vendor item sometimes rework these items in order to avoid an interruption in the repair process. The workers that MDMSC interviewed often stated that it took more time to go through the process of getting an item condemned and to get a replacement item in than what it took to rework the item to get it into an acceptable condition. The workers gave the MDMSC team the impression that two reasons why the existing procedures are not being used is that too much paperwork is required and replacement items are usually not readily available. The workers complained that there is often such a time lag in getting a replacement item in for one that has been rejected that the item under repair has to be stored. Upon the receiving of the needed component, the mechanic has to take time to retrieve the stored item and remember what point he was at in the repair process.

- MDMSC Recommendation: The ALC must get tough with its vendors and be willing to drop them if they are unable to prove that they can consistently provide a high-quality product. The present willingness to rework a vendor's items must be changed to a hard-nosed attitude where the ALC refuses to accept any items that are outside of the specifications that have been given to the vendor. The ALC can achieve major savings by simply refusing to devote its time and manpower to reworking nonconforming items that are sent in by vendors.

- <u>Change the Design of the Controller (PCN 50275A)</u>
  - Current Condition: The sensor part of the controller is pneumatically tested when the item is sent in and if it fails, the entire part goes into storage because the sensor itself cannot be repaired. There are presently over 200 controllers in storage and MDMSC believes that if the present situation is allowed to continue, aircraft will eventually be grounded because the available supply of items will run out.
  - MDMSC Recommendation: The sensor needs to be redesigned to allow it to be repaired. If this is done, the items currently being stored can be returned to service. If it is decided that a redesign is not practical, the inventory of sensors will have to be increased, though right now only enough sensors are being made to satisfy the demand on them for new aircraft.

- <u>Redesign the amplifier (PCN 48528A) or Change Components Used In It</u>
  - Current Condition: There is presently a problem with the transistor shorting out against the case of the transmitter. This situation causes an excessive amount of items to need repair.
  - MDMSC Recommendation: If the above problem can be resolved by changing the transistor being used, this should be tried. Otherwise, a design change should be made to eliminate this problem.

- Provide Sufficient Paperwork, Especially Technical Orders, to the Mecnanics
  - Current Condition: The MDMSC team was informed that in a few instances, especially where the procedure for repairing a component item was described in the same Technical Order as the procedure for repairing the end item, mechanics were sometimes delayed because they needed to reference the Technical Order and it was being used by someone else. An example where this occurs is the servo amplifier (PCN 48528A).
  - MDMSC Recommendation: The Technical Order should either be broken down or copied to ensure that information is available immediately to those people who might need it.

- Revise the Spec Limits in the Technical Order to Improve the First-Time Repair Quality
  - Current Condition: The spec limits specified for setting the microswitch of the signal convertor (PCN 48322A) provide too wide of a range and because of this, the mechanic often has to reset the microswitch during the repair process.
  - MDMSC Recommendation: Examine the problem and narrow down the spec limits if possible so that the microswitch only has to be set once.

- Modify the Signal Convertor (PCN 48322A) to Eliminate Items That No Longer Serve a Function to Reduce the Purchase Price
  - Current Condition: At one time, this item needed to be evacuated and this requirement resulted in the machining of the bottom plate so that it could accommodate a vacuum tube.
  - MDMSC Recommendation: Because the item no longer has to be evacuated, the machining of the plate and assembly of the tube are no longer needed. This information should be related to the vendor so that these manufacturing processes can be eliminated, which should reduce the price of any new signal convertors bought.

- Arrange for the End Item to be Repaired at the Same ALC Where the Components that go into it are Repaired
  - Current Condition: A signal convertor (PCN 48322A) can be repaired at OC-ALC and pass the final functional test yet fail when it is installed into the end item (the feel and trim chassis assembly) at SM-ALC. This situation increases the expense of repairing the item significantly.
  - MDMSC Recommendation: Allow the repair of the components and the end item to be done at the same site, which will allow the components to be tested in the end items, ensuring that the items will work properly.

- Streamline the Repair Process on the Computer Modules Used in the Couplers
  - Current Condition: The repair process on the modules is very time-consuming because of the time spent working on the crimped pins.
  - MDMSC Recommendation: Study the repair process and determine whether any of the tasks presently being done are unnecessary and can be eliminated.

Inventory/Sourcing

- Increase the Inventory Supply of the Amplifiers Used on the A2 Circuit Card
  - Current Condition: The repair process on the cards is sometimes being delayed because the mechanics do not have a replacement amplifier handy when it is needed.
  - MDMSC Recommendation: Increase the amount of amplifiers being kept on hand to eliminate delays being caused by the periodic shortages of this item.

- Go to Single Sourcing of Vendor Items when the Quality of Items sent in by One Vendor is Significantly Better than that of the Other
  - Current Condition: According to the information that was obtained in our interviews, there are numerous cases where an item is being supplied by multiple vendors and in many instances, one of the vendors ships a product that is easier to work with or more reliable than the others. Some of the items which the mechanics felt should be single sourced are listed below:
    - Make Portescap Transcoil the sole supplier of the tachometer-generator used in the synchros of the servo amplifier (PCN 48528A).
    - Make Howe the sole supplier of the synchro transmitter used in the signal convertor (PCN 48322A).
    - Make Dale the sole supplier of the variable resistor used in the servo amplifier (PCN 48528A).
  - MDMSC Recommendation: Keep records on the reliability of the items being supplied by each vendor so that an accurate comparison can be made to determine whether the benefits of single sourcing are worth the risks. It is also important to consider the mechanics thoughts on which items they believe are the easiest to work with.

- Take Steps to Ensure that All Components are sent in from the Field with the End Item
  - Current Condition: Some adapters (PCNs 48500A, 48540A) have been arriving at OC-ALC with the adjustment module missing, which inflates the flow time needed to repair the item.
  - MDMSC Recommendation: Check to see that items being sent in from the field have not been stripped of components.

Quality Improvements

- Improve the Packaging of Vendor Items so that more information Concerning the Manufacture of Each Item is Included
  - Current Condition: Usually, only the outer packaging of new parts has the supplier's contract number, vendor code, and date of manufacture. This identification may be lost if the part is removed from its outer packaging in order to be staged for installation. If, during installation, a part is found to be discrepant, a QDR may not result in supplier corrective action due to the lack of any of this I.D. information on the QDR.
  - MDMSC Recommendation: Mandate a general contract P.O. requirements that the above three pieces of I.D. be affixed to each part by the supplier per an acceptable method. The P.O. should also stipulate that the part(s) may be returned to the supplier whenever the outer package is opened and the noted I.D. information is missing. Implementation of this idea will produce the following benefits.
    - Suppliers will be required to take corrective action for every supplier related QDR.
    - All supplier related QDRs will be answered in a timely manner.
    - No parts still under warranty will be scrapped or repaired at the expense of the ALC.
    - There will be less down time from recurring discrepancies for new parts as suppliers are required to accept the responsibility for corrective action on QDRs with properly documented part identification.

- Improve the Recordkeeping of the RCC on Items Which are Condemned
  - Current Condition: Production operations generate scrap through a variety of causes. This scrap is ordinarily removed from the RCC for disposal, along with the accompanying WCDs.
  - MDMSC Recommendation: Each RCC should maintain a scrap logbook that lists each part as it is scrapped and the cause for scrapping the part. A periodic review of an RCC's scrap log book could be used to determine how to reduce excessive scrap by implementing methods to eliminate, or reduce, the repetitive causes for scrapping parts. By cutting down on the amount of items presently being scrapped, the RCC will increase the productivity of its manpower and equipment and reduce the amount of material being wasted.

- Develop a First In - First Out (FIFO) Inventory System
  - Current Condition: Supply receives and stores new supplier parts for subsequent distribution and usage by ALC shops. No stock rotation method is being used to assure a first in - first out distribution of these parts. New parts have a warranty that is valid for a specified period of time. This warranty becomes void when discrepant new parts are not discovered within this time period.
  - MDMSC Recommendation: Supply should date stamp every part, or the outer package of every part, as it is received. Supply should then store and rotate the new parts stock so that the oldest date stamped part is issued to the production shop first. Implementation of this idea would produce the following benefits:
    - Suppliers of discrepant parts under warranty will be required to replace or repair them at no cost to the ALC.
    - The discovery of numerous discrepant parts within a contract lot usually allows the ALC to return that entire lot to the supplier for parts screening and subsequent replacement or repair at the supplier's expense.
    - Supplier corrective action becomes more timely, responsive, and effective.

- Unreliable suppliers are eliminated early-on.
- Flow times on items will decrease because fewer discrepant parts will find their way to the production floor.

6.12 MATPFE ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

The MATPFE RCC is responsible for the repair of electronic and electro-mechanical aircraft engine instruments. A detailed description of the activities which take place in MATPFE is given in paragraph 6.12.1 of this document.

The RCC MATPFE has a number of assets which allow it to meet the demands placed upon it. The workers in this RCC are well trained and most have been working in the area for a long time. This high experience level results in the workers getting to know the repair procedures extremely well and because of this, high quality items are produced. The workers as a whole display good skills and motivation. The workers appear to enjoy the type of work that they do and are very conscientious in seeing that the items repaired have no defects. The working environment seems to be enjoyed by the workers and a good relationship exists between the workers and the supervisors. The supervisors in MATPFE do a good job of monitoring the activities within the RCC and providing the workers with assistance when it is needed.

The RCC benefits from having a relatively small percentage of one-of-a-kind equipment. Most processes have back-up equipment that can be used when the primary equipment is not available. The combination of a highly skilled work force with adequate equipment results in good throughput. The RCC is capable of maintaining good throughput under war time surge because the spreading of the manpower over two 12-hour shifts gives MATPFE the capacity to meet the requirements of war time surge.

The main problems which MATPFE suffers from is a high turnover of the work force because of discontent with the current compensation rates. This problem is compounded by a lack of cross training among the workers. Aside from these manpower problems, the RCC functions very smoothly and effectively.

The process of electronic repair in the RCC is very similar to the process used in private industry, though private companies usually benefit from economies of scale because they repair large volumes of like items. The workers in the RCC are highly aware that the quality of the work has an effect on aircraft safety and this awareness contributes to a very low defect rate on repaired items. Because of this emphasis on quality, MDMSC would rate the quality of the electronic repair work done in MATPFE superior to that done in private industry.

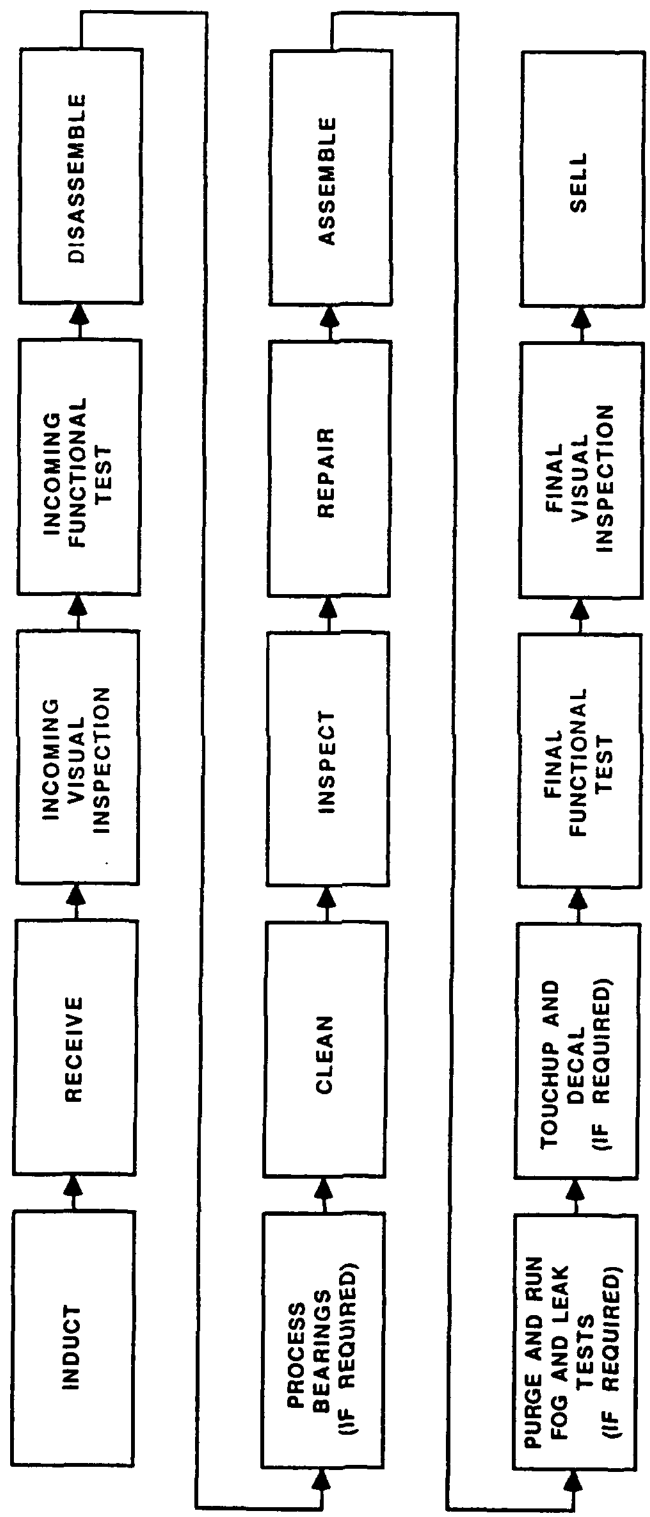
During initial characterization of the MATPFE RCC, a total of 27 potential improvement opportunities were identified (reference MATPFE Database Documentation Book, Potential Improvements section). After review of this original set of opportunities by the MDMSC/ALC team, three improvement opportunities were selected to be pursued as quick fixes relating to MATPFE.

The first two improvement opportunities, which deal with reducing the flow time of items repaired in MATPFE by reducing the turnover in skilled mechanics and by utilizing a work leader, have already been addressed in paragraphs 6.11.1 and 6.11.2 of the Quick Fix Plan for RCC MATPFA. The third opportunity, titled To Decrease the Flow Time to Repair the Pressure Ratio Transducer (PCN 45335A), recommends that a study be undertaken to determine whether the incoming functional test currently being performed should be eliminated or not. This opportunity is described in detail in paragraph 6.12.1 of the Quick Fix Plan for MATPFE.

The balance of the original MATPFE improvement opportunities are described in paragraph 6.12.4 of this document.

6.12.1 <u>Description of Current Operations</u>

The operations in MATPFE are typical of those used in commercial electronics repair, though the repair procedure at OC-ALC usually calls out for a single person to be involved in the repair process from beginning to end. The basic flow of an item going through the repair process consists of testing the incoming item to determine what is wrong with it, repairing the item, and testing the repaired item to see that it functions properly. The items that are repaired in the engine instrument unit (MATPFE) vary widely in their complexity. A generic flow diagram showing the flow of a typical item through MATPFE is shown in Figure 6.12.1-1. In addition, the workload in this RCC is highly variable, with significant changes in the quarterly requirements for a PCN fairly common. It is the nature



LSC-20248

OC-ALC MATPFE PROCESS FLOW
FIGURE 6.12.1-1

of the electronics industry to continuously make improvement and design changes; therefore, the workload in the MATPFE RCC is constantly in a state of change as new items are introduced and old items become obsolete.

Many of the items that are worked in these RCCs require a lengthy troubleshooting procedure to identify which component items are malfunctioning. The flow of an item is sometimes impacted because the mechanic doing the repair encounters a problem that he can not solve. When this situation arises, a lengthy delay often occurs as the mechanic attempts to define the cause of the problem and what action can be taken to correct it. The mechanic often has to call over his supervisor or another mechanic for assistance, which adds to the delay. Because of the unpredictable condition the items are in when brought into the RCC, there are numerous instances where unique problems arise that nobody has dealt with before. These out-of-the-ordinary problems lengthen the time that it takes to repair an item, which inflates the repair cost for that item. The MDMSC team believes that is would be beneficial to promote a mechanic in each RCC to the position of work leader, where this leader can help the other mechanics troubleshoot and repair items that do not respond when worked using the established repair procedures. This idea is addressed in paragraph 6.11.1 of the Quick Fix Plan for MATPFA.

The electronics RCCs sometimes suffer a productivity loss when a mechanic transfers out because there is usually not another mechanic available who can step in and do the job. The supervisors in MATPFE operates under the theory that the greatest productivity can be achieved by assigning a mechanic to work a limited number of items, which allows him to become very proficient at repairing them. This system has a major drawback in that when a mechanic leaves the RCC, there is a drop in productivity while another mechanic learns the job. Unfortunately, the MATPFE RCC has a history of high turnover in manpower, which usually takes place because the mechanic can transfer out of the RCCs to a higher paying position. The MDMSC team believes that a thorough evaluation of the labor grades specified for the jobs in the electronics RCCs needs to be undertaken to insure the mechanics are being adequately compensated for the work they are doing relative to what they do. It is our belief that a substantial investment has been made by OC-ALC to train the mechanics in the analysis techniques and repair processes used and that this investment should be protected by seeing that the mechanics receive a rate of pay that is compatible to that which is received in other RCCs. This idea is developed further in paragraph 6.11.2 of the Quick Fix Plan.

The MDMSC team noticed a number of problem areas in MATPFE which slowed down the flow of items that were being repaired. It was revealed to the MDMSC team that the incoming functional test that is called out on the pressure ratio transducer (PCN 45335A) may not provide the mechanic with any useful information. An investigation should be undertaken to see if this test can be eliminated. This subject is developed in detail and presented in paragraph 6.12.1 in the Quick Fix Plan for RCC MATPFE.

The MDMSC team believes that the operations within the RCC are successful in that high quality items are being produced on schedule. A main reason for this success is that the workers are well trained. They are sent to classes to insure that they remain current on the repair procedures to be used on the items processed through the RCC. The ever-changing nature of electronics demands a highly skilled work force that is knowledgeable and the MDMSC team believes that OC-ALC does an excellent job in keeping its workers trained in the state of the art repair methods that have been developed.

The success of the RCC can also be contributed in part to the relaxed working atmosphere within the RCC. The MDMSC team observed that the workers were not pressured by the supervisors. The supervisors made sure that the workers under them knew their assignments and then they left the workers on their own to complete those assignments. The workers were free to consult with other workers or the supervisor if they ran into problems. The workers in

MATPFE are self-motivated and seem to like the challenge of troubleshooting and repairing an item on their own. The supervisors make themselves readily available to the workers, but the supervisors are often called away to meetings or are unavailable to the workers because of other reasons. The MDMSC team believes that a work leader is needed in the RCC and this situation is described in paragraph 6.11.1 of the Quick Fix Plan for MATPFA.

The success of the RCC's operations is also due to the commitment of the workers to turn out nothing less than a high-quality item. The workers that were interviewed by the MDMSC team showed a great deal of pride in what they do and emphasized the amount of care that they use to guarantee that the items which they work go out defect-free. The workers' pride and feeling of ownership are contributing factors to why the workers are capable of producing high-quality items in a timely manner, despite a constantly changing workload.

The equipment being used in the MATPFE RCC varies in age, but much of it is over 15 years old. The MATPFA, PFE, & PFF RCCs have a lot of common test equipment, such as voltmeters and oscilloscopes, as well as pieces of specialized test equipment that can only handle a family of like items, or in some cases, just a single item. The MDMSC team observed instances where bottlenecks were occurring because a piece of specialized equipment lacked a backup and this was causing queues to develop at the equipment. The MDMSC team will address those operations where we believe that additional equipment will reduce the repair flow time during the model experimentation process.

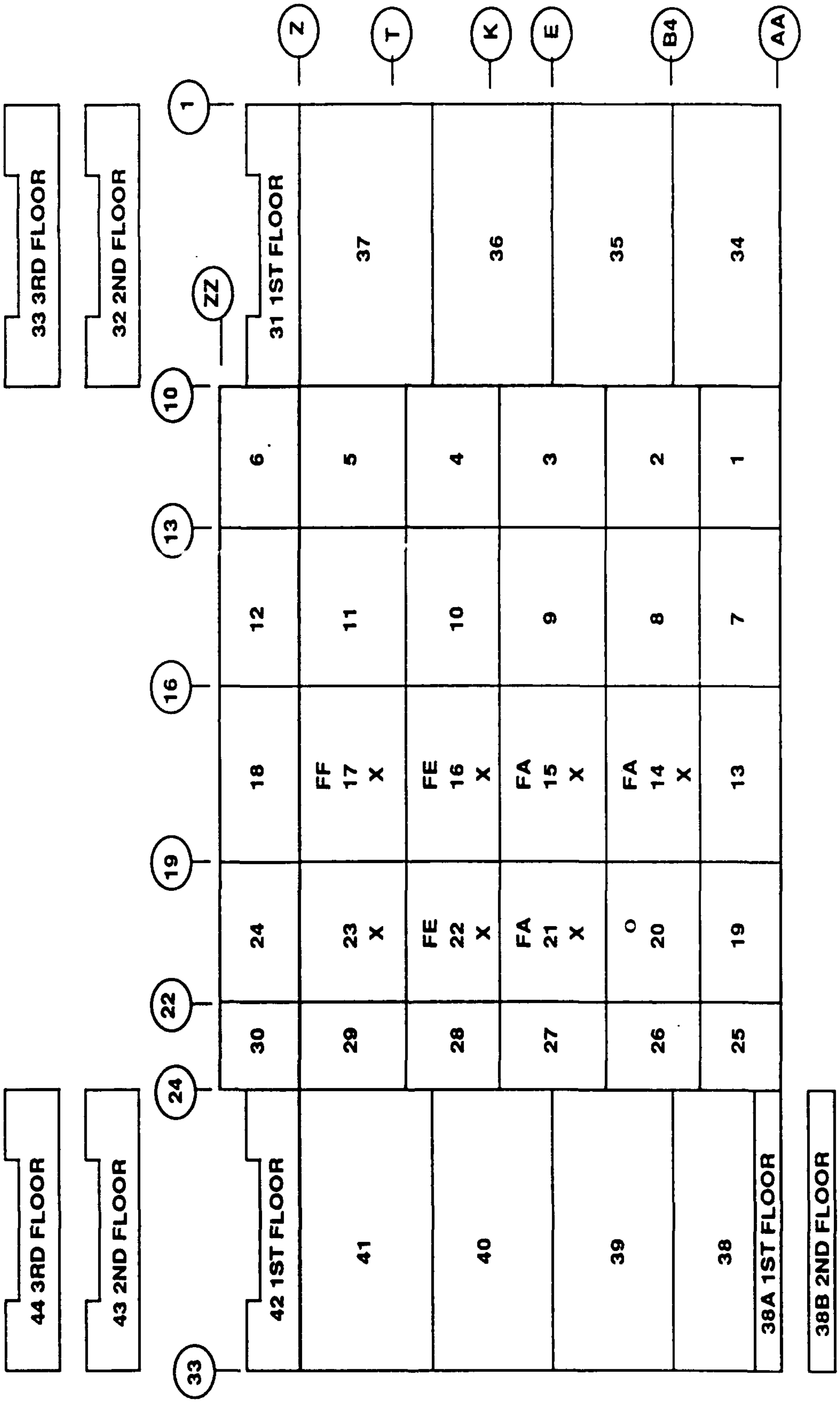
The MATPFE RCC has good storage capacity and many cabinets and racks are available for the storage of items. The present method of manually transporting parts works well, given the fairly small size of the items and the short distances involved. All of the work which is assigned to MATPFE takes place in Building 230. These facilities are adequate for the work which is being done. The RCC MATPFE is scheduled to be moved out of Building 230 in the future.

A comparison of the existing RCC layout to the ALC-supplied blueprints was made by MDMSC. The prints were found to be outdated. The prints were marked up to reflect the As-Is floor layout and these corrected prints can be found in the brown folder included in the General Information section of the DDB. Figure 6.12.1-2 shows a reference diagram giving the floor layout of Building 230. The items worked in the RCC are generally small which reduces the importance of utilizing the space within the RCC efficiently. The MDMSC team believes that the area allocated to the RCC is too big for its needs. In particular, the aisles in the RCC are much wider than they need to be. The workbench area given to each worker also appears to be excessive in most cases. The utility islands that exist between workbenches could be largely eliminated by running the utilities up from the floor or down from the ceiling for each individual workbench. The poor utilization of space in the RCC does not negatively affect its productivity, but the MDMSC team believes that when the RCC is moved out of Building 320, it can be moved into a substantially smaller area than what is allowed for it now.

Aside from the use of racks and shelves, very little utilization of vertical space takes place in the RCC. There does not appear to be a need to make more use of vertical storage given the present workload conditions within the RCC. Many mechanics have been supplied with storage bins which they use to store small, frequently used items. The RCC should wait until the workload becomes fairly stable before making any decisions concerning the purchasing of equipment to allow better utilization of vertical space.

The management structure used in the RCC during first shift seems to work well, with a section chief overseeing the activities taking place in MATPFE, as well as those in MATPFA and MATPFF. The RCC has a unit chief assigned to it, who supervises the three first-line supervisors who are assigned to each of the three subunits within each RCC. The MDMSC team believes that this

LSC-20335



REFERENCE DIAGRAM FOR FLOOR BLUEPRINTS AFFECTING MATPFE
FIGURE 6.12.1-2

structure is ideal for handling the day-to-day activities of the RCC because it allows the first-line supervisors to keep in close contact with the mechanics working under them and to assist them when it is required. There is also a section chief assigned to the swing shift who is responsible for overseeing the activities in MATPFE (as well as in MATPFA and MATPFF).

In addition to the supervision within the RCC, there are personnel assigned to support the RCC's operations in such areas as planning, scheduling, and engineering. The MDMSC team came away with the following impressions concerning the effectiveness of the support groups' activities relative to the operations in the RCC.

The planners seemed very involved in the day-to-day activities in the RCCs, but more interaction needs to take place between the planners and the workers to insure incorrect or redundant information does not get out to the floor. The workers as a whole felt that they would benefit from the WCDs being more detailed. The workers also complained about the wordiness of some of the Technical Orders and the MDMSC team believes that more extensive use should be made of schematics and logic flow diagrams (refer to paragraph 6.12.4 for more information).

Scheduling appeared very good and most items are inducted in a manner which maintains a smooth flow of items through the repair process. The items come through the repair process in fairly consistent intervals and this helps to cut down on the amount of storage space that is needed in the RCC.

Engineering needs to improve their responsiveness to the workers' requests for changes. The workers that MDMSC interviewed pointed out several instances where improvements could be made in the methods used to repair an item, yet engineering had not yet responded to their requests for a review. There were also cases where worker suggestions to implement a design change on a component or an end item in order to make the repair process easier or quicker were not being acted upon in a timely manner. These delays may be due in part to the number of steps that have to be gone through to get a design change approved.

Material support in the RCC causes numerous process delays. There are delays being caused by components not being available when they are needed, but a much more common problem is that vendor supplied items are found to be defective after the repair process has been completed. The problem that plagues the RCC is not so much that items are not on hand when needed, but that good items are not available. The reworking of an item in order to get the repair activity completed is commonplace and results in increased flow times for the items in the RCC. This situation is addressed further in paragraph 6.12.4 of this document.

The tracking of items in the RCC is simplified by the fact that on most items, a single worker will work on the item from start to finish to repair it. The tracking of items is also made easier because the items do not leave the general area where the repair work is done. The items do sometimes leave the worker's control to have processes such as sealing or painting performed, but everything which is done to the items during repair takes place within a confined area of Building 230. This situation greatly enhances the ability of the supervisors to keep track of the progress of the items that are being repaired.

The tracking of items in the RCC is complicated by the use of supplementary WCDs which enables some work a worker would normally do to be assigned to another worker. The use of supplementary WCDs fluctuates depending upon the demand for certain items and the workers usually are allowed to make the decision as to whether they will work an item solely by themselves or send some of the component work out to be performed by others. The use of supplementary WCDs not only makes the tracking of an item more difficult, but also compounds the difficulty of entering archive WCD data into a simulation program such as the one developed by MDMSC. This is because the code used to identify the component work is often the same as that used for the end item work, resulting in the intermingling of the data. The supplementary WCD system gives the RCC flexibility in adapting its manpower to the work needing to be done, but more emphasis must be placed upon getting the workers to fill out the paperwork correctly so that the RCC's ability to track the processing of items accurately is not sacrificed.

6.12.2 Statistical System Performance Measures

The OC-ALC Technology Insertion Team met with ALC representatives during the week of 17 July 1989 to perform a statistical comparison of the UDOS 2.0 Model Simulation Outputs for RCC MATPFE to the historical throughputs and flow times for FY 88. Other criteria, such as the utilization of manpower and equipment, were also used to assess the validity of the database. A detailed discussion of this validation process for the RCC is included in the Model Validation section of the Database Documentation Book (DDB). The joint validation team concluded that the statistics generated by the simulation model were within an acceptable range when compared to the As-Is condition. This model database represents the as-is condition for FY 88 and can be used as a baseline for comparison purposes.

The throughput of items in MATPFE under the FY 88 workload averaged 96%. Considering the high number of inductions, this throughput is very good, especially as the throughput on only five PCNs (41930A, 41933A, 50087A, 50115A, and 50292A) is below 90%.

The utilization of the equipment in MATPFE ranged from a low of 1% for such infrequently used equipment as the Bendix AC/DC insulation tester and the torque motor assembly test set. The utilization of some equipment, such as the Despatch thermal drying ovens and the Mensor test sets, ranged as high as 78%.

The manpower within MATPFE is heavily utilized. If the manpower which is dedicated to certain types of work (such as unsealing/sealing) or to certain types of machines (such as the purge and fill chamber) are not considered, the average utilization of manpower of all skill codes during first shift is approximately 76%. The model shows the manpower on second shift being fully utilized.

The large queues on PCN 50292A were primarily due to having only one temperature indicator test set available, but the fall-off in volume on this item has made this problem a moot point. The other large queues appear to be caused by items waiting on any of the three ovens (two manufactured by Despatch and one manufactured by Guidance Technology, Inc.) to perform the purge and fill operation. There is another oven (the Televac Temperature Chamber) that is not operational, but if hooked up, could help to relieve some of the queuing. The ALC said it would investigate why the oven is not being used and determine what action is necessary to make it operational.

During the brainstorming process, the ALC personnel expressed a desire to see the effect of changes in the amount of equipment and the assignment of manpower upon the flow of items in MATPFE under the FY 90 workload. The two pieces of equipment that were chosen as factors in the experimentation were the P87086 Mensor test set and the OC 1522 Guidance Technology purge and fill chamber. The Mensor set was originally listed as a unique piece of equipment during the profiling process, but during the validation process the MDMSC team was informed that the Mensor test sets (P87086, P87932, P93091, P93092, and P93093) are functionally interchangeable provided that the necessary set-up work is done to the unit to convert it over to run an item other than the one that it is normally set up to handle. The ALC personnel expressed a desire to see what effect the addition of another Mensor unit (one is currently on order) would have on the throughput of items in MATPFE.

The chamber was pinpointed as a bottleneck on the initial model runs, but during the validation process a joint decision was reached by the Air Force/MDMSC team to dedicate a worker to the chamber to reduce the queues.

This action greatly reduced the number of items that had to wait on the chamber and the amount of time that they spent waiting, but the ALC people still expressed the desire to see what effect an additional chamber would have on the model outputs.

Presently, the vast majority of manpower in MATPFE is assigned to first shift with a skeleton crew assigned to second shift. It was requested that the assignment of manpower be used as an experimental factor and an equal division of manpower between first and second shift was picked as the level to be tested.

The L_4 Taguchi array that was constructed for the factors and levels chosen is shown in Table 6.12.2-1. The use of this array reduced the number of experimental runs needed to test these factors from eight to four. The table also shows the overall throughput for the PCNs that were profiled (refer to the Experimentation of the MATPFE DDB for a detailed report of the results produced for the individual PCNs). This table also lists the individual PCNs which showed the best and worst throughput under each experimental run.

The results of experimentation showed that the throughput was approximately equal under all experimental conditions. The runs also showed the same PCNs producing the best and worst throughputs under each run. The difference in throughput percentages between the best and worst condition is only 15% (the large number of inductions helps to level out the throughput percentages), and this difference can be explained by the way in which items were inducted during the two quarter experimental simulation period.

Since the throughput was identical between runs, further analysis was performed to determine how the different factors affected the average flow time for an item being repaired. Refer to Table 6.12.2-2 for the array showing the flow time values for each run. The addition of an extra Mensor unit or another purge and fill chamber produced only small changes in the flow times, indicating that neither piece of equipment is a bottleneck in the processing of the FY 90 workload. However, the levelling of the manpower over two shifts rather than

MATPFE $L_4(2^3)$ TAGUCHI ORTHOGONAL ARRAY THROUGHPUT EXPERIMENTAL RESULTS - FY 90

TABLE 6.12.2-1

EXP #	EQUIPMENT QUANTITY	MANPOWER ASSIGNED*	EQUIPMENT QUANTITY	NORMAL WORKLOAD		
				AVG	BEST	WORST
1	(1) OC 1522 OVEN	AS-IS	(1) P87086 MENSOR TEST SET	100 %	45346A / 106%	49494A / 91%
2	(1) OC 1522 OVEN	LEVELED OVER 2 SHIFTS	(2) P87086 MENSOR TEST SET	100 %	45346A / 106%	49494A / 91%
3	(2) OC 1522 OVEN	AS-IS	(2) P87086 MENSOR TEST SET	99%	45374A / 106%	49494A / 91%
4	(2) OC 1522 OVEN	LEVELED OVER 2 SHIFTS	(1) P87086 MENSOR TEST SET	100%	45346A / 106%	49494A / 91%
RECOMMENDED	(2) OC 1522 OVEN	LEVELED OVER 2 SHIFTS	(1) P87086 MENSOR TEST SET			

NOTE: * TWO ADDITIONAL SEALERS (DESIGNATED UNDER LABOR CODES SL01 AND SL02) WERE ADDED WHEN MANPOWER WAS LEVELED OVER TWO SHIFTS.

LSC-20480

MATPFE $L_4(2^3)$ TAGUCHI ORTHOGONAL ARRAY FLOW HOURS EXPERIMENTAL RESULTS - FY 90

TABLE 6.12.2-2

EXP #	EQUIPMENT QUANTITY	MANPOWER ASSIGNED	EQUIPMENT QUANTITY	NORMAL WORKLOAD AVERAGE FLOW HOURS
1	(1) OC 1522 OVEN	AS-IS	(1) P87086 MENSOR TEST SET	264.9
2	(1) OC 1522 OVEN	LEVELED OVER 2 SHIFTS	(2) P87086 MENSOR TEST SET	247.0
3	(2) OC 1522 OVEN	LEVELED OVER 2 SHIFTS	(2) P87086 MENSOR TEST SET	272.0
4	(2) OC 1522 OVEN	LEVELED OVER 2 SHIFTS	(1) P87086 MENSOR TEST SET	247.2

LSC-20481A

concentrating it on the first shift produced a substantial reduction in the flow time per item. The division of manpower between shifts increased the probability of the needed manpower and equipment being available when the item needs them. Because the effect produced by the reassignment of manpower is so large relative to the effect of the other two factors, MDMSC recommends that more manpower be shifted from first to second shift. Because of the expense involved in buying more equipment, MDMSC feels that it would not be worthwhile to increase the amount of equipment from its existing levels. The levels of the experimental factors that MDMSC believes will yield the best results when considering the investment involved are as follows:

<u>Recommended Configuration</u>

Factor:	Equipment (OC 1522)	Assignment of Manpower	Equipment (P87086)
Level:	As-Is	Leveled over two shifts	As-Is

To evaluate the RCC's ability to respond to surge conditions, the resource usage report was analyzed to determine whether the present levels of manpower and equipment were sufficient to meet the additional demands.

Around-the-clock coverage was provided by putting the workers on 12-hour shifts and working them seven days a week to simulate surge conditions. To determine the workload under surge, the FY 90 workload was increased by the surge percentages provided by AFLC Headquarters.

The model shows that the existing amount of manpower and equipment is sufficient for MATPFE to meet the requirements of war time surge. The levelling of manpower over shifts helps to decrease the repair flow time on items (as was proven during experimentation) and allows MATPFE to meet the predicted demand.

6.12.3 Description of Process Problems

The intent of this paragraph is to expound on major process problems for which there are focus study recommendations. Since there are no major process problems identified for the MATPFE RCC at this time, improvement opportunities discussed in paragraph 6.12.1 are classified as other observations in this report or quick fixes in the Quick Fix Plan.

6.12.4 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist OC-ALC in developing ideas that will further enhance their repair operations.

The following observations were originally identified as Quick Fixes and Focus Study improvement opportunities, but after a review by the MDMSC/Air Force team, it was mutually agreed that they should be presented as other observations.

Environmental Improvement Opportunities

- Noise Abatement
  - Current Condition: Constant background noise makes it hard for mechanics to concentrate on their work.
  - MDMSC Recommendation: Use damping materials to cut down on the noise levels.

General Area Improvements

- Space Consolidation
  - Current Condition: The layout of the RCC takes up more space than is necessary.
  - MDMSC Recommendation: Allow the mechanics only as much workbench area as is necessary to do the job. Eliminate the island between workbenches if possible and reduce the width of the aisles.

- Ergonomic Seating
  - Current Condition: Mechanics are working while seated in desk-type swivel chairs, which usually results in the mechanic being too low relative to the height of the workbench. Many mechanics have used cushions to try to raise themselves up, but this seldom resolves the problem of the mechanics being in an uncomfortable working position.
  - MDMSC Recommendation: Purchase adjustable-height stools like those commonly used in the commercial electronics industry.

Operational Improvements

- Accuracy of Floor Documents
  - Current Condition: The Work Control Documents (WCDs) do not always accurately reflect the operations that are being done to an item to repair it.
  - MDMSC Recommendation: Review the WCDs on all items currently being repaired and correct them until they are true representations of how the items are being processed.

- Improvement of Repair Procedure Documentations
  - Current Condition: Many of the Technical Orders related to the repair of electronic components are very wordy, which often makes it difficult for a mechanic to find a specific repair procedure.
  - MDMSC Recommendation: Check all Technical Orders to see that they contain schematic diagrams. On complicated repair procedures, utilize logic flow diagrams similar to those used in computer programming to make the steps involved in the repair process easier to follow

- Equipment Study
  - Current Condition: The RCC contains equipment that is not being utilized very much.
  - MDMSC Recommendation: Do a study of the equipment in the RCC to see if it is possible to eliminate some of it by modifying certain pieces so that more than a single part can be run on them. Examine whether it would be worthwhile to replace some of the older equipment with more modern equipment.

- Tooling Study
  - Current Condition: Some mechanics lack the proper tools to do the job, which inflates the flow time needed to repair the item.
  - MDMSC Recommendation: Study the RCC and determine what the tooling requirements are for the jobs that are in it. Make sure that the proper tools in sufficient amounts are provided to the mechanics. Examine whether the tools currently being used are the best suited to the task, paying particular attention to areas where power tools can be used in place of hand tools.

- Utilization of Board Turners
  - Current Condition: Mechanics who work on circuit boards position them manually during the repair process. The flipping and rotating of the board sometimes results in damage being done to some of the components on the board. The mechanic also requires extra time during the repair process because he has to hold onto the board with one hand while he works with his free hand.
  - MDMSC Recommendation: Supply the workers with board turners that will allow the worker to have freer use of his hands during the repair process. The turners should also reduce damage done to the components on the board and reduce the time needed to repair the board.

- Eliminate the Reworking of Vendor Items
  - Current Condition: Mechanics who, during the course of their repair work, run into a defective vendor item sometimes rework these items in order to avoid an interruption in the repair process. The workers that we interviewed often stated that it took more time to go through the process of getting an item condemned and to get a replacement item in than what it took to rework the item to get it into an acceptable condition. The workers gave the MDMSC team the impression that two reasons why the existing procedures are not being used is that too much paperwork is required and replacement items are usually not readily available. The workers complained that there is often such

a time lag in getting a replacement item in for one that has been rejected that the item under repair has to be stored. Upon the receiving of the needed component, the mechanic has to take time to retrieve the stored item and remember what point he was at in the repair process.

- MDMSC Recommendation: The ALC must get tough with its vendors and be willing to drop them if they are unable to prove that they can consistently provide a high-quality product. The present willingness to rework a vendor's items must be changed to a hard-nosed attitude where the ALC refuses to accept any items that are outside of the specifications that have been given to the vendor. The ALC can achieve major savings by simply refusing to devote its time and manpower to reworking nonconforming items that are sent in by vendors.

- <u>Utilization of Quick-Connect Wires</u>
  - Current Condition: The repair procedure on the transmitter (PCN 49739A) is very time-consuming, mainly because the amount and length of the wiring that is in the case makes it difficult to operate on many of the components needing repair.
  - MDMSC Recommendation: Examine whether the use of wires that can be connected and disconnected quickly might be incorporated into the design to make components more accessible.

- <u>Better Training and Equipping of Flight Line Mechanics</u>
  - Current Condition: The mechanics on the flight line are doing things which are causing extra work to have to be done on items by the mechanics in MATPFE.
  - MDMSC Recommendation: Take steps to ensure that all flight line mechanics are thoroughly trained in the correct removal and installation techniques for items that they work on. Provide the mechanics with the proper tools needed to apply these techniques.

- Determination of Component Location on Circuit Boards
  - Current Condition: On certain items the positioning of the resistors away from the circuit boards is causing problems with reliability because an excessive amount of resistors are shorting out.
  - MDMSC Recommendation: Study how the life of the components can be improved by altering the distance between them and the circuit board and decide on optimal heights at which to set each. Industry practice is to follow up on such problems with corrective action requests.

- Reduce Repairs to the Lowest Level Possible
  - Current Condition: Mechanics are replacing the entire connectors on items when in some cases it is only defective guide pins that are causing the problem.
  - MDMSC Recommendation: Establish a repair procedure whereby the defective pins in a connector can be replaced.

- Utilization of Fixture for Drilling Yokes
  - Current Condition: When it is necessary to replace a yoke on the EPR Transducer (PCN 48703A), the mechanic has to match drill the holes in the inner and outer yokes to insure alignment. This operation, while not done frequently, is very time-consuming because of the lack of proper fixturing.
  - MDMSC Recommendation: Build or purchase from the manufacturer a fixture to speed up the drilling of the yokes.

- Purchase of Proper Tooling for Work Being Done on the EPR Transducer (PCN 48703A)
  - Current Condition: When it is necessary to replace the transducer housing, the four magnets are salvaged from the old housing for use. Sometimes the mechanic is unable to screw the magnets in as far as they are supposed to go. The mechanic also has to remove a plug from the transducer in order to replace a filter seal. He is presently using a hammer, which sometimes results in damage being done to the item.
  - MDMSC Recommendation: To resolve the problem of getting the magnets to fit into the new housings, either tighter specifications should be given to the housing manufacturer on the hole sizes or else a tap should be provided to the mechanic. The mechanic should also be provided with a spanner wrench to use to remove and reassemble the plug.

- Eliminate the Polishing of Shafts by Vendors on the EPR Transducer (PCN 48703A)
  - Current Condition: The vendor apparently is polishing down the shafts to put the gears on, which is causing excessive play and increasing the amount of repair work that has to be done.
  - MDMSC Recommendation: Advise vendor of the problem that his manufacturing methods are causing and work together to resolve it.

- Better Protect Fragile Vendor Items
  - Current Condition: The cover glass that is used on the tachometer indicator (PCN 41933A) is often broken by the time that it is received by the mechanic in MATPFE for use.
  - MDMSC Recommendation: Have the vendor use bubble wrap or other protective material to cushion the glass.

- Improve Design of EPR Transducer (PCN 41901A)
  - Current Condition: The repair procedure on the transducer is usually lengthy because the components are hard to get at and because a lot of vibration damage occurs.
  - MDMSC Recommendation: The repair process would be shortened significantly if the item was redesigned to make the components more accessible and to increase the space between components that have shown a history of rubbing against each other. The redesign of the transducer should produce benefits by reducing the number of components needing repair and by making it easier to get at the components that do need it.

- Dampen the Initial Pointer Movement When Gauges are First Activated
  - Current Condition: The rapid movement of the pointer in certain gauges when the gauge is initially powered up is so severe that the pointer becomes loose. The mechanics apply glyptal (an adhesive) to the shaft during the repair process to correct this problem.
  - MDMSC Recommendation: Have the manufacturer of the gauges redesign it so that the pointers don't "jump" when initially activated. Dampening of this movement would eliminate the need to secure the pointer back onto the shaft.

Inventory/Sourcing

- Increase the Inventory Supply of Certain Commonly Used Items
  - Current Condition: The repair process on many items is interrupted because of a mechanic not having a component handy when it is needed. Sometimes the mechanics have to wait a month or more before a component that they need to complete a repair comes in, which means that a mechanic will have to take time to figure out where he was at in the repair process when the item does finally come in. There is also the chance of an item getting damaged while it is awaiting components.

- MDMSC Recommendation: A mechanic's work flow is interrupted when he is delayed because of a needed component not being handy and this makes the flow time to repair an item longer than it has to be. The ALC needs to take steps to see that the mechanics do not run out of the items that they need to make the repairs. Items that were reported by the mechanics as being in short supply in MATPFE include:
  - The center contacts and attaching screws used in the EPR transducer (PCN 48703A).
  - The small hole, no flange bearings used in the tachometer indicator (PCN 41933A).
  - The jewel bearings and housing assemblies used in the tachometer indicator (PCN 49587A).
  - The flex circuits and circuit back plates used in the EPR transducer (PCN 41901A).

- <u>Purchase Selected Components Already Preassembled</u>
  - Current Condition: On certain items, the mechanics are receiving components separately and having to take the time to assemble these items together prior to their use in the repair process.
  - MDMSC Recommendation: Having these items preassembled by the vendor would expedite the repair process by freeing the mechanic from tasks where his skills are not being used to the best advantage. Considering the pay and fringe benefits given to the mechanics, we believe that this assembly work can be done cheaper at an outside source than at the ALC. Some cases that should be examined to see whether it would be cost justified to bring the items in preassembled (provided that the vendor would agree to the arrangement) are:
    - Purchase of the speed decreaser gear assembly of the transmitter synchronizer used in the transmitter (PCN 49739A) with the spur gear and hub preassembled to it.
    - Purchase of the clutch gear used in the EPR Transducer (PCN 41901A) with the bearing preassembled and torqued to it.

Quality Improvements

- Improve the Packaging of Vendor Items so that more information Concerning the Manufacture of Each Item is Included
  - Current Condition: Usually, only the outer packaging of new parts has the supplier's contract number, vendor code, and date of manufacture. This identification may be lost if the part is removed from its outer packaging in order to be staged for installation. If, during installation, a part is found to be discrepant, a QDR may not result in supplier corrective action due to the lack of any of this I.D. information on the QDR.
  - MDMSC Recommendation: Mandate a general contract P.O. requirements that the above three pieces of I.D. be affixed to each part by the supplier per an acceptable method. The P.O. should also stipulate that the part(s) may be returned to the supplier whenever the outer package is opened and the noted I.D. information is missing. Implementation of this idea will produce the following benefits.
    - Suppliers will be required to take corrective action for every supplier related QDR.
    - All supplier related QDRs will be answered in a timely manner.
    - No parts still under warranty will be scrapped or repaired at the expense of the ALC.
    - There will be less down time from recurring discrepancies for new parts as suppliers are required to accept the responsibility for corrective action on QDRs with properly documented part identification.

- Improve the Recordkeeping of the RCC on Items Which are Condemned
  - Current Condition: Production operations generate scrap through a variety of causes. This scrap is ordinarily removed from the RCC for disposal, along with the accompanying WCDs.

- MDMSC Recommendation: Each RCC should maintain a scrap logbook that lists each part as it is scrapped and the cause for scrapping the part. A periodic review of an RCC's scrap logbook could be used to determine how to reduce excessive scrap by implementing methods to eliminate, or reduce, the repetitive causes for scrapping parts. By cutting down on the amount of items presently being scrapped, the RCC will increase the productivity of it's manpower and equipment and reduce the amount of material being wasted.

- Develop a "First In - First Out" (FIFO) Inventory System
  - Current Condition: Supply receives and stores new supplier parts for subsequent distribution and usage by ALC shops. No stock rotation method is being used to assure a "first in - first out" distribution of these parts. New parts have a warranty that is valid for a specified period of time. This warranty becomes void when discrepant new parts are not discovered within this time period.
  - MDMSC Recommendation: Supply should date stamp every part, or the outer package of every part, as it is received. Supply should then store and rotate the new parts stock so that the oldest date stamped part is issued to the production shop first. Implementation of this idea would produce the following benefits:
    - Suppliers of discrepant parts under warranty will be required to replace or repair them at no cost to the ALC.
    - The discovery of numerous discrepant parts within a contract lot usually allows the ALC to return that entire lot to the supplier for parts screening and subsequent replacement or repair at the supplier's expense.
    - Supplier corrective action becomes more timely, responsive, and effective.
    - Unreliable suppliers are eliminated early-on.
    - Flow times on items will decrease because fewer discrepant parts will find their way to the production floor.