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Technology Insertion (TI)/Industrial Process Improvement (IPI) Summary Report for AGMC. This document contains Focus Study and Quick Fix Recommendations for 1 Resource Control Centers (RCC's). These RCC's are: MAPBGA (Gyroscopic Repair).

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VOLUME II
AGMC

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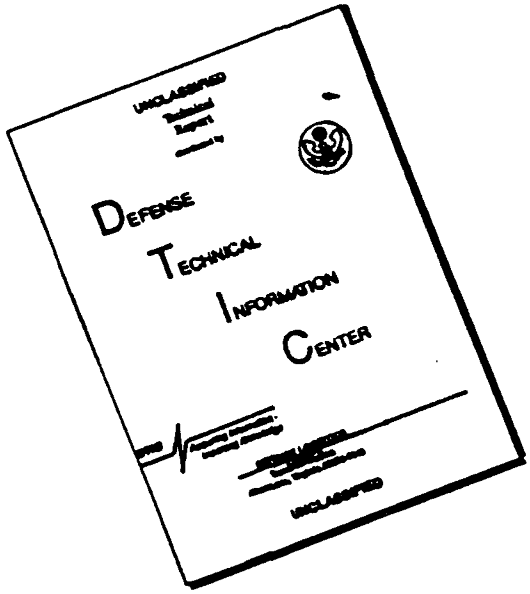

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LIST OF ACRONYMS AND ABBREVIATIONS

AFLC	AIR FORCE LOGISTICS COMMAND
AFLC/MA	AIR FORCE LOGISTICS COMMAND DIRECTORATE OF MAINTENANCE
AGMC	AEROSPACE GUIDANCE AND METROLOGY CENTER
ALC	AIR LOGISTICS CENTER
ATE	AUTOMATIC TEST EQUIPMENT
CAD	COMPUTER-AIDED DESIGN
CSR	CONTRACT SUMMARY REPORT
FSR	FOCUS STUDY RECOMMENDATION
FY	FISCAL YEAR
GRU	GYROSCOPIC REFERENCE UNIT
IE	INDUSTRIAL ENGINEER
JON	JOB ORDER NUMBER
LIFT	LOGISTICS IMPROVEMENT OF FACILITIES AND TECHNOLOGY
MAP	MAINTENANCE PRODUCTION DIVISION
MDC	MCDONNELL DOUGLAS CORPORATION
MDGATS	MULTIPLE DISPLACEMENT GYRO AUTOMATED TEST SYSTEMS
MDMSC	MCDONNELL DOUGLAS MISSILE SYSTEMS COMPANY
MISTR	MANAGEMENT OF ITEMS SUBJECT TO REPAIR
MTBF	MEAN TIME BETWEEN FAILURES
MTTR	MEAN TIME TO REPAIR
PAC	PRODUCTION ACCEPTANCE CERTIFICATION
PRAM	PRODUCTIVITY, RELIABILITY, AVAILABILITY AND MAINTAINABILITY
QFP	QUICK FIX PLAN
RCC	RESOURCE CONTROL CENTER
RDGATS	REFURBISHED DISPLACEMENT GYROSCOPE AUTOMATED TEST STATIONS
ROI	RETURN ON INVESTMENT
SAMP	STATION AVAILABILITY MAINTENANCE PROGRAM

TI-ES	TECHNOLOGY INSERTION-ENGINEERING SERVICES
TO	TASK ORDER
TQM	TOTAL QUALITY MANAGEMENT
UDOS 2.0	UNIVERSAL DEPOT OVERHAUL SIMULATOR 2.0
WIP	WORK IN PROCESS
WR-ALC	WARNER ROBINS AIR LOGISTICS CENTER

AGMC CONTRACT SUMMARY REPORT

5.0 AEROSPACE GUIDANCE AND METROLOGY CENTER (AGMC)

During the fourth quarter 1988, McDonnell Douglas Missile Systems Company (MDMSC) completed process baseline development of Resource Control Center (RCC) MAPBGA at AGMC at Newark, Ohio. The process baseline development effort was performed as a part of the Technology Insertion-Engineering Services (TI-ES) Program.

Process baseline development revealed that opportunities for improvement exist at MAPBGA. After review of the identified improvement opportunities recorded by MDMSC during process baseline development, it was discovered that many of the areas had already been addressed by AGMC management. These areas will be pursued no further. The focus study and quick fix areas which were defined and pursued are described in paragraphs 5.1 through 5.1.6 of the Contract Summary Report (CSR) and within paragraphs 1.0 through 2.8 of the Quick Fix Plan (QFP). A summary of focus studies and quick fixes is provided in Tables 5.0-1 and 5.0-2.

The Air Force identified RCC MAPBGA to have its process baseline developed and analyzed. MDMSC reviewed 100% of the current workload repair processes for two purposes: first, to establish an operational baseline from which improvements can be measured and second, to identify technological improvements to assist the base command in meeting its commitments.

The MDMSC team has developed a good working relationship with the Gyroscopic Reference Unit (GRU) repair operations personnel. GRU personnel were instrumental in the success of the site survey tasks such as data collection, shop floor interviews and review of facility layouts. These tasks provide the basis to characterize the operation of RCC MAPBGA at AGMC and allows for the identification of process improvement opportunities. MDMSC appreciates the excellent cooperation received from the entire AGMC team. The AGMC/MDMSC team is shown in Figure 5.0-1.

AGMC FOCUS STUDY RECOMMENDATION SUMMARY

TABLE 5.0-1

MDMSC RECOMMENDATION	IMPACT	ANNUAL BUDGET SAVINGS	COST AVOIDANCE			INVESTMENT COST
			FLOW TIME REDUCTION	WIP INVENTORY REDUCTION*	FLOOR SPACE REDUCTION	
IMPROVE GYRO REPAIR METHODS	DIRECT LABOR SAVINGS (DLS), ENVIRONMENTAL IMPROVMENT	$245,158**	0 DAYS	$ 0	0 SQ. FT.	$341,122**
IMPROVE ATE UTILIZATION	DLS	$1,048,006**	0 DAYS	$ 0	0 SQ. FT.	$281,000**
TOTALS		$1,293,164**				$622,122**

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

** SAVINGS AND INVESTMENT COSTS ARE ATTRIBUTABLE TO RECOMMENDATIONS BEING IMPLEMENTED AT MAPBGA/AGMC AND MANPGB/WR-ALC

LSC-20578

AGMC QUICK FIX RECOMMENDATION SUMMARY

TABLE 5.0-2

MDMSC RECOMMENDATION	IMPACT	ANNUAL BUDGET SAVINGS	COST AVOIDANCE			INVESTMENT COST
			FLOW TIME REDUCTION	WIP INVENTORY REDUCTION*	FLOOR SPACE REDUCTION	
STANDARDIZE GRU DECAL TAPE	DIRECT LABOR SAVINGS (DLS)	$14,557	0 DAYS	$ 0	0 SQ. FT	**
IMPROVE 2171s RESEALING CONSISTENCY	DLS	$14,557	0 DAYS	$ 0	0 SQ. FT	**
IMPROVE CN 1375 WHEEL VACUUM PUMPDOWN	DLS	$10,455	0 DAYS	$ 0	0 SQ. FT	**
ENHANCE CN1375 BEARING ASS'Y PRELOAD	DLS.	$5,228	0 DAYS	$ 0	0 SQ. FT	**
ELIMINATE MECHANICAL WIRE STRIPPING	DLS	$4,997	0 DAYS	$ 0	0 SQ. FT	**
DETERMINE VIABLE REPLACEMENT FOR ACETONE	IMPROVE SAFETY, ENVIRONMENT	NQ	NQ	NQ	NQ	NQ
DETERMINE UNIFORM WHEEL RUN-IN TEST	DLS	NQ	NQ	NQ	NQ	NQ
DETERMINE FEASIBILITY OF CONSISTENT, COMMAND-WIDE COMPUTER BASED TRAINING	IMPROVE WORKFORCE TRAINING	NQ	NQ	NQ	NQ	NQ
TOTALS		$49,794				*** $ 9859

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

** NOT SEPARATELY PRICED

*** TOTAL FOR ALL QUICK FIXES ESTIMATED AT 20% OF COMBINED ANNUAL BUDGET SAVINGS

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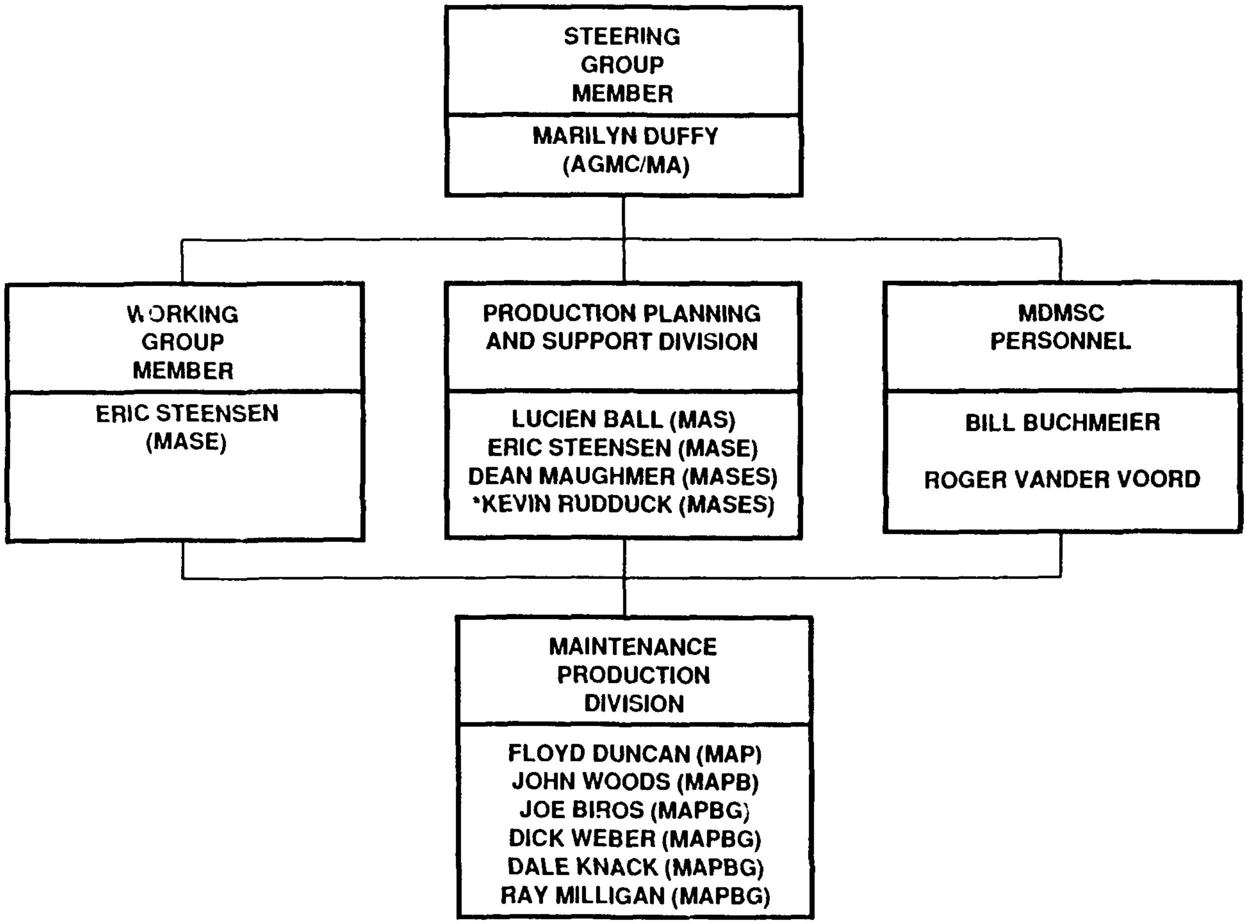

* POC FOR SUPPORT DIV. BASELINE & ENGINEERING (AUTOVON 346-7571)

AGMC/MA TECHNOLOGY INSERTION TASK ORDER NO. 1 ORGANIZATION CHART
FIGURE 5.0-1

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This CSR presents an overview of the MDMSC effort and details recommendations to improve AGMC performance.

Ten improvement opportunities, two focus studies and eight quick fixes, relating to gyroscope repair were selected as the focus of the MAPBGA TI-ES Program activities. The first focus study, titled RCCs MAPBGA/AGMC and MANPGB/WR-ALC To Determine Improved Methods to Unseal, Depaint, Seal, Leak Check and Paint GRUs, detailed in paragraph 5.1.4, proposes an analysis of the subject GRU repair process technology to develop productivity and safety improvement recommendations. An estimated annual cost savings of $245,158 may be realized by implementation of this focus study within both RCCs.

A second focus study, titled RCCs MAPBGA/AGMC and MANPGB/WR-ALC to Improve Utilization of Gyro Automatic Test Equipment (ATE), detailed in paragraph 5.1.5, proposes investigation of maintenance problems associated with these RCCs ATE to determine efficient methods to improve the utilization of the sophisticated automated test stations. An estimated annual cost savings of $1,048,006 may be realized by the command-wide implementation of this focus study within AGMC and WR-ALC gyro section RCCs.

The eight quick fixes applicable to RCC MAPBGA are summarized below with their respective estimated cost savings.

- Standardize the GRU Cover Decal Tape Material at AGMC recommends a single 3M brand film tape such as "Scotchcal" should be utilized for all decal applications due to its durability, ease of application and removal, and minimum adhesive residue characteristics. Yearly savings of $14,557 may be realized.
- Eliminate Mechanical Stripping of GRU Flex Wire Leads at AGMC proposes flex leads be purchased pre-stripped and tinned or a separate, well-ventilated workstation be set up to chemically strip off the wire insulating material with sodium hydroxide or alternate solution. Yearly savings of $4,997 may be realized.
- Determine Possible Replacement for Acetone as a Solder Flux Removal Agent at AGMC recommends introducing viable, less hazardous solder

flux cleaning solutions where applicable. Yearly savings are not quantifiable for this safety related quick fix opportunity.

- Utilize Uniform Cycle Times To Perform Gyroscopic Wheel Run-In Test proposes test data be gathered and analyzed by a QP4 team to determine a uniform test procedure of shorter duration. Yearly savings are unquantifiable until the feasibility of a uniform test procedure is approved for each GRU PCN application.
- Improve CN1375 Wheel Assembly Vacuum Pumpdown and Refill Operation recommends a QP4 task team evaluate control factors affecting the Veeco system performance and determine necessary corrective action to eliminate the current secondary test restart procedure. Yearly savings of $10,455 may be realized.
- Enhance the CN1375 Bearing Assembly Preload Method recommends developing some minor fixturing revisions to improve throughput and accuracy by eliminating several non-value added sequences. Yearly savings of $5,228 may be realized.
- Determine the Feasibility of Licensing AFLC to Utilize MDAIS Computer-Based Personal Computer (PC) Training Courses at AGMC recommends that AFLC examine the command-wide applicability of utilizing MDC's existing formatted training materials for their in-house employee training efforts. Intangible yearly savings could be significant but MDMSC cannot quantify at this time.

AFLC may realize an estimated $1,328,401 in recurring savings if all of the focus studies and all the quick fix plan opportunities are incorporated.

5.1 MAPBGA ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

AGMC/MA's primary mission is to perform diagnostic tests and repair of Air Force inertial guidance systems. This volume of TO No. 1 Contract Summary Report (CSR) specifically addresses improvement recommendations identified at AGMC's Displacement Gyroscope Repair Facility. MAPBGA is part of the Maintenance Production Division (MAP) and responsible for the repair of navigational gyros from such aircraft as the F-4, F-111, T-38, F-15, F-16 and B1-B. The workload is projected to decrease slightly during the next five years.

It was observed that RCC MAPBGA is organized in a cellular manufacturing layout where aircraft gyros are repaired within a single "cell." All disassembly, inspection (diagnostic test), repair and reassembly is performed within the RCC. Responsibility and authority for repairing gyros rests with a single supervisor who traces problems and establishes priorities. The repair process technology utilized is effective for producing the 1950's designed products with a mission-capable throughput. MDMSC views the overall MAPBGA facilities layout as being comparable to most commercial layouts. Table 5.1-1 illustrates the overall benefits derived from a cellular manufacturing environment.

It was also noted that the repair cell environment complements the use of Total Quality Management (TQM) in the depot. AGMC is the pilot site for the collaborative work efforts of the Quality Thru People, Processes, Performance and Product (QP4) quality/productivity improvement program activities. This participative management style of shop problem troubleshooting fosters continuous improvement and a morale incentive for the team. This TQM environment is definitely conducive to meeting the AFLC goals and overall mission to maintain quality Air Force weapon system platforms in a timely and cost efficient manner.

During initial process baseline development of MAPBGA, a total of 16 potential improvement opportunities were identified (reference MDMSC outbriefing to AGMC 16 November 1988). After review of this original set of opportunities by the joint AGMC/MDMSC TI-ES team, ten improvement opportunities were selected to be pursued as the focus of the TI-ES Program activities relating to

CELLULAR MANUFACTURING ENVIRONMENT ADVANTAGES/BENEFITS
TABLE 5.1-1

	ADVANTAGES/BENEFITS				
CHARACTERISTICS	IMPROVED RESOURCE UTILIZATION	REDUCED COST	IMPROVED QUALITY	REDUCED FLOW TIMES	IMPROVED THROUGHPUT
MINIMIZE PRODUCT MOVEMENT	X			X	X
WORK-IN-PROCESS (WIP) MINIMIZED	X	X			X
PAC TRAINED WORKFORCE	X		X		
WORKLOAD SCHEDULE ADHERENCE	X	X		X	X
FOCUSED SUPERVISION	X	X	X	X	X
WORKLOAD CHANGE RESPONSIVENESS	X	X			

LSC-20183A

MAPBGA. Because Simulation Modeling was not required for MAPBGA during TO No. 1, the AGMC/MDMSC TI-ES team has established a priority ranking of the subject AGMC improvement opportunities based on shop survey information, engineering judgement and product knowledge.

The two proposed focus study investigations will provide a detailed summary of the expected cost savings/benefits to MAPBGA repair/remanufacturing operations. Upon completion of a focus study, the baseline information will be used to define discrete quantitative as well as qualitative changes that can be made to improve the following:

- Resource Utilization
- Cost
- Quality
- Product Throughput
- Process Flow Time

Also, since rate gyroscopes repaired at Warner Robins Air Logistics Center (WR-ALC) undergo similar manufacturing operations, recommended improvements should be considered for both ALCs.

Focus Study Recommendation (FSR) No. 1 will determine optimum methods to unseal, depaint, seal, leak check and paint gyros at RCCs MAPBGA/AGMC and MANPGB/WR-ALC. The new process technologies have a potential for decreasing the GRU gas-filled "leakers" from the As-Is 25% rate to an estimated 5% rate. Improved quality will thereby increase throughput and Mean Time Between Failures (MTBF). MDMSC will survey aerospace GRU suppliers and investigate improved soldering/sealing systems which can be successfully implemented. Also, gyro cover holding fixtures will be designed and fabricated for maximum utilization and flexibility to enhance disassembly/assembly operations. This focus study is presented in detail in paragraphs 5.1.4 through 5.1.4.4.

FSR No. 2 will improve utilization of Automatic Test Equipment (ATE) through a significant reduction (from 50% to an estimated 10% rate) in downtime at RCCs

MAPBGA/AGMC and MANPGB/WR-ALC. In addition, the focus study will determine real compatibility and/or differences between the gyro ATE and manual test stations. MDMSC will conduct interviews with AGMC production and maintenance personnel to determine and quantify causes of excessive ATE downtime. This focus study will also involve assessing the positive attributes of the ATE and coordinating further hardware/software enhancements through Contraves (ATE OEM supplier) and AGMC. This focus study is presented in detail in paragraphs 5.1.5 through 5.1.5.4.

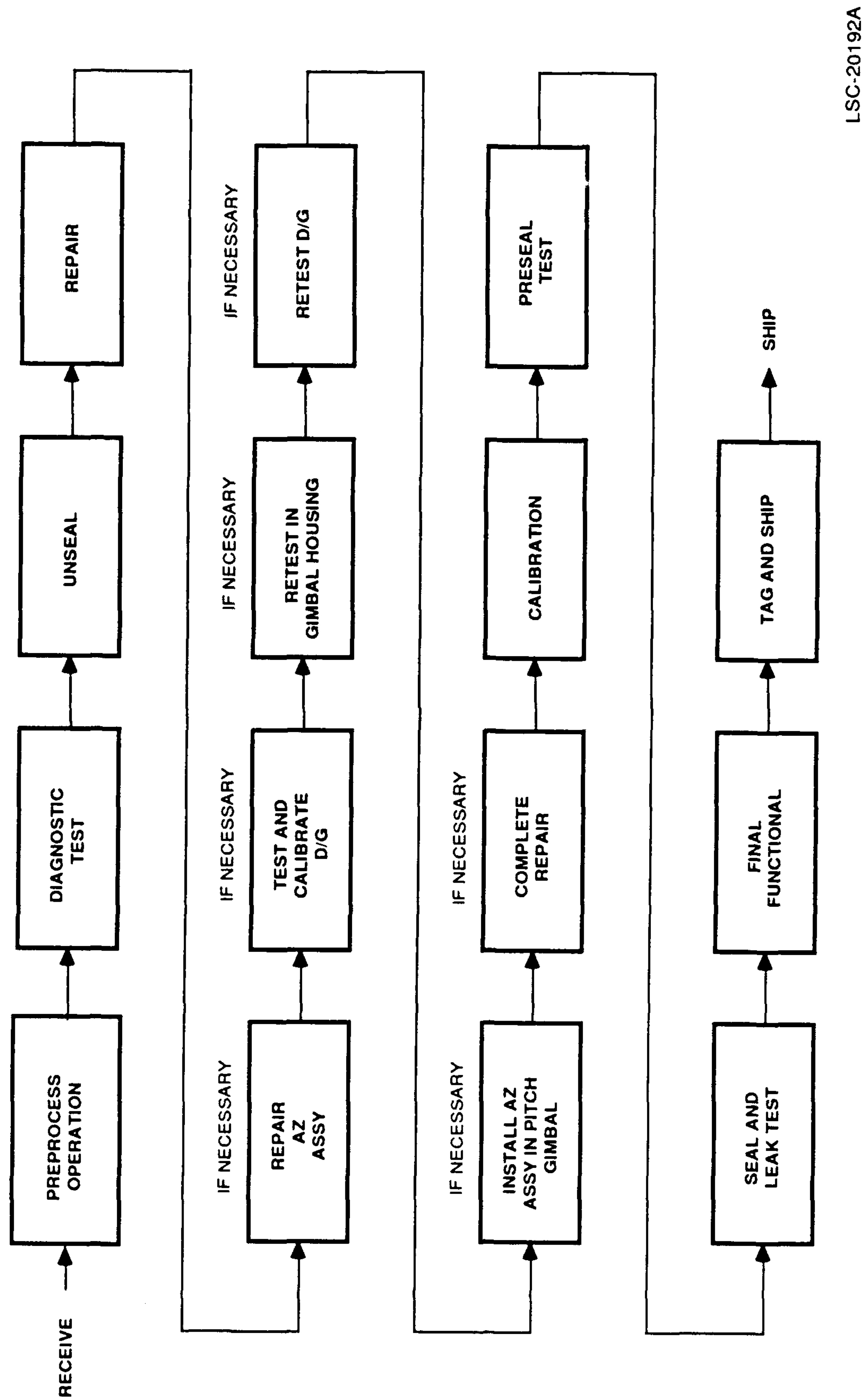
The third through tenth improvement opportunities are quick fix opportunities and are described in detail under separate cover. Refer to TI-ES Task Order No. 1, Volume II Quick Fix Plan AGMC MAPBGA Quick Fix Opportunities for their descriptions.

The balance of MAPBGA opportunities are described as general observations in paragraph 5.1.6 of this document.

5.1.1 Description of Current Operations

The Displacement Gyroscope Repair Facility (RCC MAPBGA) is a typical cost center at AGMC working in a job shop atmosphere to process the 100% Management of Items Subject To Repair (MISTR) planned workload. This RCC, located in AGMC Building 4 complex is comprised of three laboratory type Class 300,000 environmentally controlled facilities totaling 11,943 square feet. Manpower consists mostly of WG-10 skilled technicians of sufficient quantity to handle current MISTR workloads. Figure 5.1.1-1 is a general process flow chart of gyro repair operations most common within RCC MAPBGA.

During peacetime, MAPBGA handles unplanned workload and surges by utilizing Air Force Reserve personnel. The reservists augment the civilian work force. The MDMSC site team was informed that AGMC has the only depot maintenance reserve group working within the AFLC. Regular Production Acceptance Certification (PAC) trainers have certified each reservist during an intensive 6-10 week training session. These same reservists, cross-trained to



DISPLACEMENT GYRO FLOW CHART
FIGURE 5.1.1-1

work in various RCCs throughout AGMC, add even more flexibility into this effective resource utilization method as workloads fluctuate.

Actual wartime readiness/surge requirements can be handled within RCC MAPBGA by simply adding manpower to staff workload requirements. Since existing displacement gyros are maintained on a single work shift basis, the facilities and equipment are adequate to handle a 100% surge workload induction with increased manpower staffing.

MAPBGA equipment consists mainly of individual workbench stations, vacuum and circulating ovens, leak detecting stations, and many manual and semi-programmable test stands. Most of the tooling is standard precision hand tools furnished to the technical operators in complete kit sets. Each separate PCN model does require some special tooling but little is complex enough to require concern in this study. The circulating and vacuum ovens are minor adaptions of standard units. The leak detection equipment are standard catalog items such as Veeco or Varian, then adapted to specific model gyros or families of gyros. The test sets and stands, except for the Contraves rate test stations, are of an age consistent with the product design age. It is doubtful that it can be properly supported much longer. LIFT Plan modernization efforts are underway to replace critical equipment as deemed necessary. The Contraves test stations are of a more recent design than the rate test stations and are closer to state of the art. They are manually programmable and are capable of testing a large variety of gyroscopes.

The first step in the gyro repair process is the manual desoldering of the sealed gyro case (cover) to allow removal of the gyro for repair. The metallic cover halves must then be thoroughly depainted by plastic bead blasting and cleaned. Cost efficiencies and improved throughput could be achieved if certain operations were performed in cost-effective lot quantities with egronomically designed tools and fixtures (addressed in Focus Study No. 1).

A quick fix opportunity was observed where GRU informational decals were difficult to manually remove just prior to depainting the gyro covers. This problem is addressed in detail and presented in paragraph 2.1 in the MAPBGA QFP.

In depot repair of displacement gyroscopes, most of the time is spent in testing. Units are diagnostically tested, faulty components replaced and functionally tested. Repair is usually performed by a single technician at a bench-type laminar flow booth workstation. Bench repair does not require complex routings and is dedicated to a particular product.

Material handling in MAPBGA is mostly accomplished by the repair operator hand carrying the items between stations. The gyroscopes are relatively small, weighing a few pounds. Units are repaired by a single mechanic rather than by line flow process. The one exception of this method is rotor repair, which are repaired in batches rather than one at a time. The repair is still accomplished by a mechanic, not a line, but an operation is completed on multiple assemblies before moving to the next operation. Parts are tracked adequately by conscientious material control/scheduling personnel. A barcoding identification system, if available, would definitely assist much of the labor intensive monitoring of WIP and pan stock materials.

Two additional quick fix opportunities were identified during electrical component repair processing. These opportunities, GRU Flex Lead Stripping and Acetone Flux Removal Replacement are presented in paragraphs 2.2 and 2.3 respectively in the MAPBGA QFP.

The preferred method of test operations at RCCs MAPBGA/AGMC and MANPGB/WR-ALC is to route all incoming diagnostic and final acceptance GRU testing across the Contraves Automated Test Stations. The intent is to reduce labor input by performing testing on multiple GRUs in test stations with minimum test personnel and to gain maximum product reliability by improving personnel confidence in test results.

GRUs are currently tested on Multiple Displacement Gyro Automated Test System (MDGATS), or manual test stands. Future testing will be performed on the recently installed Refurbished Displacement Gyroscope Automated Test Stations (RDGATS). The six MDGATS are utilized to perform diagnostic and final functional testing of the 7901s, CN1375, T-38 and F5E gyros. The four RDGATS are scheduled to perform diagnostic and final functional testing of the 2171s, SR-3 and 7851 model gyros. Unit performance levels are printed out with product specification limits and accept/reject decisions. This same information is recorded and stored on computer hard disks. This methodology is currently unusable because the ATE is down approximately 50% of the time due to malfunctions and/or lack of confidence of the test values obtained.

Both MAPBGA/AGMC and MANPGB/WR-ALC maintain monthly records of the ATE availability. AGMC has initiated a formal reporting system referred to as Station Availability Maintenance Program (SAMP). WR-ALC has an informal report developed by the ATE area supervisor for his own use. Although different in format and completeness, each reporting system shows uptime/downtime of GRU test stations.

Further process simplification and improved productivity will be accomplished by moving selected diagnostic operations from complex, multipurpose ATE to simpler, dedicated test equipment. Focus Study No. 2 will detail the strengths and weaknesses of the MDGATS within both subject RCCs.

After repair and calibration, resealing of the GRU covers is accomplished by a manual soldering process. Two soldering technicians (skill level WG-7) are assigned to solder seal the two cover halves using the large hand-held soldering irons. These soldering irons frequently remain operating continuously to maintain temperature.

Shop floor interviews indicated another quick fix opportunity existed due to the lack of proper alignment fixturing during 2171 gyro covers resealing operation. This opportunity is presented in paragraph 2.4 of the QFP.

The gyro sealing/soldering process requires approximately one-half hour to complete. This sequence of operations includes:

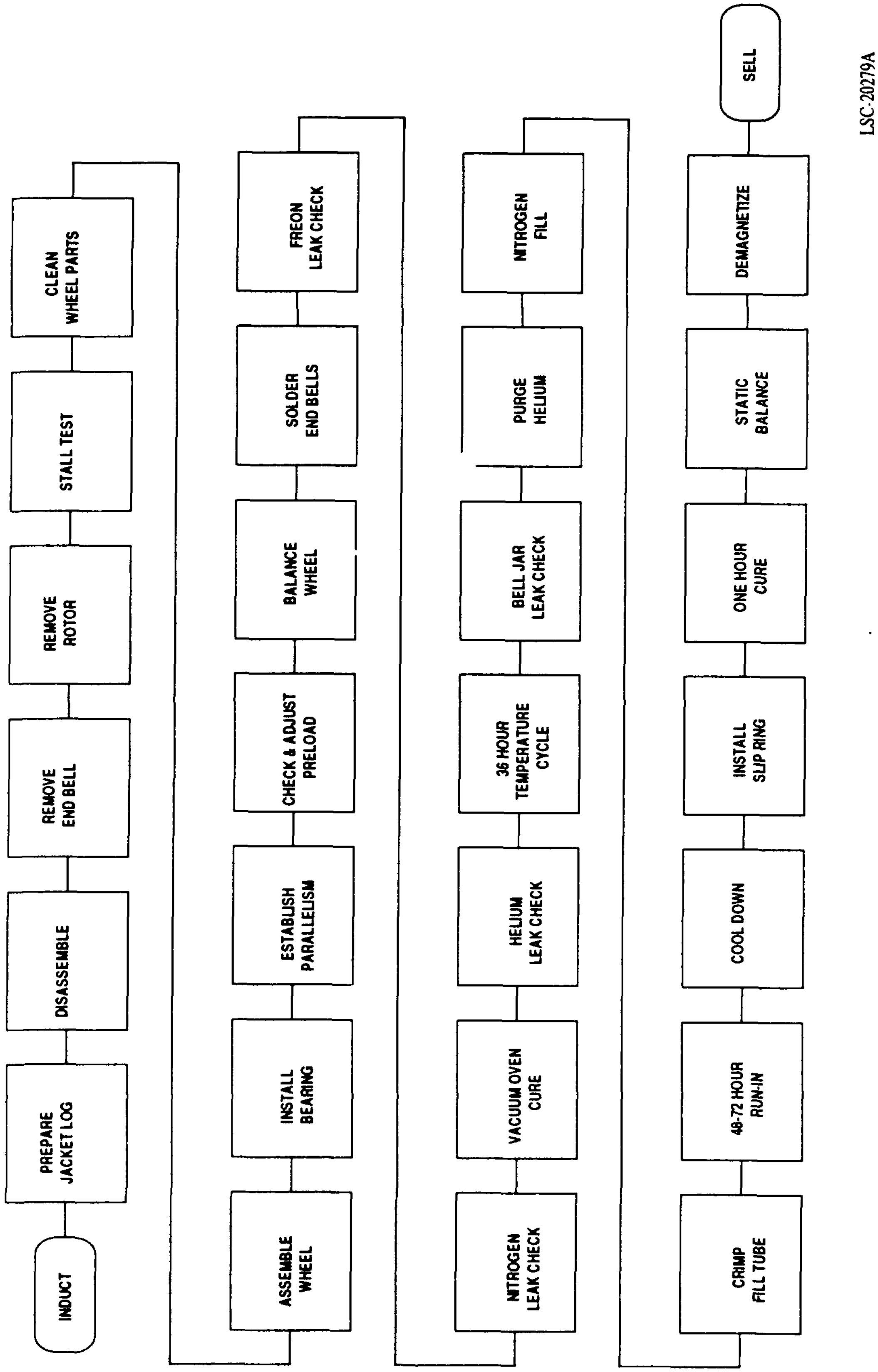
- cleaning the cover flanges if necessary,
- applying a pliable metallic solder sealing strip,
- manually applying solder flux,
- feeding solder wire while soldering,
- final cleaning of remaining flux from the assembled GRU case.

The next major process involves the technician pressurizing the GRU with a gas, immersing it into a liquid and performing a gross leak check through a bubble test. If a leak is detected, the unit must be resealed in the area of the visible leaks. After subsequent recycles and successful completion through the gross leak bubble test, the GRU seal integrity is final functional tested on a Veeco vacuum leak detection system. FSR No. 1 will enhance GRU unseal, depaint, seal and leak check product quality through the utilization of an improved soldering/sealing system.

Also, conducted in parallel with gyro repair activities, all wheel (gyro rotor) repair process technologies are routinely batch processed in room number 41R9A approximately 200 feet away. Figure 5.1.1-2 is a general process flow chart of MAPBGA wheel repair operations. This occasional travel distance is not viewed as a major concern because of the efficient material flow planning and implementation by MAPBGA's management of gyro wheel batch processing methodologies.

Several quick fix opportunities involving wheel repair operations were determined during the industrial engineering assessment and are presented in paragraphs 2.5 through 2.7 of the MAPBGA QFP.

The As-Is facility arrangement drawings are current with the exception that two additional RDGATS units are shown in room 41H14 which do not exist. It was explained to the MDMSC site team that plans had recently been revised to



WHEEL (GYRO ROTOR) REPAIR FLOW CHART
FIGURE 5.1.1-2

reduce the number of RDGATS required for scheduled workloads. Also, the plastic bead blasting room section of room 41H17 (approximately 96 sq. ft.) is not illustrated.

Specific workstation nomenclature is not functionally identified nor are special tools and fixtures depicted on the facility layouts. MDMSC recommends that AGMC utilize its existing Intergraph computer-aided design (CAD) system to upgrade its facility drawings with this useful information.

Storage is conducted on line in MAPBGA. It is accomplished on static, multi-tiered metal shelves and enclosed cabinets. The items for repair are received, logged in, and placed in designated shelves for diagnostic tests. All work-in-process (WIP) is maintained within clean, environmentally controlled Class 10,000 laminar flow booth type workstations. It was also noted during interviews that electro-static discharge (ESD) conductive storage containers and assembly aids were on order for future implementation within MAPBGA. The displacement gyro is repaired, calibrated, functionally tested and stored on other shelves ready for sell/ship.

One final, general quick fix opportunity was identified upon reviewing AGMC's personal computer employee training facility. This opportunity is presented in detail in paragraph 2.8 of the MAPBGA QFP.

MAPBGA has a stable work force with little variance. The work force is comprised of instrument mechanics, three supervisors, four PAC training leaders, and a senior supervisor. The following is a breakdown of the mechanics within MAPBGA.

Skill Code	Skill Level	Quantity
WG 3359	WG-10	58
WG 3359	WG-08	3
WG 3359	WG-07	11
WG 3359	WG-05	1
WG 3359	WL-09	4

Experience is high and a well-coordinated training program is continually upgrading younger workers to adequately meet RCC workload demands. MAPBGA is well supported by scheduling, planning, industrial engineering and product engineering personnel.

5.1.2 Statistical System Performance Measures

TO No. 1 Process Characterization efforts at AGMC vary slightly from the five major ALCs in that the industrial engineering analysis includes only the process baseline development criteria. Stochastic modeling, analysis and recommendations were not required.

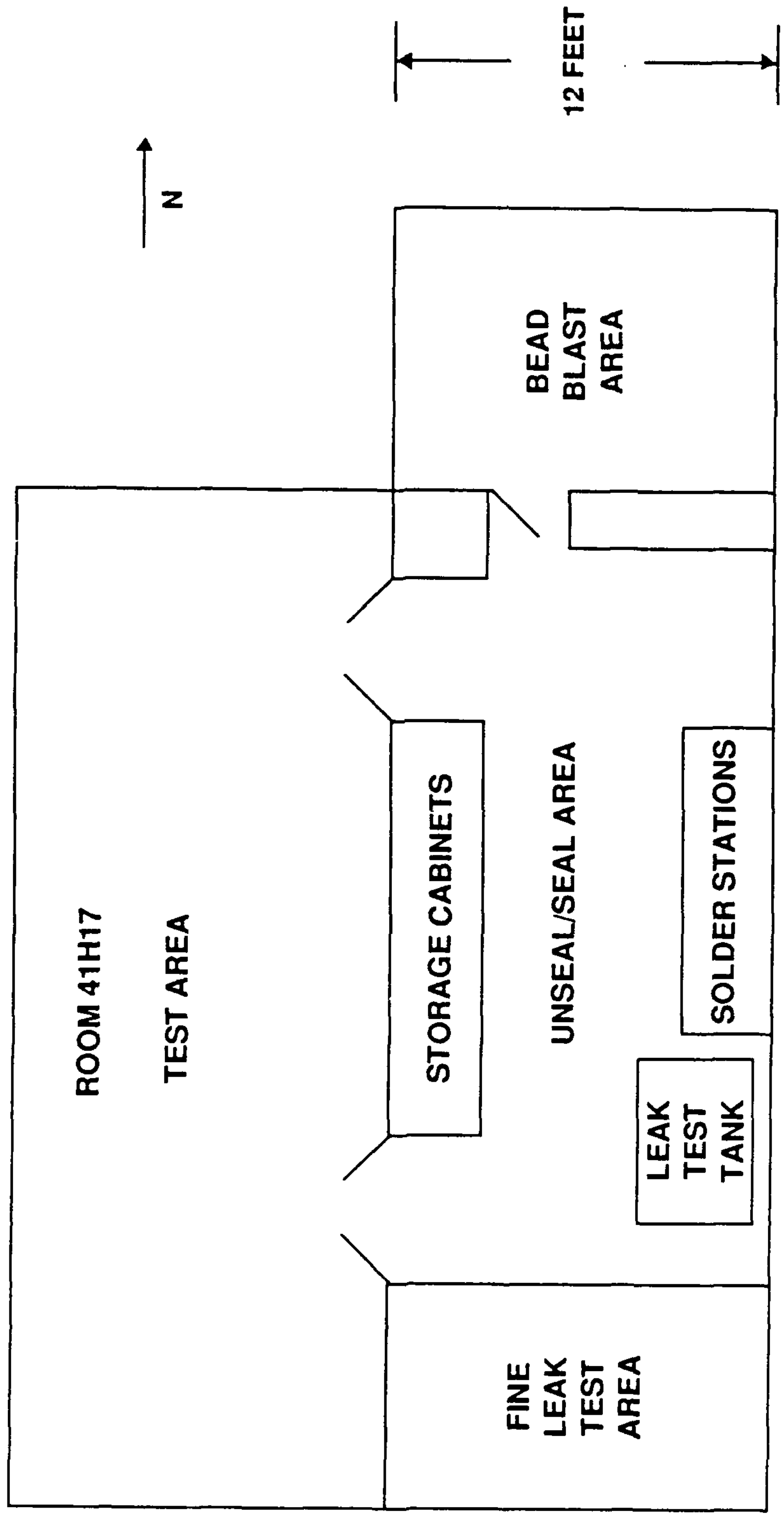
5.1.3 Description of Process Problems

The number of times the displacement gyroscope is returned for rework from DoD inventory is beginning to cause minor repair process problems not previously encountered, i.e. until the 10th recycle or more occurs. In particular, paint coating buildups due to previous touchup painting processes must now be completely removed by plastic grit blasting to restore the covers to an acceptable condition for adequate flange resealing.

The metallic GRU covers must be thoroughly cleaned and resealed properly to provide adequate gas fill integrity of the gyro unit to prevent overheating during actual high rpm gyroscopic guidance performance.

During MAPBGA interviews, it was estimated that 25% of the GRU covers do not pass the initial leak check after repair and must be recycled to the soldering workstation for rework.

GRUs are currently manually unsealed, depainted, resealed and leak checked one at a time in a semi-enclosed portion of Building 4 room 41H17 adjacent to normal gyro repair and test activities. Figure 5.1.3-1 depicts the As-Is unseal/seal area facility layout. Gyro covers are painted by a back shop support area. Environmental, safety and antiquated equipment conditions in this small work area are a management concern as compared to most AGMC facilities.



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AS-IS GYRO UNSEAL/SEAL FACILITY
FIGURE 5.1.3-1

The manual soldering operations are difficult to perform with the limited tools, fixtures and localized exhaust systems. It has been observed that similar outdated conditions exist within the WR-ALC rate gyro repair unseal/seal area as well.

The subject area is adequately supervised with one foreman. The WG-7 technicians could use improved hand tools, fixtures and equipment to perform their assigned tasks. In summary, manual disassembly/assembly methodologies combined with outdated equipment and poor material handling/storage capabilities provide few opportunities for productivity enhancements without major changes. In particular, the large high-temperature soldering irons used to manually unseal and reseal the gyro cover lids cause quality related problems and undue recycles. FSR No. 1 will identify all these process improvement opportunities.

Also, there is considerable concern, among both supervisory and RCC technical personnel about the low availability of the ATE and variance in values obtained between various test and repair stations. GRUs are currently tested on MDGATS, manual test stands and planned for the recently installed RDGATS. FSR No. 2 will identify quantifiable process improvement opportunities.

5.1.4 Recommended Focus Study: RCCs MAPBGA/AGMC and MANPGB/WR-ALC To Determine Improved Methods to Unseal, Depaint, Seal, Leak Check and Paint GRUs

This focus study will provide a detailed analysis of the repair process technology currently utilized in GRU unsealing, depainting, sealing, leak checking and repainting.

Table 5.1.4-1 details the areas that will be affected by this focus study. Also shown is MDMSC's assessment of the level of effort required in the focus study to evaluate individual areas of analysis.

FOCUS STUDY NO. 1 CRITERIA CHECKLIST

TABLE 5.1.4-1 (SHEET 1 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Process/Material Flow	Identify most cost effective soldering/sealing automation processes as well as most flexible fixturing technology by conducting interviews with both equipment manufacturers and users.			X
Equipment/Work Place Layout	Develop optimal shop layout for implementation of automated soldering & sealing and fixture improvement technologies by performing industrial engineering analysis and developing shop layout drawings.			X
Facility Requirements	Define focus study recommendations impact to LIFT modernization plans by reviewing current LIFT plans.		X	
Labor Standards	Define impact to Labor Standards which would result from implementation of focus study recommendations by using statistical projections.		X	
Manpower	Define projected manpower utilization which would result from implementation of focus study recommendations by using statistical projections.		X	
Task Assignments	Define task assignment changes (if any) and training requirements which would result from implementation of focus study recommendations by evaluating current personnel skills against recommended equipment operation requirements.		X	
Material Requirements	Define material requirements for soldering, sealing & leak checks which would result from implementation of focus study recommendations based on equipment manufacturer statistics.		X	
Scrap Rates	No changes anticipated.	X		

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FOCUS STUDY NO. 1 CRITERIA CHECKLIST

TABLE 5.1.4-1 (SHEET 2 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Material Handling & Storage Methods	Define revision in methodologies required due to batch processing by evaluating methodologies used by current users of the recommended equipment.			x
Inspection Techniques	Identify changes in inspection operations (if any) by evaluating current inspection techniques against those in use by users of the recommended equipment.			x
Equipment/Tools/Fixtures	Define costs and ordering lead times for soldering/sealing equipment and flexible fixturing recommendations by obtaining quotes from manufacturers.			x
Process Delays	Identify projected process delay savings by statistical projection.			x
Part Identification	Remain the same.	x		
Quality	Identify reduction in recycles resulting from equipment modernization by statistical projection.			x
Personnel Safety	Define personnel safety considerations, both positive & negative, resulting from implementation of focus study recommendations by engineering evaluation of technology versus OSHA requirements.		x	
Environmental Assessments	Assess environmental impact of recommended changes by engineering evaluation of technology versus EPA requirements.		x	

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5.1.4.1 Rationale Leading to Change

A focus study is recommended to provide a detailed analysis of the repair process currently utilized in the GRU depainting, desealing, resealing and leak check operations in order to develop productivity improvement recommendations. The present condition of some support equipment is deteriorated, causing inaccuracies and recycling of the displacement gyros. Safety and environmental problems within the work place layout are also a major concern. For example:

- Manual positioning/holding of heavy gyros during deseal/seal activities.
- Worker discomfort from high temperatures generated by heavy duty soldering irons.
- Recycles cause increased exposure to irritating soldering and leak check chemical fumes.

Improvements would result through implementation of cost effective equipment modernization, batch processing methods and possible elimination of hazardous operations. Table 5.1.4-2 illustrates the current actual manpower utilized to accomplish unseal/seal operations.

- MDMSC estimates equipment modernization such as an improved soldering/sealing system could enhance product quality thereby reducing gyro leak check recycles approximately 80% and reducing flow times by 20%.
- MDMSC estimates batch processing methodology in depainting/painting operations which will accomplish productivity gains through process simplification in terms of a 10% reduction in flow time and similar improved wartime/readiness surge posture.
- MDMSC also estimates possible elimination of hazardous operations through evaluation of cost effectiveness of procurement of new casings to replace the effort to repair old casings. This would eliminate employee safety and environmental concerns and lead to an estimated 10% improvement in product throughput within the subject area.

MAPBGA/AGMC UNSEAL/SEAL WORKLOAD
TABLE 5.1.4-2

GRU Model	Workload (FY 89)	Unseal (U) Actual Hrs.	Unseal Occurrence Factor($O.F._u$)	Seal (S) Actual Hrs.	Seal ($O.F._s$)	As-Is Total Hrs. *
T-38	734	0.70	1.05	1.02	1.28	1,498
F5E	214	0.70	1.68	0.87	1.83	592
7901A	338	0.69	0.79	0.86	1.01	478
7901A1	433	0.70	0.76	0.99	0.96	642
7901G2	284	0.68	0.74	0.94	0.84	367
2171AB	807	0.19	1.14	0.60	1.25	780
2171AB1	51	0.57	1.04	0.86	1.17	82
2171ABN	40	0.55	1.05	0.75	0.80	47
CN1375	517	0.65	0.90	0.81	1.08	755
B1-B	128	1.60	0.50	0.91(s)	1.14(s)	235
7851	178	0.72	0.70	0.76	1.01	226
SR3	177	0.69	0.97	1.11	1.28	370
TOTALS	3,901 units					6,072 hrs.

* Total GRU Unseal/Seal workload equals ($U \times O.F._u + S \times O.F._s$) x workload
Note: Above hours and occurrence factors are "actuals" obtained from current 6 month Job Order Number (JON) reports.
(s) Indicates standard hours used

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The major process deficiencies to be addressed in FSR No. 1 are:

- Time consuming desoldering and soldering activities
- Recycles through the soldering process to close leaks remaining after the initial soldering sequence
- Worker discomfort from high temperatures generated by the soldering irons which are left continually operating due to the long time required to reach operating temperatures
- Safety issues regarding manual positioning of heavy parts
- Gyro covers grit blasted clean and painted in small lot quantities by back shop support areas

MDMSC recommends performance of FSR No. 1 tasks at both AGMC and WR-ALC to insure development of an effective command wide executable plan to improve AFLC's Return On Investment (ROI).

5.1.4.2 Potential Cost Benefits

An annual cost savings of $245,158 occurs from the implementation of the recommended improvements as shown in Table 5.1.4-3. This represents a 20% reduction in unseal/seal process flow times and improved first time quality resulting from modernized equipment.

Additional potential cost savings resulting from batch processing methodologies and reduction or elimination of hazardous operations cannot be quantified until the focus study is completed.

Intangible benefits from the estimated safety improvements (described below) should be considered of equal importance.

- Improved product quality
- Improved adherence to production schedules
- Reduced worker exposure to high temperature/heavy duty soldering irons, chemicals, and associated fumes
- Clean, efficient work stations
- Egronomically designed fixtures and tools

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 5.1.4-3 (SHEET 1 OF 2)

	CURRENT ANNUAL COSTS	PROPOSED CHANGE INVESTMENT COSTS	PROPOSED CHANGE ANNUAL COSTS
NONRECURRING COSTS (1)			
FOCUS STUDY	$0	$270,000 (2)	$0
FACILITIES			
LAND	$0	$0	$0
BUILDINGS	$0	$0	$0
SUPPORT EQUIPMENT			
DEVELOPMENT	$0	$0	$0
ACQUISITION	$0	$60,000 (3)	$0
INSTALL & CHECKOUT	$0	$6,000 (4)	$0
LOGISTICS SUPPORT			
INITIAL SPARES	$0	$0	$0
INITIAL TRAINING (DEV & PRESENTATION)	$0	$5,122 (5)	$0
TECHNICAL DATA	$0	$0	$0
TOTAL NONRECURRING COST	$0	$341,122	$0
RECURRING COSTS (1)			
TOUCH LABOR	$811,049 (6)	$0	$565,891 (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	$811,049	$0	$565,891
TOTAL COSTS	$811,049	$341,122	$565,891
ANNUAL COST SAVINGS	$245,158		

NUMBER OF MONTHS FOR FOCUS STUDY	4
NUMBER OF MONTHS TO IMPLEMENT CHANGES	8

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 5.1.4-3 (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) IMPROVED SOLDERING/SEALING SYSTEM
$25,000/RCC X 2 RCCs

FLEXIBLE FIXTURING
$5,000/RCC X 2 RCCs

(4) ESTIMATED AT 10% OF SUPPORT EQUIPMENT ACQUISITION COST

(5) TRAINING OF PERSONNEL
(2 PEOPLE X 40 AGMC HRS X $32.42HR) +
(2 PEOPLE X 40 WR-ALC HRS X $31.61/HR)

(6) BASED ON ACTUAL LABOR HOURS & RATES
(6,072 AGMC HRS X $32.42/HR) + (19,430 WR-ALC HRS X $31.61/HR)
AGMC HOURS PER TABLE 5.1.4-2
WR-ALC HOURS = 3.2 X AGMC HOURS (BASED ON FY88 GYRO QUANTITIES, AGMC 3,901; WR-ALC 12,422)

(7) IMPROVEMENT OF 20% OF EFFORT TO UNSEAL & SEAL GYRO COVERS
(.8 X 6,072 AGMC HRS X $44.22/HR) + (.8 X 19,430 WR-ALC HRS X $31.61HR)
WR-ALC HOURS = 3.2 X AGMC HOURS (BASED ON FY88 GYRO QUANTITIES, AGMC 3,901; WR-ALC 12,422)

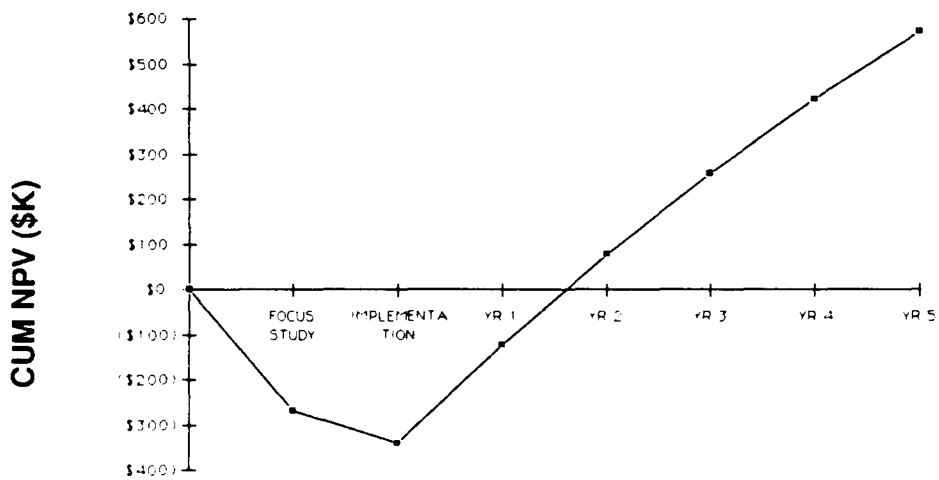
SAVINGS DUE TO REDUCED RECYCLES
(-621 AGMC HRS X $32.42/HR) + (-1,987 WR-ALC HRS X $31.61/HR)
WR-ALC HOURS = 3.2 X AGMC HOURS (BASED ON FY88 GYRO QUANTITIES, AGMC 3,901; WR-ALC 12,422)

ANALYSIS:
CURRENT RECYCLE RATE IS 25%
ESTIMATED NEW RECYCLE RATE IS 5%
REDUCED RECYCLES BY 80% DUE TO IMPROVED FIRST TIME QUALITY

SEAL ACTUAL HRS IS 3,882
SEAL HRS FOR NO RECYCLING IS 3,106 (3,882/1.25)
SEAL HRS FOR 5% RECYCLING IS 3,261 (3,106 X 1.05)
SAVINGS FOR GOING FROM 25% TO 5% RECYCLES IS 621 HRS

The investment cost of the recommendations is estimated at $341,122. This cost includes the focus study effort and the implementation cost resulting from an improved soldering/sealing system and egronomically designed flexible fixturing.

The Cost Benefit Analysis (CBA) shows an Internal Rate of Return (IRR) of 59% and a savings of $570,148 in terms of Net Present Value (NPV) using constant FY 89 dollars, see Figure 5.1.4-1. The CBA is in compliance with regulation AFR173-15, cost analysis procedures, dated 4 March 1988, and rates per AFLCR 78-3.



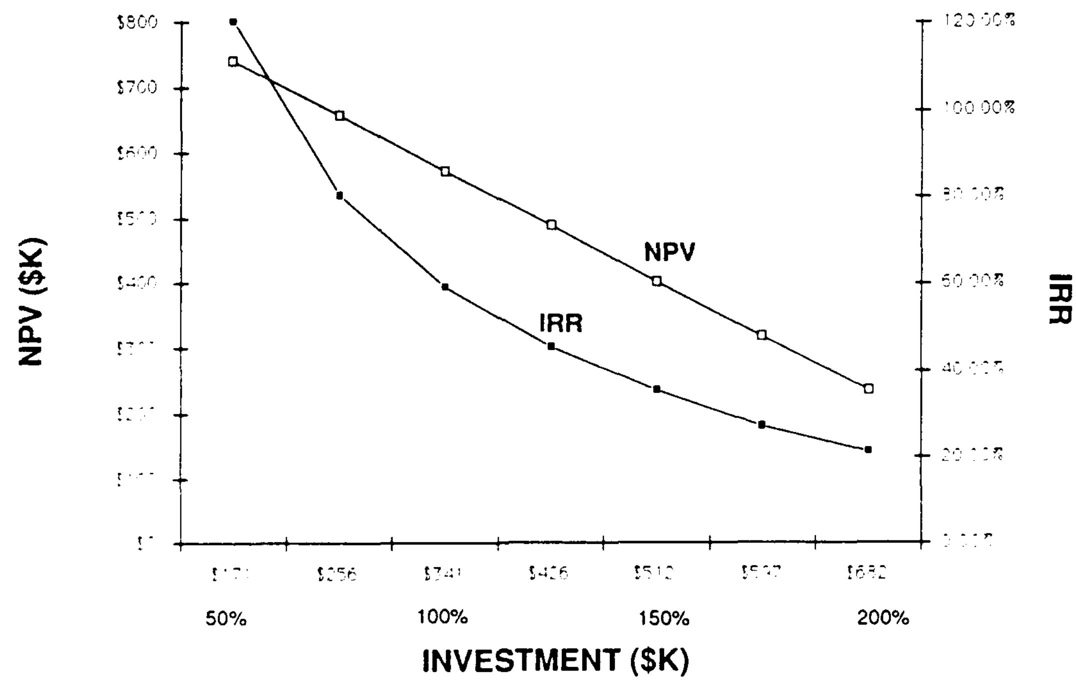
CUM NPV IN CONSTANT FY89 DOLLARS
FIGURE 5.1.4-1

The CBA covers the time frame starting with the focus study through five years after the completion of implementation. The annual 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 5.1.4-2.

MDMSC estimates that a similar 20% reduction in flow times can be achieved in WR-ALC rate gyro unseal/seal operations based on a modernization of process technologies and has included the additional investment cost ($86K) and resultant savings in the cost numbers.



CBA SENSITIVITY ANALYSIS
FIGURE 5.1.4-2

5.1.4.3 Risk Assessment of Achieving Study Goals

The following is a list of the possible risks in achieving the study goals. MDMSC believes these risks are minimal.

- Actual cost savings can be quantified only after the detailed focus study is completed and the optimum improvement recommendations selected for implementation.
- Current five-year AGMC displacement gyro workload projections are summarized in Table 5.1.4-4.
- Implementation costs are based on minimum facility rearrangement.
- Some inventory stockpiling may be required prior to production interruption when inserting the proposed process technology improvement.

5.1.4.4 Duration and Level of Effort

A thorough review of state-of-the-art commercial aerospace Gyro manufacturers such as Honeywell, Sperry, Bendix, and Lear Siegler (Smith Industries) will determine the cost effective modernization improvements possible at AGMC and WR-ALC.

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

- Survey commercial aerospace industry GRU vendors
  (Particular focus will be placed on review of Honeywell's Space and Strategic Avionics Division where a computer integrated manufacturing (CIM) system makes precision gyros for Air Force Peacekeeper and Minuteman missiles.)
- Meet with AGMC and WR-ALC personnel to coordinate activities
- Summarize all cost-effective productivity improvement opportunities for AFLC review
- Prepare descriptive facility layouts of proposed work stations
- Perform an environmental impact assessment to identify and devise new approaches for reducing and minimizing hazardous wastes through process modification.

PLANNED MAPBGA GYRO WORKLOAD

TABLE 5.1.4-4

	PLANNED INDUCTIONS					5 YEAR TOTALS
GYRO MODEL	FY89	FY90	FY91	FY92	FY93	
ROOM 41H17						
T38	734	715	709	663	663	3,484
F5E	214	202	197	187	187	987
7901A	338	322	322	312	312	1,606
7901A1	433	433	430	418	418	2,132
7901G2	284	283	249	233	233	1,282
ROOM 41H14						
2171AB (AF)	807	594	362	286	286	2,335
2171AB (N)	40	40	40	40	40	200
2171AB1	51	46	42	43	43	225
CN1375	517	521	484	485	485	2,492
7851	178	178	178	178	178	890
SR3	177	177	177	177	177	885
B1-B	128	128	125	125	125	631
TOTAL	3,901	3,639	3,315	3,147	3,147	17,149

SOURCE: PLANT LABOR ACCOUNT REPORT, 11 JULY 1988

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The improvement concepts are meant to be implemented quickly and consistently command-wide with minimal capital funding.

Figure 5.1.4-3 illustrates the proposed schedule to accomplish FSR No. 1.

It is estimated that a total of $270,000 is required to implement this recommendation. This number is an engineering Rough Order of Magnitude (ROM) estimate for engineering studies only, it does not represent firm pricing.

5.1.5 Recommended Focus Study: RCCs MAPBGA/AGMC and MANPGB/WR-ALC to Improve Utilization of Gyro Automatic Test Equipment (ATE)

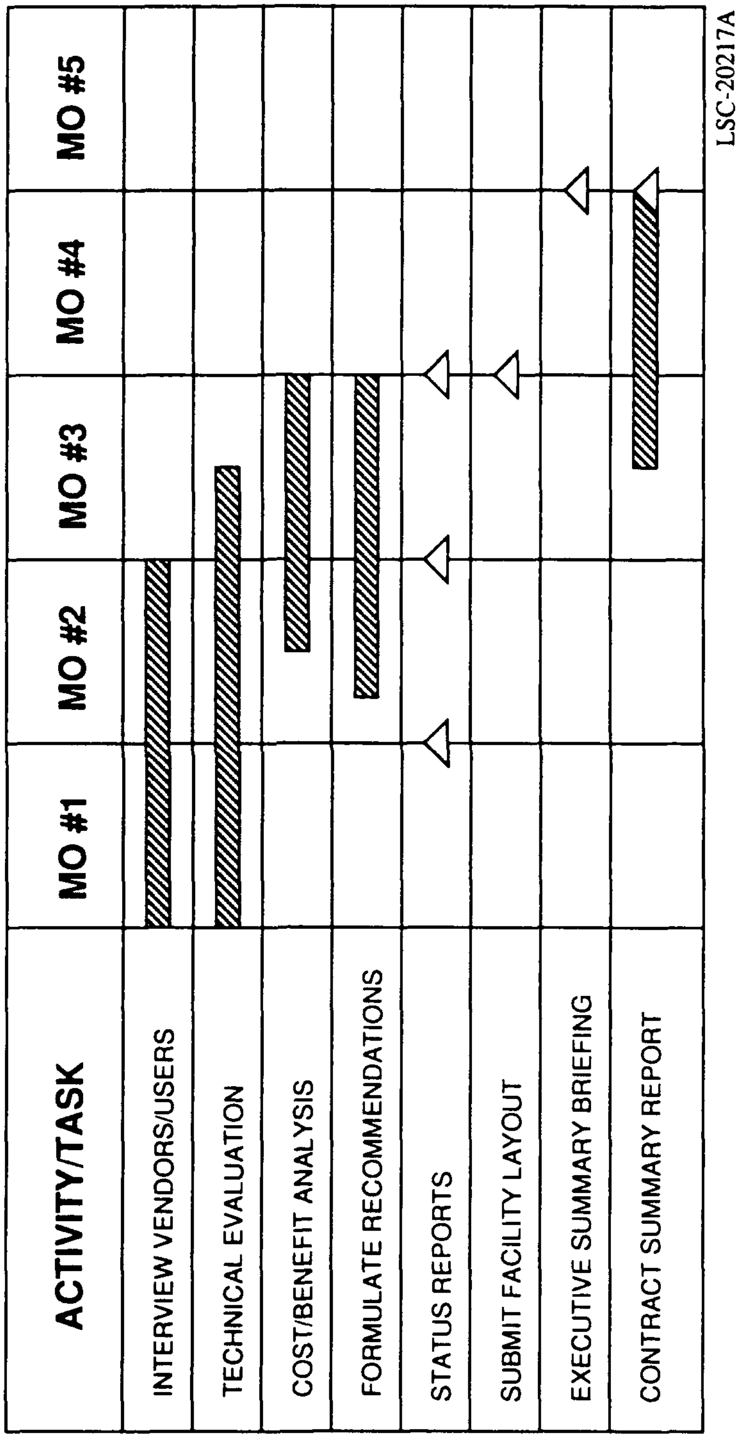
This focus study will provide a detailed analysis of the maintenance problems associated with the subject ATE and propose efficient methods to improve the utilization of the sophisticated automated test stations.

Table 5.1.5-1 details the areas that will be affected by this focus study. Also shown is MDMSC's assessment of the level of effort required in the focus study to evaluate individual areas of analysis.

5.1.5.1 Rationale Leading to Change

It has been McDonnell Douglas Corporation's (MDC's) experience that ATE for electronics hardware manufacture is reliable and efficient. A 90% ATE availability factor within MAPBGA and MANPGB will permit maximum testing of GRUs, therefore accomplishing near term productivity gains, improving wartime readiness and surge posture, as well as improving schedule flexibility.

The above should result in an overall decreased cost of operation. Table 5.1.5-2 illustrates the current actual manpower utilized to accomplish diagnostic and functional test operations.



PROPOSED FSR NO. 1 SCHEDULE
FIGURE 5.1.4-3

FOCUS STUDY NO. 2 CRITERIA CHECKLIST

TABLE 5.1.5-1 (SHEET 1 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Process/Material Flow	Identify most cost effective gyro test processes as well as most flexible fixturing technology by conducting interviews with RCC personnel, equipment manufacturers and users.			X
Equipment/Work Place Layout	No changes anticipated.	X		
Facility Requirements	Define focus study recommendations impact to LIFT modernization plans by reviewing current LIFT plans.		X	
Labor Standards	Define impact to Labor Standards which would result from implementation of focus study recommendations by using statistical projections.		X	
Manpower	Define projected manpower utilization which would result from implementation of focus study recommendations by using statistical projections.			X
Task Assignments	Define task assignment changes (if any) and training requirements which would result from implementation of focus study recommendations by evaluating current personnel skills against recommended equipment operation requirements.	X		
Material Requirements	No changes anticipated.	X		
Scrap Rates	No changes anticipated.	X		

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FOCUS STUDY NO. 2 CRITERIA CHECKLIST

TABLE 5.1.5-1 (SHEET 2 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Material Handling & Storage Methods	No changes anticipated.	x		
Inspection Techniques	Identify changes in inspection operations (if any) by evaluating current inspection techniques.			x
Equipment/Tools/Fixtures	Define costs and ordering lead times for enhanced ATE and equipment maintenance training recommendations by obtaining quotes from manufacturers.			x
Process Delays	Identify projected process delay savings by statistical projection.			x
Part Identification	Remain the same.	x		
Quality	Identify reduction in recycles resulting from improved ATE capability and alternative manual test equipment options by statistical projection.		x	
Personnel Safety	No changes anticipated.	x		
Environmental Assessments	No changes anticipated.	x		

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MAPBGA/AGMC DISPLACEMENT GYRO TEST WORKLOAD

TABLE 5.1.5-2

GRU Model	Workload (FY 89)	Diagnotics (D) Actual Hrs.	Occurrence Factor($O.F._D$)	Functional Test (F) Actual Hrs.	$O.F._F$	As-Is Total Hrs. *
T-38	734	2.94	0.77	2.32	1.04	3,433
F5E	214	2.57	0.68	2.80	1.17	1,075
7901A	338	3.46	0.42	5.37	0.99	2,288
7901A1	433	2.69	0.60	5.20	1.00	2,950
7901G2	284	3.61	0.58	4.97	0.91	1,879
2171AB	807	0.94	0.57	1.98	0.98	1,998
2171AB1	51	0.95	0.56	1.97	0.85	126
2171ABN	40	0.84 (s)	0.68 (s)	1.47 (s)	1.39 (s)	104
CN1375	517	2.19	0.74	3.31	0.93	2,429
7851	178	2.18	1.03	3.70	1.07	1,104
SR3	177	2.41	1.17	3.47	1.02	1,126
B1-B	128	6.42	1.00	2.40	0.92	1,104
TOTALS	3,901 units					19,616 hrs

* As-Is total test hours equals (D x $O.F._D$ + F x $O.F._F$) x workload
Note: Above hours and occurrence factors are "actuals" obtained from current 6 month JON reports.
(s) indicates standard hours used

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FSR No. 2 will address the following specific problems:

- Frequent (50% is the norm) downtime.
- Poor confidence (low morale) in test data due to variance between individual ATE units and the previously used manual test stations.
- Increased test time because multiple tests cannot be run (ATE program stoppage occurs due to first failure made without identifying problems. The manual test stand is required for detailed diagnostic analysis and validation of test failures).
- It was stated in interviews that the lengthy duration of the ATE software programs causes the equipment to be non-cost efficient unless at least three of the six MDGATS units are operational. This in turn creates production scheduling problems.
- No current use of stored historical data.

MDMSC recommends performance of FSR No. 2 tasks at both AGMC and WR-ALC to insure development of an effective, command-wide executable plan to maximize AFLC's Return On Investment (ROI).

5.1.5.2 Potential Cost Benefits

An annual cost savings of $1,048,006 occurs from the implementation of the recommended improvements as shown in Table 5.1.5-3. This is based on a reduction in ATE downtime from 50% to 10%.

Additional potential cost savings result from:

- Cost avoidance of deferred or eliminated Logistics Improvement of Facilities and Technology (LIFT) capital investments to expand or sustain mission workloads.
- Possibly eliminate existing under-utilized equipment
- Improve control of process
- Lower inspection costs
- Reduce floor space requirements

These cost benefits cannot be quantified until the focus study is completed.

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

TABLE 5.1.5-3 (SHEET 1 OF 2)

	CURRENT ANNUAL COSTS	PROPOSED CHANGE INVESTMENT COSTS	PROPOSED CHANGE ANNUAL COSTS
NONRECURRING COSTS (1)			
FOCUS STUDY	$0	$250,000 (2)	$0
FACILITIES			
LAND	$0	$0	$0
BUILDINGS	$0	$0	$0
SUPPORT EQUIPMENT			
DEVELOPMENT	$0	$10,000 (3)	$0
ACQUISITION	$0	$10,000 (4)	$0
INSTALL & CHECKOUT	$0	$1,000 (5)	$0
LOGISTICS SUPPORT			
INITIAL SPARES	$0	$0	$0
INITIAL TRAINING (DEV & PRESENTATION)	$0	$10,000 (6)	$0
TECHNICAL DATA	$0	$0	$0
TOTAL NONRECURRING COST	$0	$281,000	$0
RECURRING COSTS (1)			
TOUCH LABOR	$2,620,148 (7)	$0	$1,572,142 (8)
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	$2,620,148	$0	$1,572,142
TOTAL COSTS	$2,620,148	$281,000	$1,572,142
ANNUAL COST SAVINGS	$1,048,006		

NUMBER OF MONTHS FOR FOCUS STUDY 5

NUMBER OF MONTHS TO IMPLEMENT CHANGES 6

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 5.1.5-3 (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) SOFTWARE IMPROVEMENTS (ESTIMATED)

(4) IMPROVED GRU FIXTURING
$5,000/RCC X 2 RCCS

(5) ESTIMATED AT 10% OF SUPPORT EQUIPMENT ACQUISITION COST

(6) TRAINING OF PERSONNEL ON ATE
$5,000/RCC X 2 RCCS

(7) BASED ON ACTUAL LABOR HOURS & RATES
(19,616 AGMC HRS X $32.42/HR) + (62,771 WR-ALC HRS X $31.61/HR)
AGMC HOURS PER TABLE 5.1.5-2
WR-ALC HOURS = 3.2 X AGMC HOURS (BASED ON FY88 GYRO QUANTITIES, AGMC 3,901; WR-ALC 12,422)

(8) IMPROVEMENT OF ATE DOWNTIME FROM 50% TO 10%
(11,770 AGMC HRS X $32.42/HR) + (37,664 WR-ALC HRS X $31.61/HR)
WR-ALC HOURS = 3.2 X AGMC HOURS (BASED ON FY88 GYRO QUANTITIES, AGMC 3,901; WR-ALC 12,422)

ANALYSIS:
1 ATE OPERATOR HR EQUIVALENT TO 3 MANUAL TESTERS OPERATOR HOURS

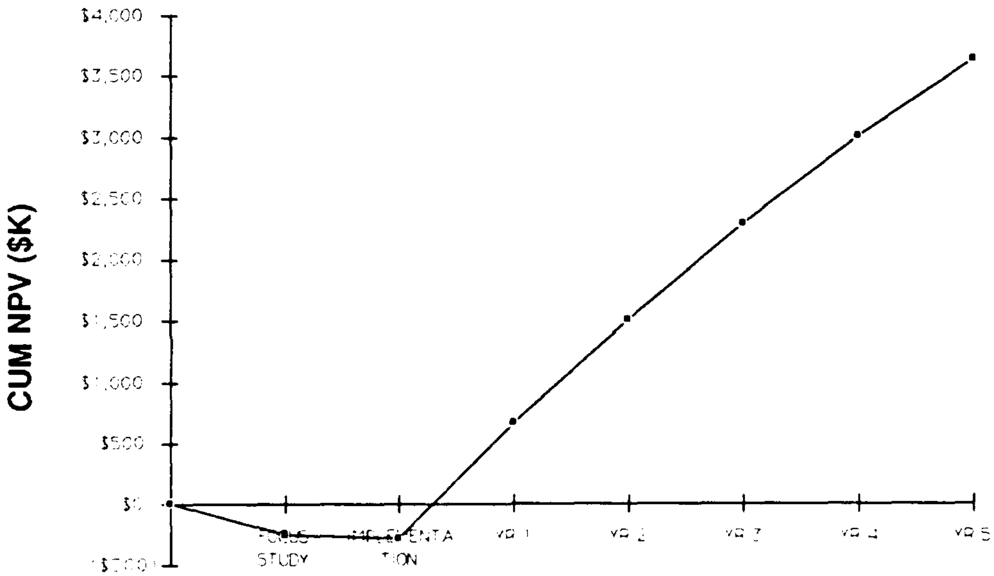
AGMC CURRENT HOURS:	4,904	ATE HOURS
	14,712	MANUAL TESTER HOURS
	19,616	HOURS

10% DOWNTIME HOURS: 9,808 ATE HOURS IF 100% ATE, 0% DOWNTIME

8,827	ATE HOURS (.9 X 9,808 HOURS)
2,943	MANUAL TESTER HRS (.1 X 9,808 HRS. X 3 MANUAL TESTERS)
11,770	HOURS

The investment cost of the recommendations is estimated at $281,000. This cost includes the focus study effort and the implementation cost.

The Cost Benefit Analysis (CBA) shows an Internal Rate of Return (IRR) of 323% and a savings of $3,633,180 in terms of Net Present Value (NPV) using constant FY 89 dollars, see Figure 5.1.5-1. The CBA is in compliance with regulation AFR173-15, cost analysis procedures, dated 4 March 1988, and rates per AFLCR 78-3.

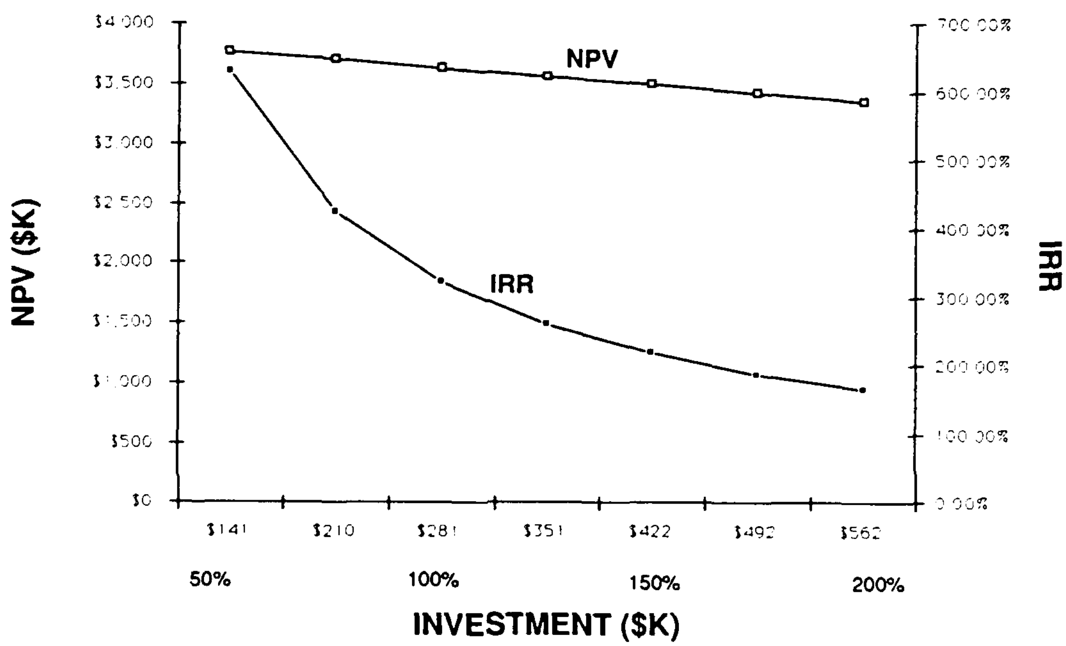


CUM NPV IN CONSTANT FY89 DOLLARS
FIGURE 5.1.5-1

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 5.1.5-2.



CBA SENSITIVITY ANALYSIS
FIGURE 5.1.5-2

MDMSC estimates that a similar reduction in ATE downtime can be achieved at WR-ALC and has included the additional investment cost ($30K) and resultant savings in the cost numbers.

5.1.5.3 Risk Assessment of Achieving Study Goals

Some technical risk may evolve from commercial industry visits not revealing significantly improved ATE technology. There are risks associated with data accuracy, being unable to gain enough detailed knowledge of station design, historical data of control panel failure causes and degree of design margin from panel equipment error profiles to quantify measurable improvements.

Some equipment re-specification (interaction with OEM, Contraves Corp.) may be required to procure additional detailed preventive maintenance schedule information, troubleshooting manuals and/or electronics maintenance training for AGMC personnel. Equipment and system support recurring costs may increase.

5.1.5.4 Duration and Level of Effort

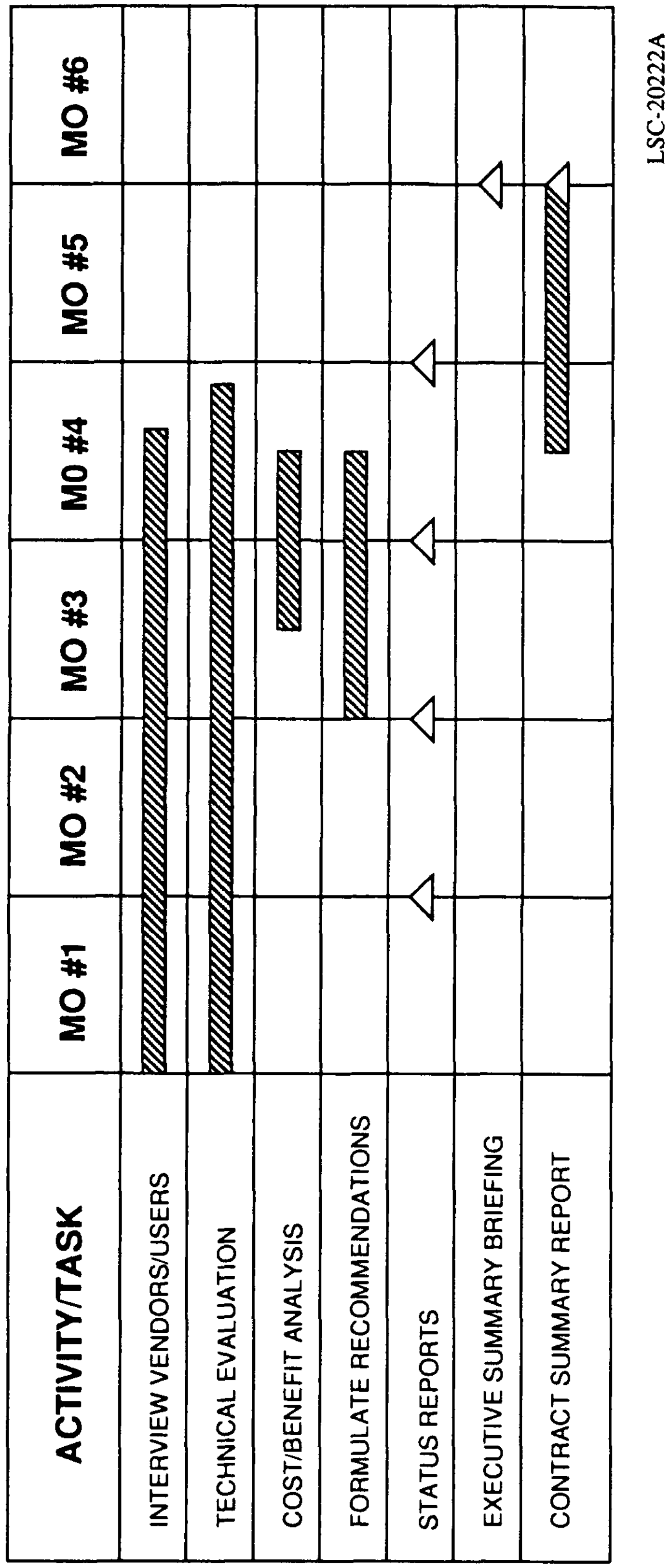
A thorough review of state-of-the-art commercial aerospace Gyro manufacturers such as Honeywell, Sperry, Bendix, and Lear Siegler (Smith Industries) will determine the cost effective modernization improvements possible at AGMC and WR-ALC.

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

- Survey commercial aerospace industry GRU vendors.
- Meet with AGMC and WR-ALC cognizant personnel to coordinate activities. Note: Time will be required at both RCCs but AGMC should be used to develop methodology and programming approach because more resources are currently available there.
- Interface with original equipment manufacturer (Contraves) personnel to coordinate potential software and/or hardware improvement activities.
- Summarize all cost-effective productivity improvement opportunities for AFLC review.
- An environmental impact assessment will be conducted.

Figure 5.1.5-3 illustrates the proposed schedule to accomplish FSR No. 2 goals.

It is estimated that a total of $250,000 is required to implement this recommendation. This number is an engineering ROM estimate for engineering trade studies only, it does not represent firm pricing.



PROPOSED FSR NO. 2 SCHEDULE
FIGURE 5.1.5-3

5.1.6 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 on the areas of time, quality, or cost. These observations are recorded to assist AGMC 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 were detailed as such in the MDMSC outbrief report presented to AGMC/MA personnel on 16 November 1988. After review by the joint MDMSC/AGMC TI-ES team, it was mutually agreed that they should be presented as other observations in this document for future reference.

Improve Instrument Bearings Procurement and Handling Procedures

Instrument bearings quality related problems impact costs and schedule within AGMC's displacement gyroscope repair activities. Corrosion is frequently evident on packaged bearings when initially received at the MAPBGA facility. Significant repair costs occur associated with bearing reinspection and nearly 100% Cyl-Sonic cleaning.

Zero defect components from suppliers will reduce repair labor costs, increase throughput and reduce flow times in AGMC GRU repair operations. Also, the methodology of improving supplier quality could be transferred across the command, avoiding any similar rework costs at WR-ALC or other bearing users.

It is difficult to currently assess AFLC's Item Management System ability to respond in a timely manner to any requested procurement revision requirements. Also, bearing manufacturers may be unwilling to renegotiate outstanding purchase order agreements.

Determine the Overall Effectiveness of the Future Material Control System

It was observed that production control personnel spend considerable time conducting visual inventory assessments and updating material and workload availability throughout MAPBGA. Work in process, spare pan stock and spare bench stock are stored in various stationary storage racks and enclosed cabinets.

During process baseline development interviews, it was learned that space-efficient glide-out type storage shelving systems were being considered for MAPBGA.

THE FOLLOWING AGMC QUICK FIX PLAN WAS PREVIOUSLY SUBMITTED ON 13 JANUARY 1989 AND ACCEPTED. MDMSC IS SUBMITTING THIS DUPLICATE COPY TO ENSURE CONTINUITY OF THIS REPORT. (REFERENCE HQ AFLC/MAQF-WPCC/PMRP-MDMSC MEETING MINUTES FOR APRIL 13-14 1989.)

TECHNOLOGY INSERTION ENGINEERING SERVICES
PROCESS CHARACTERIZATION
(TASK ORDER NO. 1)

AGMC
QUICK FIX PLAN RECOMMENDATIONS
13 JANUARY 1989

CONTRACT NO. F33600-88-D-0567
CDRL SEQUENCE NO. B00̄7

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

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ACRONYMS AND ABBREVIATIONS

AFLC	AIR FORCE LOGISTICS COMMAND
AFLC/MA	AIR FORCE LOGISTICS COMMAND DIRECTORATE OF MAINTENANCE
AGMC	AEROSPACE GUIDANCE AND METROLOGY CENTER
ALC	AIR LOGISTICS CENTER
C/CHE	CHEMIST/CHEMICAL ENGINEER
CAD/CAM	COMPUTER-AIDED DESIGN/COMPUTER-AIDED MANUFACTURING
CAM	COMPUTER-AIDED MANUFACTURING
CBA	COST BENEFIT ANALYSIS
CDRL	CONTRACT DATA REQUIREMENTS LIST
CPI	CONTRACT PROFESSIONALS, INC.
DOD	DEPARTMENT OF DEFENSE
GFI	GOVERNMENT FURNISHED INFORMATION
GRU	GYROSCOPIC REFERENCE UNIT
IE	INDUSTRIAL ENGINEER
IGES	INTERACTIVE GRAPHICS EXCHANGE STANDARD
IMIS	INTEGRATED MANAGEMENT INFORMATION SYSTEM
IRR	INTERNAL RATE OF RETURN
IRAD	INDEPENDENT RESEARCH AND DEVELOPMENT
JE	JOURNEYMAN ENGINEER
MCAIR	MCDONNELL AIRCRAFT COMPANY
MDAIS	MCDONNELL DOUGLAS AEROSPACE INFORMATION SYSTEMS
MDC	MCDONNELL DOUGLAS CORPORATION
MDISC	MCDONNELL DOUGLAS INFORMATION SYSTEMS COMPANY
MDMSC	MCDONNELL DOUGLAS MISSILE SYSTEMS COMPANY
ME	MECHANICAL ENGINEER
MFG E	MANUFACTURING ENGINEER
MISTR	MANAGEMENT OF ITEMS SUBJECT TO REPAIR
MTBF	MEAN TIME BETWEEN FAILURES

ACRONYMS AND ABBREVIATIONS

MTTR	MEAN TIME TO REPAIR
NASP	NATIONAL AEROSPACE PLANE
NAVAIR	NAVAL AIR SYSTEMS COMMAND
NPV	NET PRESENT VALUE
NDI	NON-DESTRUCTIVE INSPECTION
OC-ALC	OKLAHOMA CITY AIR LOGISTICS CENTER
OO-ALC	OGDEN AIR LOGISTICS CENTER
PMS	PROGRAM MASTER SCHEDULE
QFD	QUALITY FUNCTION DEPLOYMENT
RCC	RESOURCE CONTROL CENTER
RFP	REQUEST FOR PROPOSAL
ROI	RETURN ON INVESTMENT
SA-ALC	SAN ANTONIO AIR LOGISTICS CENTER
SIM	SYSTEM INTEGRATION MANAGER
SLAM II	SIMULATION LANGUAGE FOR ALTERNATIVE MODELING II
SM-ALC	SACRAMENTO AIR LOGISTICS CENTER
SOW	STATEMENT OF WORK
SPC	STATISTICAL PROCESS CONTROL
SSA	SENIOR SIMULATION ANALYST
SWRI	SOUTHWEST RESEARCH INSTITUTE
TESS	THE EXTENDED SIMULATION SYSTEM
TI	TECHNOLOGY INSERTION
TO	TASK ORDER
TOP	TASK ORDER PROPOSAL
UDOS 2.0	UNIVERSAL DEPOT OVERHAUL SIMULATOR 2.0
USAF	UNITED STATES AIR FORCE
VMS	VIRTUAL MEMORY SYSTEM
WBS	WORK BREAKDOWN STRUCTURE
WCD	WORK CONTROL DOCUMENT
WPAFB	WRIGHT-PATTERSON AIR FORCE BASE
WR-ALC	WARNER ROBINS AIR LOGISTICS CENTER

AGMC QUICK FIX PLAN

1.0 GENERAL

MDMSC has concluded a detailed site survey of RCC MAPBG at the Aerospace Guidance and Metrology Center (AGMC) in direct support of the main objectives of the Technology Insertion Engineering Services Program. The Quick Fix Plan summarizes the quick, no/low cost process improvement opportunities identified for the Displacement Gyroscopes Repair Facility of AGMC.

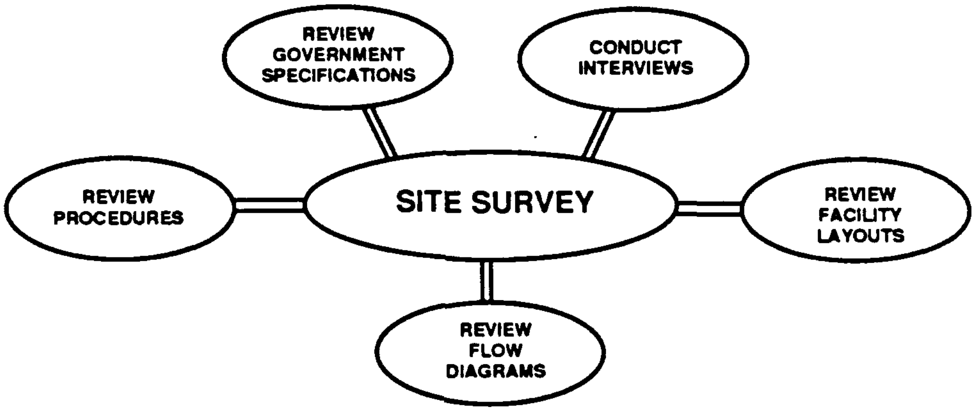
1.1 INTRODUCTION

The MDMSC team has developed a good working knowledge of the Gyroscopic Reference Unit (GRU) repair operations through data collection, shop floor interviews and review of facility layouts (see Figure 1.1-1). This familiarization provides a method to characterize the operation of a high cost/labor intensive RCC such as MAPBG at AGMC and allows for the identification of process improvement opportunities.

A quick fix opportunity is defined as a no/low cost process improvement opportunity which can be implemented within six months of identification. The quick fix opportunities at AGMC were identified using the As-Is process baseline knowledge developed during the various shop floor survey tasks, floor interviews and product knowledge. The As-Is baseline will be used to measure the discrete improvements that can be made to improve resource utilization, cost, product thruput and reduce processing flow time.

1.2 SUMMARY

The current displacement gyroscope repair processes were examined to determine their effectiveness and efficiency. It was noted that the PAC trained technicians within the MAPBG RCC were very familiar with their responsible workload and participated in weekly Quality Thru People, Processes, Product and Performance (QP4) quality/productivity improvement activities. This participative management style of shop environment is definitely conducive to many of the AFLC "continuous improvement" goals and overall mission to maintain Air Force weapon system platforms in a timely and cost efficient



SITE SURVEY ELEMENTS
FIGURE 1.1-1

LSC-20018

manner. Recommend that the methodology and personnel responsible for QP4 at AGMC be used to introduce QP4 at other ALCs.

1.3 CONCLUSIONS

MDMSC is now familiar with AGMC displacement gyroscope repair processes and problems. Our main objective in Task Order No. 1 is to utilize our understanding of the As-Is condition of the processes from detailed site survey analyses to identify quick fix opportunities and problem areas for further investigation.

1.3.1 <u>Quick Fix Recommendation Listing By RCC Per ALC</u>

Not applicable at AGMC because only one RCC was evaluated.

1.3.2 <u>Quick Fix Recommendation Listing For AFLC</u>

To establish a priority ranking of the recommended improvements to MAPBG repair/remanufacturing processes telecon discussions were held with AGMC/MA responsible personnel involved in GRU repair activities and the MDMSC site survey team. Because a Universal Depot Overhaul Simulator 2.0 (UDOS 2.0) simulation model was not developed for MAPBG at this time, engineering judgement is deemed to be a valid method to grade the recommendations for their quantitative as well as qualitative characteristics.

Following is an abbreviated list in prioritized order of process improvement recommendations, all of which can be implemented organically in the near term.

- Utilize standard 3M decal tape which minimizes adhesive residue
- Eliminate mechanical stripping of gyro flex leads
- Replace acetone as a solder flux removal agent
- Improve 2171's cover seal ring installation
- Perform wheel run-in tests with uniform cycle time program
- Improve CN1375 wheel vacuum pumpdown/fill operation
- Develop enhanced CN1375 bearing preload method
- License AFLC to utilize MDAIS computer-based training courses.

2.0 QUICK FIX RECOMMENDATION DESCRIPTIONS

MDMSC has identified eight (8) particular opportunities of process and/or operation improvement within RCC MAPBG at a AGMC. The following information describes methodologies and implementation plans to allow AFLC/MA to incorporate the subject no/low cost improvements.

2.1 QUICK FIX OPPORTUNITY TO STANDARDIZE THE GRU COVER DECAL TAPE MATERIAL AT AGMC

2.1.1 Description of Current Operation

Various 3M brand informational decals are used on the exterior surface of GRU assemblies. The 2171 gyro, in particular, has three (3) such decals.

2.1.2 Overall Assessment of Current Operation

The mature nature of the displacement gyroscope workload is beginning to cause minor repair process problems not previously encountered, i.e. until the 10th recycle or more occurs. Paint coatings buildup must now be removed by plastic grit blasting methods to restore the cover to an acceptable condition for resealing to maintain product integrity.

2.1.2.1 Current Process Problems

Except for one decal material (Scotchcal), the adhesive residue left after decal removal is very difficult to clean. Part surface must be residue-free for plastic grit depainting and subsequent repainting efforts. Extra labor hours are being expended peeling and sometimes scraping off various 3M brand informational decals whenever covers require general cleanup and/or paint touchup processing.

2.1.2.2 Shop Organization

The GRU repair facility (room no. 41H14) has a dedicated workstation area with static storage shelves and workbenches where decals are removed from incoming GRU assemblies being inducted for general repair.

2.1.3 <u>Rationale Leading to Change</u>

There are new, improved aerospace industrial masking tape products constantly being developed by Original Equipment Manufacturer (OEM) suppliers to aid manufacturers.

2.1.3.1 Supporting Data

MDMSC continuously interacts with its own various masking tape suppliers to seek productivity/quality improvements. Adhesive residue transfer is a known source for possible product contamination and hampers subsequent cleaning and finishing operations.

2.1.4 <u>Description of New Process</u>

MDMSC recommends a single 3M brand film tape such as "Scotchcal" should be utilized for all decal applications due to its durability, ease of application and removal, and minimum adhesive residue characteristics.

2.1.4.1 Productivity Improvements

There should be an average flow time reduction of approximately 0.5 hours per unit for all 2171AB GRUs with this simplification technique.

2.1.4.2 Quality Improvements

There will be reduced nicks and scratches on the cover plate from not using x-acto blades to scrape off old decals, thus enhancing overall end product appearance.

2.1.4.3 Resource Utilization

Manpower will be more efficiently utilized by the labor savings incurred.

2.1.4.4 Flexibility

"Scotchcal" is already used for one of the three existing decals and should be an easily incorporated design change.

2.1.5 <u>Benefits/Trade-Offs</u>

2.1.5.1 Cost Savings

Actual interviews with RCC personnel determined an engineering estimate of 0.5 manhours per 2171 GRU assembly could be saved. Therefore; 0.5 manhours X $55/hr X 898 units (FY '89 scheduled workload) would result in a

operational labor cost savings of $ 24,695 per year in cost center MAPBG after implementation.

2.1.6 <u>Implementation Cost/Schedule</u>

Some AFLC/MA administrative costs will be incurred due to procurement specifications revision required to change the GRU informational decal material callout. An estimate of 24.0 hours should suffice to allow changeover. Also, scrap costs to discontinue usage of existing decals in inventory would be greatly outweighed by the labor cost savings incurred with the immediate use of new, improved material. AGMC will have to determine the actual scrap costs if existing supplies are not consumed prior to implementation of the new decals.

2.1.6.1 Impact

AFLC/MA and AGMC could conveniently implement this process improvement into their normal procurement cycle at their earliest opportunity with no impact to production schedules.

2.1.7 <u>Safety Improvements</u>

A minor safety improvement would result from a reduced usage of sharp x-acto-type knife blades to peel/scrape off the old decals.

2.1.8 <u>Environmental Hazards/Improvements</u>

None exists.

2.1.9 <u>Reliability/Maintainability Characteristics</u>

An easier to repair and maintain GRU assembly will result during future field returns.

2.1.10 Human Factors Design Criteria

Less laborious peeling and scraping of difficult to remove decals will permit a cleaner workstation and improved employee morale. Commonality in decal material will ease operator training requirements.

2.2 QUICK FIX OPPORTUNITY TO ELIMINATE MECHANICAL STRIPPING OF GRU FLEX WIRE LEADS AT AGMC

2.2.1 Description of Current Operation

Current stripping of insulation on .015" diameter flex leads occurs inside the laminar flow booth workstations utilizing mechanical wire stripping pliers and x-acto blades. The Federal Specification J-W-1177B magnetic electrical wire with polyurethane overcoated material is very delicate and difficult to handle in a spooled condition.

2.2.2 Overall Assessment of Current Operation

A better method is needed to repair/replace damaged flex leads on 7901 and 7851 GRUs due to process problems stated in paragraph 2.2.2.1.

2.2.2.1 Current Process Problems

This procedure is time consuming, may cause nicks and wire embrittlement, and also is a possible source of GRU foreign particulate contamination.

2.2.2.2 Shop Organization

GRU repair occurs in room nos. 41H14 and 41H17 where PAC trained grade 10 technicians work at any available laminar flow booth workstation to perform the necessary disassembly/assembly repair operations.

2.2.3 Rationale Leading to Change

Resoldered, delicate flexible wire leads can be easily damaged even by the most conscientious technicians. Any possible source of foreign particulate contamination should be eliminated where possible to improve the reliability of the GRU and overall availability of the aircraft weapon system.

2.2.3.1 Supporting Data

Actual observation of the flex wire replacement technique indicated an effort of 2.0 hours was expended on four (4) wires on a 7901 unit and the technician commented he would turnover the GRU and '"hope" any foreign matter would fall out where he could not vacuum.

2.2.4 Description of New Process

MDMSC recommends flex leads be purchased pre-stripped and tinned or AGMC setup a separate, well-ventilated workstation to chemically strip off the wire shielding material with sodium hydroxide or alternate solution. MAPGB technician would then simply unsolder damaged wires and reinsert new flex wires inside the laminar flow booth area.

2.2.4.1 Productivity Improvements

Prestripped, cut and tinned flexible lead wires would improve the repair flow time on future 7901 and 7851 GRUs an average of approximately 0.5 hours per damaged flex wire (four flex wires per GRU).

2.2.4.2 Quality Improvements

Less foreign particulate contamination would result by removing the mechanical wire stripping method from inside the MAPBG repair area. Future field returns may show less evidence of foreign matter contamination related failures.

2.2.4.3 Resource Utilization

Manpower will be more efficiently utilized by eliminating a difficult and tedious task within the RCC.

2.2.4.4 Flexibility

MAPBG could maintain the flexibility of returning to the mechanical stripping method whenever prestripped supplies were temporarily unavailable.

2.2.5 Benefits/Trade-Offs

2.2.5.1 Cost Savings

Actual operation observation and interviews with RCC personnel determined an engineering estimate of 0.5 manhours per 7901 GRU assembly could be saved. Therefore; 0.5 manhours X $55/hr X 1233 units (FY '89 scheduled workload)/4 (estimating only one of four wires requires replacement per returned GRU) would result in an operational labor cost savings of $ 8,477 per year in cost center MAPBG after implementation.

2.2.6 Implementation Cost/Schedule

Some AFLC/MA administrative costs will be incurred due to procurement specifications revision required to change the flex wire material callout to a stripped and pretinned condition. An estimate of 40.0 hours should suffice to allow changeover to a purchased part. Note: The alternative implementation of in-house lead stripping is not strongly recommended unless an existing locally exhausted workstation can be readily identified.

2.2.6.1 Impact

There would be no production schedule impact. Implementation could be planned concurrent with present operations.

2.2.7 Safety Improvements

No measurable amount will occur.

2.2.8 Environmental Hazards/Improvements

There would be no environmental impact if the flex leads can be procured prestripped by an outside source. If AGMC has to internally setup a separate workstation to perform the necessary preliminary processing there could be some worker exposure to hazardous fumes during the chemical wire stripping operation. A possibly costly localized exhaust system may be required negating the labor cost saving identified above.

2.2.9 Reliability/Maintainability Characteristics

Should improve MTBF by reducing the possibility of returning physically damaged new flex wires to GRU assemblies as well as a reduction in foreign particulate contamination occurrences.

2.2.10 Human Factors Design Criteria

Employee morale would be improved by removing a difficult, tedious task from the Class 300,000 environment.

2.3 QUICK FIX OPPORTUNITY TO DETERMINE POSSIBLE REPLACEMENT FOR ACETONE AS A SOLDER FLUX REMOVAL AGENT AT AGMC

2.3.1 Description of Current Operation

MAPBG utilizes acetone exclusively for solder flux cleaning applications during GRU repair operations involving soldering.

2.3.2 Overall Assessment of Current Operation

Although acetone is an excellent industrial cleaning agent, its usage is discouraged by OSHA since water-based solder fluxes and cleaning solutions have been introduced.

2.3.2.1 Current Process Problems

There are no actual process problems involving the acetone usage.

2.3.2.2 Shop Organization

MAPBG technicians are well organized in their work and maintain only a small supply of acetone at each active workstation.

2.3.3 Rationale Leading to Change

AFLC/MA may wish to follow MDMSCs example of introducing viable, less hazardous solder flux cleaning solutions where applicable. A joint AFLC/MDMSC review would determine if an alternative, less hazardous solder flux and cleaning solution is suitable for MAPBG electronics assembly and repair applications. For example, MDMSC currently utilizes various aqueous cleaners for flux removal applications when solvents are not functionally required.

2.3.3.1 Supporting Data

MDMSC has historical files and current Material Safety Data Sheets (MSDS) providing relevant information regarding various aqueous wipe solvents for fluxes.

2.3.4 Description of New Process

An alternative, biodegradable and non-hazardous cleaning solution would be used in daily operations once it becomes approved for AFLC usage.

Possible candidate aqueous solvents include:

- MSI-7000 from Magnatonic Systems Inc.
- Solderflux 815 from J&S Laboratories Inc.
- Solderflux 821 from J&S Laboratories Inc.
- Loncoterge 446 from London Chemical Co.
- Loncoterge 530 from London Chemical Co.

2.3.4.1 Productivity Improvements

No significant productivity improvements will occur.

2.3.4.2 Quality Improvements

Quality assurance testing will determine if any measurable improvements have been accomplished in each substitution application.

2.3.4.3 Resource Utilization

No significant change.

2.3.4.4 Flexibility

Process flexibility will be enhanced if an alternative cleaning solution can be utilized and acetone reserved for secondary requirements.

2.3.5 Benefits/Trade-Offs

Benefits upon implementation are mostly safety and environment related.

2.3.5.1 Cost Savings

Measurable cost savings can be calculated only after each PCN application is evaluated and approved for process substitution.

2.3.6 Implementation Cost/Schedule

Some AFLC/MA administrative costs will be incurred due to procurement specification revisions required to change the solder flux cleaning agent material callout. Actual costs can be calculated only after design engineering approves each application revision.

2.3.6.1 Impact

There would be no production schedule impact. Implementation could be planned concurrent with present operations.

2.3.7 Safety Improvements

Upon implementation of an acceptable substitute , AGMC personnel will not be exposed to the health risks associated with acetone.

2.3.8 Environmental Hazards/Improvements

Acetone is a ketone-based solvent type cleaning solution which exhibits several environmental and health risks such as low flash point flammability (133°F), unhealthful fumes and is a known skin irritant.

2.3.9 Reliability/Maintainability Characteristics

No significant changes will occur.

2.3.10 Human Factors Design Criteria

Due to the health and safety implications, AFLC/MA may desire to implement this methodology command-wide to improve employee morale.

2.4 QUICK FIX OPPORTUNITY TO IMPROVE CONSISTENCY OF RESEALING 2171 COVERS AT AGMC

2.4.1 Description of Current Operation

All displacement GRUs are unsealed when initially inducted into the overall repair process by applying high heat to the existing electroplated seal while manually held by the grade level 7 technician.

2.4.2 Overall Assessment of Current Operation

Environmental, safety and equipment conditions are substandard as compared to most AGMC facilities. Without an enclosed ventilation system there is a risk of periodic foreign particulate contamination to the adjacent class 300,000 area when processing equipment malfunctions.

2.4.2.1 Current Process Problems

There are frequent slightly misaligned 2171 GRU cover assembly seal rings after the resealing operation. This scenario causes a protrusion to extend outside the normal edges of the GRU bottom plate allowing the seal to get scratched and gouged during any mishandling and the GRU may become a premature leaker in the field without ever being flown.

2.4.2.2 Shop Organization

GRU unsealing/resealing operations occur in a small dedicated section of room no. 41H17 to reduce dirt contamination problems.

2.4.3 Rationale Leading to Change

A shop aid device such as a simple part holding fixture should eliminate periodic misalignment problems.

2.4.3.1 Supporting Data

Interviews held with shop personnel highlighted this recurring problem.

2.4.4 Description of New Process

MDMSC recommends a simple part holding fixture to improve the technician's ability to maintain proper alignment of the seal ring to the cover assembly details during the manual resoldering operation. Minor operator retraining would also improve reseal quality.

2.4.4.1 Productivity Improvements

Increased throughput of 2171 GRUs should be attained due to process simplification and reduced manual techniques.

2.4.4.2 Quality Improvements

Misalignment discrepancies and reworks should be eliminated. Improved seal integrity is vital to GRU performance due to heat dissipation and wheel drag minimization requirements.

2.4.4.3 Resource Utilization

More efficient utilization of Grade level 7 technicians will result.

2.4.4.4 Flexibility

Manpower resources will be better utilized and therefore more flexible to perform new workload requirements.

2.4.5 Benefits/Trade-Offs

2.4.5.1 Cost Savings

During actual shop interviews it was stated that an estimated 25% of the 2171 GRUs display some misalignment of the cover /plate assembly. If these units were corrected the first time worked then estimated cost saving would be as follows: 898 units (FY '89 workload) X 25% X 2.0 hours/assembly X $55/hour equals $24,695 annually after implementation.

2.4.6 Implementation Cost/Schedule

It is estimated that a simple part holding fixture could be designed in less than 40.0 hours and then fabricated out of aluminum or even wood materials.

2.4.6.1 Impact

There would be no schedule impact as tool design and fabrication can occur concurrent with daily production.

2.4.7 Safety Improvements

Improved part fixturing will reduce the risk of exposing the technician to the constant-output type soldering iron high temperatures in the manual deseal/ resealing procedure.

2.4.8 Environmental Hazards/Improvements

No significant changes will occur.

2.4.9 Reliability/Maintainability Characteristics

Improved assembly alignment methodology will provide a consistently reliable GRU seal.

2.4.10 Human Factors Design Criteria

The reseal operator will feel more assured he has done a good job as the occurrence factor for premature leaker field returns will decrease.

2.5 QUICK FIX OPPORTUNITY TO UTILIZE UNIFORM CYCLE TIMES TO PERFORM GYROSCOPIC WHEEL RUN-IN TEST

2.5.1 Description of Current Operation

Gyro wheel assemblies are presently "run-in" with cycle times varying from a few hours to as many as 72 hours. As many as forty (40) units can be run simultaneously at a dedicated workstation.

2.5.2 Overall Assessment of Current Operation

Current gyro wheel assembly flow time is impacted by the long run-in test routines. Run-in of spin bearing accomplishes both lubrication distribution and indication of early failure from assembly errors. Distribution is accomplished early during run-in. Early failures can be plotted for best length of run-in process time.

2.5.2.1 Current Process Problems

Run-in testing of various GRU wheel assembly configurations sometimes are cycled for as long as 72 hours with no real data gained after 12 hours elapsed time.

2.5.2.2 Shop Organization

Gyro wheel assembly run-in tests take place in an efficiently designed workstation within room no. 41R9A where multiple units can be simultaneously run-in.

2.5.3 Rationale Leading to Change

More efficient utilization of manpower and facilities resources can be attained with a uniform test procedure of shorter duration. Test data should be gathered by a QP4 team to determine an optimum condition.

2.5.3.1 Supporting Data

It was noted during floor interviews with cognizant personnel that approximately 90% of wheel bearing run-in spin test failures occur within the first twelve (12) hours of run-in performance testing and operational procedures should be updated to reflect floor experiences. Failures are manifested by excessive electrical current draw or shorter than normal rundown times.

2.5.4 Description of New Process

A test program should be developed for uniform run-in processing of 24 hours or less in duration. Properly preloaded wheels should display any evidence of failure early in the run-in cycle and preclude the need for longer cycle testing.

2.5.4.1 Productivity Improvements

Product flow time will be enhanced.

2.5.4.2 Quality Improvements

No significant changes will result.

2.5.4.3 Resource Utilization

Reduced flow times (vary from 12 to 48 hours), more efficient manpower and facility utilization will result.

2.5.4.4 Flexibility

MAPBG will still be flexible enough to return to longer test cycle times if certain PCNs reflect that requirement after new statistical process control and/or Pareto analysis is completed.

2.5.5 Benefits/Trade-Offs

Uniform run-in profiles would simplify training and improve assurance of consistent operation. Increased fixture and station availability for surge or workload induction increases.

2.5.5.1 Cost Savings

Cost savings are difficult to project until the feasibility of a uniform test procedure is approved for each GRU PCN application.

2.5.6 Implementation Cost/Schedule

A QP4 team could develop failure rate versus run-in time data. Some engineering time would be required to evaluate obtained data and change process. Implementation costs could be minimal if test programs require only a cycle duration limit revision.

2.5.6.1 Impact

There would be no production schedule impact. Implementation could be planned concurrent with present operations.

2.5.7 Safety Improvements

None will occur.

2.5.8 Environmental Hazards/Improvements

Not applicable.

2.5.9 Reliability/Maintainability Characteristics

Some improvement in MTBF is anticipated through removal of early failures and unnecessary wheel life loss from long run-in tests.

2.5.10 Human Factors Design Criteria

A more consistent wheel run-in test procedure will simplify technician training and improve morale.

2.6 QUICK FIX OPPORTUNITY TO IMPROVE CN1375 WHEEL ASSEMBLY VACUUM PUMPDOWN AND REFILL OPERATION

2.6.1 Description of Current Operation

The present vacuum leak test operation takes from 8 to 10 hours to cycle twice and maintain the required 10 micron vacuum environment.

2.6.2 Overall Assessment of Current Operation

A vacuum leak check operation should not take as long as the observed eight hour test.

2.6.2.1 Current Process Problems

The personnel confidence level in the integrity of the leak test equipment setup is so low that MAPBG supervision requires the four hour vacuum pumpdown sequence of events repeated a second time to insure the 10 micron test parameter specification is met.

2.6.2.2 Shop Organization

The Veeco vacuum leak check test equipment is located in a side room area partitioned from room no. 41R9A. The vacuum pump itself is located outside in a hallway approximately 10 feet away. This distance separation is considered great enough to adversely impact the overall vacuum test performance.

2.6.3 Rationale Leading to Change

A single pumpdown cycle time of 5 hours or less should be attainable with reliable equipment and/or procedures.

2.6.3.1 Supporting Data

Interviews conducted with RCC personnel indicated that similar vacuum problems elsewhere at AGMC was usually corrected by simply relocating the vacuum source pump closer to the test station.

2.6.4 Description of New Process

MDMSC recommends a QP4 task team evaluate control factors affecting the Veeco system performance and determine necessary corrective action.

2.6.4.1 Productivity Improvements

Process flow time will improve by a factor of 50% with one reliable pumpdown cycle.

2.6.4.2 Quality Improvements

A single, more reliable test procedure will improve personnel confidence level and integrity of delivered GRU hardware.

2.6.4.3 Resource Utilization

Improved utilization of equipment and manpower will result.

2.6.4.4 Flexibility

MAPBG flexibility will be enhanced to efficiently induct additional workload due to reduced process flow time.

2.6.5 Benefits/Trade-Offs

2.6.5.1 Cost Savings

Engineering estimates that 0.50 hours could be saved if the secondary restart test setup procedure could be eliminated on future CN1375 workload. Therefore, 645 units (FY '89 scheduled workload) X 0.50 hours saved/unit X $55/hour would yield annual savings of approximately $17,738.

2.6.6 Implementation Cost/Schedule

AGMC will incur some facility rearrangement/maintenance costs to resolve the vacuum integrity problem.

2.6.7 Safety Improvements

No measurable improvement will occur.

2.6.8 Environmental Hazards/Improvements

Not applicable.

2.6.9 Reliability/Maintainability Characteristics

An improved vacuum line capability will allow for a single, reliable test routine.

2.6.10 Human Factors Design Criteria

RCC personnel confidence levels in leak check test performance will improve.

2.7 QUICK FIX OPPORTUNITY TO ENHANCE THE CN1375 BEARING ASSEMBLY PRELOAD METHOD AT AGMC

2.7.1 Description of Current Operation

There are twenty-six (26) incremental operation sequences to be performed while adjusting the CN1375 directional gyro rotor assembly preload.

2.7.2 Overall Assessment of Current Operation

There appears to be several nearly repetitive steps taken during the delicate bearing preload operation to assure a reliable test.

2.7.2.1 Current Process Problems

Grade 10 technician feels somewhat uncomfortable with the reliability of the existing preload test procedure as the precision incremental travel observations will not always yield repeatable results.

2.7.2.2 Shop Organization

The current work area where bearing assemblies are preload tested in a small fixture within room no. 41R9A is clean and has adequate space.

2.7.3 Rationale Leading to Change

The MDMSC site survey personnel were specifically requested to observe the tedious CN1375 bearing assembly preload methods to comment on the existing methodology.

2.7.3.1 Supporting Data

During actual observation and an interview with shop personnel it was noted that CN1375 preloading and verification was difficult to perform and accuracy was somewhat questionable because different results were obtained sometimes even when redundant operational sequences were followed.

2.7.4 Description of New Process

MDMSC recommends developing some minor fixturing revisions to improve thruput and accuracy by eliminating several non value-added sequences. In particular, a cam-type weight fixture detail to semi-automate the incremental addition/deletion of small loads would be very beneficial.

2.7.4.1 Productivity Improvements

Actual operation observations show that 0.25 hours could be reduced from the preload testing effort if near-repetitive steps were eliminated.

2.7.4.2 Quality Improvements

A more reliable, accurate one-time preload procedure will result.

2.7.4.3 Resource Utilization

Employee would not tend to perform the repetitive steps and therefore improve process flow time.

2.7.4.4 Flexibility

No significant change.

2.7.5 Benefits/Trade-Offs

2.7.5.1 Cost Savings

Engineering estimates that 0.25 hours could be saved if the repetitive test sequences could be eliminated on future CN1375 (both F-15 and B-1B) bearing preloads. Therefore, 645 units (FY '89 scheduled workload) X 0.25 hours saved/unit X $55/hour would yield annual savings of approximately $8,869 before implementation cost expenditures.

2.7.6 Implementation Cost/Schedule

Some AFLC tool design costs and implementation costs will occur but MDMSC cannot estimate at this time. A QP4 review team could identify any non value-adding methods.

2.7.6.1 Impact

There would be minor production disruptions while a new fixture and preload testing methodology is implemented into routine activities.

2.7.7 Safety Improvements

Not applicable.

2.7.8 Environmental Hazards/Improvements

Not applicable.

2.7.9 Reliability/Maintainability Characteristics

No significant measurable improvements will occur other than operator confidence of more reliable results.

2.7.10 Human Factors Design Criteria

After some minor operator retraining employees will feel more assured of accurate preload test results with consistent fixturing.

2.8 QUICK FIX OPPORTUNITY TO DETERMINE THE FEASIBILITY OF LICENSING AFLC TO UTILIZE MDAIS COMPUTER-BASED PERSONAL COMPUTER (PC) TRAINING COURSES AT AGMC

2.8.1 Description of Current Operation

AGMC has a Learning Center Facility with a large quantity of PC hardware systems for periodic employee review of video, audio and PC software training information.

2.8.2 Overall Assessment of Current Operation

Training programs could be enhanced with the utilization of more modern, user-friendly computer systems.

2.8.2.1 Current Process Problems

Some hardware appears to be quite outdated and may require replacement with modern, "user-friendly" systems for more efficient training.

2.8.2.2 Shop Organization

At AGMC there already exists an effective facility area where internal training can occur.

2.8.3 Rationale Leading to Change

MDC has an extensive in-house employee voluntary Computer-Based Training Program which enhances career opportunities and provides a continuously improving work force.

2.8.4 Description of New Process

MDMSC recommends that AFLC examine the command-wide applicability of utilizing MDCs existing formatted training materials for their in-house employee training efforts.

2.8.4.1 Productivity Improvements

Each ALC could also review and specify unique programs which suit individual needs.

2.8.4.2 Quality Improvements

This effort would further expedite the existing Air Force quality/productivity initiatives like QP4, PAC teams, TQM
and R & M 2000.

2.8.4.3 Resource Utilization

Would provide the AFLC a more efficient utilization of its training resources.

2.8.4.4 Flexibility

AFLC/MA would have a more flexible work force capable of handling future , highly technical factory or office related assignments.

2.8.5 <u>Benefits/Trade-Offs</u>

Without command-wide consistency in its computer-based training efforts there will be substantial disparity amongst the AFLC work force level of knowledge and ability to handle new inducted workloads.

2.8.5.1 Cost Savings

Intangible savings could be significant but MDMSC cannot accurately project figures at this early stage.

2.8.6 <u>Implementation Cost/Schedule</u>

Training hardware and software costs could be negotiated to suit particular ALC needs and budgets.

2.8.6.1 Impact

No schedule impact exists.

2.8.7 <u>Safety Improvements</u>

Not applicable except where safety training is concerned.

2.8.8 Environmental Hazards/Improvements

Not applicable.

2.8.9 Reliability/Maintainability Characteristics

A more highly motivated, trained and competent work force will result.

2.8.10 Human Factors Design Criteria

Employee morale will improve as they realize it enhances their education and they are capable of working on more difficult assignments thus earning promotional career opportunities.