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Airline Enhancement for Shuttle Ground Turnaround

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AIRLINE ENHANCEMENTS FOR SHUTTLE GROUND TURNAROUND

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ABSTRACT

Technical progress in the evolution of a transportation system, is marked by various stages. Namely, concept, design and development, test and verification, and operations. The airline industry has been successfully transitioning high technology equipment through these phases both safely and economically. The techniques which they employ are being effectively applied to the Space Shuttle Program, as it enters the operational era.

INTRODUCTION

Pan Am is working with the Lockheed Space Operations Company and NASA to inject airline techniques and procedures into the shuttle turnaround processing operations at both KSC and VLS. We are currently involved in three primary areas - process planning and control, logistics and operations analysis. It is within this latter area that we have our largest challenge and broadest area of operation. Our task is to identify changes in the processing system which will allow higher launch rates, reduce operating costs and maintain the safety record established by earlier launches. Solutions to this task are obviously varied and complex. However, we are confident that progress can be made by the application of airline operations and maintenance techniques to shuttle processing.

Our operations analysis efforts are focused in three general areas - processing analysis, maintenance analysis and personnel productivity. Processing analysis is concerned with the end-to-end review of the entire ground processing cycle to identify constraints to launch, rate increases, processing deficiencies and cost anomalies. Maintenance analysis focuses on the maintenance program for both flight element and ground support hardware. Personnel productivity could actually be considered a subject of processing analysis. After all, the prime components of the ground processing cycle are the flight hardware elements, ground support facilities and equipment, the processing and maintenance program, spare parts and material, and people. We have emphasized personnel productivity because it is involved in all segments of the processing cycle and is potentially the easiest area to realize improvements. It doesn't cost a lot of money as do increases in spares, new facilities and more reliable flight hardware. It only requires an awareness of non-productive time and a management discipline to correct the conditions causing the non-productivity.

The prime topic for this paper is Pan Am's approach to maintenance analysis for the shuttle program. We are applying airline industry maintenance program techniques to both flight element and ground support hardware. These are based upon our experience with and confidence in the maintenance programs derived through the Maintenance Steering Group (MSG) established by the airline industry.

The airline maintenance concept (MSG-3) analyzes from the consequence of failure standpoint. It establishes an initial maintenance program made up of tasks that are both applicable and effective, while recognizing key safety factors. It also provides for the modification of the initial program through the analysis of operating data. This results in a viable maintenance program over the life of the vehicle. It assures that only those tasks which prevent deterioration of inherent reliability and safety are scheduled during the processing cycle.

MAINTENANCE PROGRAM EVOLUTION

In the early phases of aviation, maintenance programs were developed by a few experienced mechanics. They looked at the airplane, they talked to the manufacturer and they decided what should be done. Also, the maintenance activity was based on the cause and effect relationship of the equipment. Thus, traditional maintenance concepts evolved based on this type of experience.

Early aircraft had very little tolerance for failure. Generally, all parts had to function properly. Many of the early accidents and fatalities were the result of mechanical failures.

The lessons that were learned from these early experiences were:

Mechanical parts wear out.
Wearouts cause failures.
Failures affect safety.

This then became the doctrine of preventive maintenance. It was logical. It was based on experience. It became a tradition.

Traditional Concept

Another way of viewing this traditional cause and effect relationship, as it applies to maintenance programs, is:

Reliability and safety are directly related

or

failures of parts or components have a direct affect on operating safety.

Reliability degrades with increase in age

or

there is a finite unairworthy age for each part.

This traditional concept results in the conclusion that the more frequently equipment was overhauled, the more it was protected from failure.

Thus, in the early phases of aviation, or the make-it-work phase, most of the maintenance emphasis was placed on keeping parts from wearing out. Programs were developed intuitively, and for the most part, they worked quite well.

Relationship Between Reliability and Safety

For many years, these maintenance concepts remained static, while considerable progress was being made in aircraft design. The designers recognized that certain failures could not be effectively prevented or reduced. Therefore, designs incorporated failure-tolerance or redundancy.

Failure-tolerance significantly altered the relationship between reliability and safety.

The reliability of an aircraft is a function of the discrete reliability of its parts which depend on their inherent design qualities. Operating safety is also a function of the inherent design characteristics. The dependence of both reliability and safety upon the inherent design characteristics leads to the conclusion that safety and reliability are necessarily related. This is not so. Another factor controls this relationship, i.e., the ability of the design to retain its essential functions even though failures have occurred.

Thus, where in the early phases of aviation, reliability was directly related to safety, now redundancy or failure-tolerance enhances safety by assuring that system or hardware failures do not degrade operating safety.

Relationship Between Age and Reliability

The rationale for periodic maintenance is to restore resistance to failure prior to the failure occurring. This implies some predictability and an effective task.

However, the time honored belief or perhaps intuitive concept that reliability is directly related to overhaul intervals cannot be confirmed on complex units. For many items, contrary to expectations, likelihood of failure did not increase with increasing time. The failure rates were constant or independent of time. Hundreds of analyses showed that there is no optimum time for overhaul for many complex units. Consequently, maintenance policy based exclusively on operating age has little or no effect on failure rate. As a matter of fact, in many cases, there was an increase in failures due to maintenance induced actions.

By the late 1950's and early 1960's, there was sufficient data and maintenance costs were sufficiently high to question the effectiveness of preventive maintenance vis-a-vis reliability. At the same time, the FAA was frustrated by experience showing that changes in overhaul content or frequency did not produce changes in the failure rates of certain engines.

This lead to the establishment of FAA/Industry reliability programs in the early 1960's. The objective of the reliability programs was to control reliability through an analysis of factors that affect reliability and provide a system of actions to improve reliability. This approach was a direct challenge to the traditional concepts that length of time between overhauls controls failure rates.

The conclusion of this activity led to the recognition that:

> Overhaul has little effect on reliability of complex units.
> Preventative maintenance has no effect on the reliability of certain parts.

Experience with MSG 1/2

The culmination of these activities was the development of MSG-1 and MSG-2 (Maintenance Steering Group) decision-diagram logic. The MSG process ties together safety and economics and the effectiveness of action.

Until the MSG process, maintenance was a craft acquired mostly through experience and rarely examined analytically. The significance of MSG-1/2 is that it introduced engineering discipline into the maintenance program development. It quantified the judgement previously used. It recognized and documented what aircraft had been telling us for years and took into account the inherent design safety of the aircraft and equipment.

MSG-1/2 developed a logic which categorized safety and economics and provided an orderly and disciplined process to:

> Identify all the important elements of the aircraft.
> Analyze their failure mode and effect.
> Develop systems to control these.

These procedures provide a systematic review of the aircraft design so that in the absence of real experience, the best maintenance process could be utilized for each component and system. In all of this effort, however, good technical judgement was still a prerequisite.

The high expectation for the wide body aircraft in the late 1960's have been confirmed by the experience of the 1970's. First, the B747 and subsequently, the DC-10 and L1011 have achieved the highest levels of safety and comfort. From a maintenance program standpoint, the most significant achievement has been the validation and realization of the benefits of the program developed using MSG-1/2 techniques.

MSG-1 was developed for the B747 and the programs implemented were the result of the application of the MSG-1 logic. MSG-1 was revised and updated and then was adopted as MSG-2 for the subsequent DC-10 and L1011 wide body aircraft. The Europeans, working concurrently, adopted some of the same principles and developed EMSG-2 and used it on the Concorde.

The wide body aircraft were the first to exclusively use the MSG-1/2 techniques for their maintenance program development. The resulting programs achieved reliability levels equal to, or better than, those of previous jets, while holding the line on maintenance costs.

Development of MSG-3

Like any other activity, once you have an opportunity to gain experience and see how something works, the process to improve it begins. With MSG-2 now ten years old, we could see where improvement should be made. The revision to MSG-2 was initiated and MSG-3 evolved.

There are a number of differences between MSG-2 and MSG-3. However, MSG-3 does not constitute a fundamental departure from the previous version, it is built upon the existing framework of MSG-2 which has been validated by years of reliable aircraft operation using maintenance programs based thereon.

MSG-3 has adjusted the decision logic flow paths to provide a more rational procedure for task definition and a more straightforward and linear progression through the decision logic.

MSG-3 logic takes a "from the top down" or consequence of failure approach. At the outset, the functional failure is assessed for consequence of failure and is assigned one of two basic categories:

> Safety
> Economics

Further classification determines sub-categories based on whether the failure is evident to or hidden from the operating crew. (For Structures, category designation is "significant" or "other" structure, and all functional failures are considered safety consequence items).

With the consequence category established, only those task selection questions pertinent to the category need be asked. This eliminates unnecessary assessments and expedites the analysis. A definite applicability and effectiveness criteria has been developed to provide a more vigorous selection of tasks. In addition, this approach helps to eliminate items from the analytical procedure whose failures have no significant consequence.

Task selection questions are arranged in a sequence such that the most preferred task, most easily accomplished, is considered first. In the absence of a positive indication concerning the applicability and effectiveness of a task, the next task in sequence must be considered, down to and including possible redesign.

Structures logic has evolved into a form which more directly assesses the possibility of structural deterioration processes. Considerations of fatigue, corrosion, accidental damage, age exploration programs and others, are incorporated into the logic diagram and are routinely considered.

MSG-3 recognizes the new damage tolerance rules of the Federal Aviation Regulations and the supplemental inspection programs. Concepts such as multiple failures, effect of failure on adjacent structure, crack growth from detectable to critical length, and threshold exploration for potential failure, are also covered.

MSG-3 logic is task-oriented and not maintenance process oriented (MSG-2). This eliminates the confusion associated with the various interpretations of Condition Monitoring (CM), On-Condition (OC), Hard Time (HT) and the difficulties encountered when attempting to determine what maintenance was being accomplished to an item that carried one of the process labels.

Servicing/Lubrication is included to ensure that important task is considered each time an item is analyzed.

Treatment of hidden functional failures is more thorough than that of MSG-2.

The effect of concurrent or multiple failure is considered. Sequential failure concepts are used as part of the hidden functional failure assessment (Systems, Powerplant) and multiple failure is considered in structural evaluation.

There is a clear separation between tasks that are economically desirable and those that are required for safe operation.

The structures decision logic no longer contains a specific numerical rating system. The responsibility for developing rating systems has been assigned to the individual maintenance program review teams.

EFFICIENT MAINTENANCE PROGRAM

The prime purpose of MSG-3 is to assist in the development of an initial scheduled maintenance program for new types of aircraft and/or powerplants. The purpose of the program developed is to maintain the inherent safety and reliability levels of equipment.

It is desirable, therefore, to define the objectives and the content of an efficient maintenance program and the method by which the program can be developed.

The objectives of an efficient airline maintenance program are:

> To ensure realization of the inherent safety and reliability levels of equipment.
> To restore safety and reliability to their inherent levels when deterioration has occurred.
> To obtain the information necessary for design improvement of those items whose inherent reliability proves inadequate.
> To accomplish these goals at minimum total cost, including maintenance costs and the costs of residual failures.

These objectives recognize that maintenance programs, as such, cannot correct deficiencies in the inherent safety and reliability levels of the equipment. The maintenance program can only prevent deterioration of such inherent levels. If the inherent levels are found to be unsatisfactory, design modification is necessary to obtain improvement.

The content of the maintenance program itself consists of two groups of tasks:

1) A group of scheduled tasks to be accomplished at specified intervals. The objective of these tasks is to prevent deterioration of the inherent safety and reliability levels of the equipment. The tasks in a scheduled maintenance program may include:

    Lubrication/Servicing
    Operating Crew Monitoring
    Operational Check
    Inspection/Functional Check
    Restoration
    Discard
    Combinations of the above

2) A group of non-scheduled tasks which result from:

The scheduled tasks accomplished at other than the specified intervals.
Reports of malfunctions (usually originated by the operating and maintenance crews).
Data analysis.

The objective of these non-scheduled tasks is to restore the equipment to an acceptable condition.

An efficient program is one which schedules only those tasks necessary to meet the stated objectives. It does not schedule additional tasks which will increase maintenance costs without a corresponding increase in reliability protection.

MSG-3 describes the method for developing the scheduled maintenance program. Non-scheduled maintenance results from scheduled tasks, normal operation or data analysis.

MSG-3 System/Powerplant Analysis Method

The first essential element is to identify all the Maintenance Significant Items (MSI).

Selection of an MSI begins at the highest manageable level, i.e., system, subsystem, component or part. MSI's are identified as those whose failure:

Could affect safety (on ground or in flight) and/or
Is detectable during operations, and/or
Could have significant operational economic impact, and/or
Could have significant non-operational economic impact.

Once identified, then each MSI must have documented, its:

Function - the normal characteristic actions of the item.
Functional failure - how an items fails to perform its function.
Failure effect - what is the result of functional failure.
Failure cause - why failure occurs.

For each significant item, an analysis of the functional failures, failure causes and the applicability and effectiveness of the tasks must be carried out. Each functional failure will be processed through the logic into one of the five consequence of failure categories.

The process begins at the operating crew level by asking the question:

> IS THE OCCURRENCE OF A FUNCTIONAL FAILURE EVIDENT TO THE OPERATING CREW DURING THE PERFORMANCE OF NORMAL DUTIES?

This question is asked for each functional failure. It is intended to segregate the evident and hidden failures from the operating crew perspective.

A hidden function is defined as one which:

Is normally active and whose cessation will not be evident to the operating crew during their performance of normal duties.

Is normally inactive and whose readiness to perform prior to it being needed, will not be evident to the operating crew during performance of their normal duties.

A "YES" answer leads to the following question:

> DOES THE FUNCTIONAL FAILURE OR SECONDARY DAMAGE RESULTING FROM THE FUNCTIONAL FAILURE HAVE A DIRECT ADVERSE EFFECT ON OPERATING SAFETY?

In order to answer this question, the following definitions are in order:

Direct - a direct functional failure achieves its effect by itself and not in combination with other functional failures.

Adverse Effect on Safety - consequence of failure are extremely serious, may cause loss of vehicle and/or injury to occupants.

Operating - this is the interval of time from the moment the vehicle is operating under its own power to the moment it comes to rest at the next point of landing.

A "YES" answer leads to the safety effects category for task determination. A "YES" answer requires that there be an applicable and effective task or the part must be redesigned.

A "NO" answer indicates an economic effect and these tasks are developed based on the functional failure effect on the capability of the aircraft to perform its operating mission requirement.

This is taken into account by asking:

> DOES THE FUNCTIONAL FAILURE HAVE A DIRECT ADVERSE EFFECT ON OPERATING CAPABILITY?

The question reviews consequence of failure which:

> Would require correction prior to dispatch.
> Would compromise the mission flexibility by imposing operating restrictions.

This question is asked of each evident, non-safety functional failure. The task selection process then goes down the appropriate paths based on a "YES" or "NO" response.

The process described so far covers evident functional failures. However, had the answer to the initial question been "NO", indicating that the functional failure was not evident to the operating crew, then one further question is required before the determination of the consequence of failure is completed.

The question which must be asked in this case:

> DOES THE COMBINATION OF A HIDDEN FUNCTIONAL FAILURE AND ONE ADDITIONAL FAILURE OF A SYSTEM RELATED OR BACK-UP FUNCTION HAVE AN ADVERSE EFFECT ON OPERATING <u>SAFETY</u>?

Again, this question is asked for each <u>hidden</u> functional failure. It takes into account failures in which the loss of one hidden function alone, i.e., a failure unknown to operating crews does not affect safety; however, in combination with an additional functional failure, has a adverse effect on operating safety.

Depending on either a "YES" or "NO" answer, tasks are developed for <u>safety</u> or <u>economic</u> considerations.

The MSG-3 process described to this point covers the consequence of failure category. Based on the logic path followed, each functional failure will fall into one of the following effect categories:

> Safety
> Operational (economic)
> Non-Operational (economic)
> Hidden, Safety
> Hidden, Non-Safety (economic)

Each of these categories contains a task definition logic which must be completed to develop an applicable and effective task.

Task development is handled in a similar manner for each of the five effect categories. For task determination, it is necessary to apply the failure causes for the functional failure to the second level of the logic. There are seven possible task resultant questions in the Effect categories. See Figure 1.

The MSG-3 method for conducting structural item analysis is quite extensive and therefore, only a brief outline of the process will be discussed here.

The process is designed to relate the scheduled maintenance program to consequences of structural item functional failure. The structures susceptability to damage and the degree of difficulty involved in detecting such damage. Once this is established, the effectiveness of several levels of inspections and accomplishment are evaluated and the results compared. Finally, based on the most effective combination, a structural maintenance program is determined.

The important elements of the process are:

> Identify items as Structural Significant Items (SSI) or Other Structure.
> A Structural Significant Item (SSI) is a structural detail, a structural element, or a structural assembly, which is judged significant because of the reduction in aircraft residual strength or loss of structural function which are consequences of its failure.
> Other Structure is that which is judged not to be a Structural Significant Item. It is defined both externally and internally within zonal boundaries.
> Classify SSI's as damage tolerant of safe-life structure.
> An item is judged to be damage tolerant if it can sustain damage and the remaining structure can withstand reasonable loads without structural failure or excessive structural deformation until the damage is detected.
> Safe-life Structure is structure which is not practical to design or qualify as damage tolerant:
>
> Its reliability is protected by discard limits which remove items from service before failures are expected.

For each damage tolerant SSI, rate separately its susceptibility to each of the three deterioration processes:

- Fatigue
- Environmental deterioration
- Accidental damage

Select for each damage tolerant SSI the following inspection features:

- Level and method of inspection
- Inspection of threshold
- Frequency of inspection (repeat interval)
- Fleet leader/age exploration program, if applicable

For each safe-life SSI, rate separately its susceptibility to the two deterioration processes:

- Environmental
- Accidental Damage

Select for each safe-life SSI the following inspection features:

- Level and method of inspection
- Threshold of initial inspection (if appropriate)
- Frequency of inspection (repeat interval)

Overlay the inspection requirements for each SSI according to the deterioration processes for which it was rated. Consolidate tasks and document the results.

For Other Structure, establish appropriate maintenance tasks based on:

Past experience, and/or

Manufacturer's recommendation for new materials and/or concepts.

APPLICATION OF MSG-3 TO SHUTTLE

A project was initiated in 1982 by Pan Am, under contract to Rockwell International at Downey, California, to develop a Shuttle Maintenance Steering Group - 1 (SMSG-1) system for application to Space Shuttle, based on the MSG-3 analytical system. During fiscal year '83, the SMSG-1 was developed and applied to three orbiter systems and the aft fuselage structure. The resulting maintenance tasks were compared with the existing maintenance requirements (OMRSD) with the following conclusions:

- Existing OMRSD requirements are not excessive.
- SMSG reveals a valid need to add some tasks for detection of failure of hidden functions.
- SMSG performs a valuable systematic audit function.
- Assures important requirements are not overlooked, deleted.
- Assures current requirements are justified (not excessive).
- Provides a data base for evaluating future proposed changes.

SMSG structural analysis will provide a comprehensive, cost effective structural inspection requirements plan.

An extension of the project into 1984/85 has been made to apply SMSG-1 analysis to the remainder of the orbiter systems and develop the structural inspection requirements for the entire Orbiter.

APPLICATION OF MSG-3 TO SHUTTLE GSE (Fig. 2)

The great quantity of ground support equipment at KSC, its complexity and the enormous number of man hours spent maintaining it prompted the question - Can application of MSG-3 concepts to the GSE produce efficient maintenance programs, while retaining the inherent safety and reliability of the equipment?

The Pan Am team at KSC, under SPC, initiated a project to develop an adaptation of MSG-3 for GSE. The acronym, 'SEMSG-1' was selected for identification and stands for, "Support Equipment Maintenance Steering Group", First issue. The SEMSG-1 User's Guide was developed to supplement the MSG-3 document in producing the GSE maintenance programs.

The first piece of GSE selected for application of the SEMSG-1 concepts was a new mobile aerial work platform (cherry picker) with a 170 foot vertical reach, the Condor 170.

The analysis is complete and an example is attached as Appendix I. The complete maintenance program is still under development. However, the sample indicates the program will be successful in meeting its goals.

SPACE SHUTTLE MAINTENANCE PROGRAM

The Space Shuttle maintenance program is presently made up of the following elements:

The Operational Maintenance Requirements and Specifications Documents (OMRSD) are the basis of the Shuttle routine maintenance programs. The requirements were established during Shuttle development by the manufacturers of the Orbiter, ET and SRB's in conjunction with and approval of NASA. Now that the Shuttle is operational, these requirements need constant review to keep the maintenance program viable and effective and to reduce costs while ensuring the desired level of safety is maintained (See Figure 3).

The Operational Maintenance Instructions (OMI's), also part of the routing maintenance program, translate the OMRSD into a working document which provides the step by step procedures for doing the tasks required on the Shuttle elements. It also sets the material and ground support equipment requirements. The OMI's need review to insure the OMRSD requirements are not exceeded and that the tasks are performed in a safe and efficient manner (See Figure 4). The OMI system will be replaced by a Job Card system to streamline the control, handling and accomplishment of the tasks.

The non-routine part of the maintenance program originates from flight anomalies (Figure 5) and inspection/test generated discrepancy items (Figure 6). This is the part of the maintenance program that restores the safety and reliability to their inherent levels when deterioration has occurred. It also is telling us something very important, if we are listening. It is like going to a doctor when you don't feel "up to par". He examines you, runs various tests, X-rays, etc., analyzes your symptoms and results of the tests, than gives you some medication or puts you in the hospital to correct your immediate problems. To complete the process, he then advises you what changes you must make in your lifestyle to keep these problems from recurring. The same is true of our Shuttle maintenance programs. We must analyze the anomalies and problem reports to determine if routine programs are keeping our Shuttle healthy, safe and efficient.

MAINTENANCE INFORMATION FEEDBACK SYSTEMS

The maintenance process, to remain dynamic and efficient, must have an effective monitoring system. This is provided in the airlines through Maintenance Information Feedback Systems. These systems are developed from the user standpoint, thus, assuring an effective program.

The first phase of the program is to determine what data needs to be retained to provide a measure of the various aspects of performance. The data sources can be component unscheduled removals, systems test discrepancies, flight anomalies, inspection findings, launch delays, etc.. Once collected, the data must be cataloged to enable those needing the data to retrieve it in a logical, usable manner. The data is then analyzed to determine what it can tell us, if we ask the right questions:

> Do we have a problem affecting safety?
> What is the economic impact?
> Are we exceeding our economic projections?.
> Will we be exposed to possible launch delays?
> Is the maintenance program adequate?

A good information feedback system can provide the answers for these questions and many more.

Therefore, we propose to review the present data gathering, cataloging, retrieval and analysis systems to determine their adequacy in supporting the maintenance process.

EFFECT CATEGORIES						
EVIDENT SAFETY	EVIDENT OPERATIONAL (ECONOMIC)	EVIDENT NON-OPERATIONAL (ECONOMIC)	HIDDEN SAFETY	HIDDEN NON-SAFETY (ECONOMIC)	TASK QUESTIONS	YES/NO
●	●	●	●	●	A. IS LUBRICATING OR SERVICE TASK APPLICABLE AND EFFECTIVE?	
●	●	●			B(1). IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY OPERATING PERSONNEL MONITORING APPLICABLE AND EFFECTIVE?	
			●	●	B(2). IS CHECK TO VERIFY OPERATION APPLICABLE AND EFFECTIVE? (FAILURE FINDING TASK).	
●	*●	*●	●	*●	C. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY ON-UNIT OR OFF-UNIT TASK(S) APPLICABLE AND EFFECTIVE?	
●	*●	*●	●	*●	D. IS RESTORATION TASK TO REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	
●	*●	*●	●	*●	E. IS DISCARD TASK TO AVOID FAILURES OR REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	
●			●		F. IS THERE A TASK OR COMBINATION OF TASKS WHICH IS APPLICABLE AND EFFECTIVE?	

*USE ONLY IF ANSWER TO PREVIOUS QUESTION IS "NO".

FOR "YES" ANSWER, DESCRIBE TASK. FOR "NO" ANSWER, STATE WHY.

Figure 1

MSG-3 APPLICATION TO STS GSE

- FIRST YEAR — FY 1984
  - USING MSG-3 ANALYTICAL SYSTEM AS A BASIS, DEVELOP SEMSG-1 SYSTEM FOR APPLICATION TO SPACE SHUTTLE GROUND SUPPORT EQUIPMENT
  - APPLY SEMSG-1 ANALYSIS TO SELECTED GSE:
    - SHUTTLE NON-FLIGHT HARDWARE GSE
    - GROUND FACILITIES
    - SHUTTLE FLIGHT HARDWARE GSE
  - COMPARE SEMSG-1 RESULTING MAINTENANCE TASKS WITH EXISTING REQUIREMENTS
  - EVALUATE RESULTS OF ANALYSIS AND COMPARISON
  - REVISE REQUIREMENTS TO ADD, DELETE OR CHANGE MAINTENANCE TASKS AS SUBSTANTIATED BY SEMSG-1 ANALYSIS
- SECOND YEAR - FY 1985 AND CONTINUING
  - APPLY SEMSG-1 ANALYSIS TO REMAINDER OF SHUTTLE GSE
  - COMPARE SEMSG-1 RESULTING MAINTENANCE TASKS WITH EXISTING REQUIREMENTS
  - ESTABLISH MAINTENANCE INFORMATION SYSTEM TO MONITOR GSE MAINTENANCE PROGRAMS

Figure 2

OMRSD

BASIC ROUTINE MAINTENANCE PROGRAM

OPERATIONAL AND FUNTIONAL TESTS
SERVICING ITEMS
COMPONENT REPLACEMENTS
STRUCTURAL INSPECTION PROGRAM
SYSTEMS INSPECTION PROGRAM

THESE WILL BE REVIEWED TO:

1. RE-ESTABLISH THE NEED FOR THEIR EXISTANCE
2. RE-ESTABLISH THE FREQUENCY REQUIREMENTS
3. INVESTIGATE FOR REDUCTION IN TASK LEVEL AND SCOPE

Figure 3

OMI'S
(WORK ITEMS)

SET THE MATERIAL AND GROUND SUPPORT REQUIREMENTS TO ACCOMPLISH THE OMRSD'S AND PROVIDE THE STEP BY STEP PROCEDURES FOR ACCOMPLISHING THE ACTUAL WORK

THESE WILL BE REVIEWED TO:

1. VERIFY WORK CONTENT COMPLIES WITH AND DOES NOT EXCEED OMRSD REQUIREMENTS
2. SIMPLIFY WORK PROCEDURES
3. GAIN INFORMATION REGARDING GROUND SUPPORT EQUIPMENT REQUIREMENTS AND INTERFACES.

Figure 4

FLIGHT ANOMALIES

(FLIGHT LOG ITEMS OR
IN-FLIGHT DISCREPANCIES)

PART OF NON-ROUTINE MAINTENANCE PROGRAM

COMPONENT FAILURES
SYSTEM MAL FUNCTIONS

THESE WILL BE REVIEWED TO:

1. DETERMINE THE SIGNIFICANCE OF THE FAILURE AND ITS EFFECT ON SAFETY AND/OR ECONOMIC IMPACT.
2. DETERMINED ADEQUACY OF MAINTENANCE PROGRAM.

Figure 5

INSPECTION/TEST GENERATED DISCREPANCY ITEMS

THESE ARE NON-ROUTINE ITEMS RESULTING FROM STRUCTURAL AND SYSTEMS ROUTINE INSPECTIONS. ALSO, ARE ANOMALIES FOUND DURING SYSTEMS TESTS AND CHECK OUTS.

WE WILL REVIEW THESE FOR:

1. STRUCTURAL OR SYSTEMS DEFECTS/ANOMALIES WHICH WILL DICTATE A MORE RESTRICTIVE INSPECTION/MAINTENANCE PROGRAM.
2. ABSENCE OF DEFECTS/ANOMALIES WHICH WILL DICTATE A MORE LIBERAL INSPECTION/MAINTENANCE PROGRAM.

Figure 6

AIRLINE MAINTENANCE INFORMATION SYSTEMS

- **TYPICAL AIRLINE DATA REPORTS**
  - AIRCRAFT SYSTEM PROBLEM ALERTS
  - FLIGHT DEPARTURE DELAYS
  - FLIGHT CANCELLATIONS
  - COMPONENT REMOVAL/FAILURE RATES
  - COMPONENT FAILURE ANALYSIS
    - BY SERIAL NO.
    - BY AIRCRAFT
    - BY FAILURE TYPE
  - INSPECTION FINDINGS
    - BY AIRCRAFT ZONE FOR STRUCTURES
    - BY ATA CHAPTER FOR SYSTEMS
- **RESULTING ACTIONS**
  - REVISE MAINTENANCE PROGRAM REQUIREMENTS
    - ADD ITEMS (TEST OR INSPECTION)
    - REVISE SCOPE OF WORK
    - REVISE FREQUENCY OF ACCOMPLISHMENT
  - REVISE MAINTENANCE OR OPERATIONS MANUALS
  - MODIFY AIRCRAFT AND/OR COMPONENTS
  - REVISE SPARES REQUIREMENTS

Figure 7

AIRLINE ENHANCEMENTS FOR
SHUTTLE GROUND TURNAROUND

APPENDIX I

TYPICAL
SEMSG-1 ANALYSIS

----- 0 -----

CALAVAR

CONDOR MODEL 170

SYSTEM

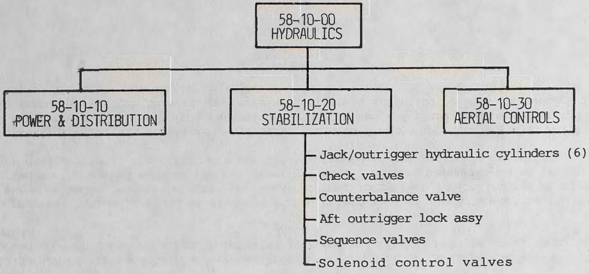
HYDRAULIC

SUB-SYSTEM

STABILIZATION

IDENTIFICATION NUMBER	ITEM
58-10-20 SYSTEM/SUBSYSTEM	HYDRAULICS - STABILIZATION

SYSTEM BREAKDOWN AND FUNCTIONAL DESCRIPTION:



Form F1 Feb. 13/84

Prepared by: ______________ Date: ______________

SYSTEM BREAKDOWN AND FUNCTIONAL DESCRIPTION

IDENTIFICATION NUMBER 58-10-20 SYSTEM/SUBSYSTEM	ITEM HYDRAULICS - STABILIZATION

SYSTEM BREAKDOWN AND FUNCTIONAL DESCRIPTION:

The vehicle platform is leveled and stabilized by four hydraulic cylinders. Two forward jacks are mounted in the end of the front bumper frame. The two aft jacks are mounted on outriggers and are spread horizontally outward from the vehicle frame by the outrigger hydraulic cylinder.

Leveling and stabilization of the vehicle platform must be accomplished prior to using the aerial lift functions. Limit switches mounted on each jack and wired in parallel lock out all other functions until each jack is firmly positioned and loaded.

During the jacking process, hydraulic fluid is directed to the extend side of the actuators by the solenoid operated control valve. A sequence valve causes the outrigger lock cylinder to retract, unlocking the outrigger assembly. Fluid is then directed to the extend side of the outrigger cylinder. A second sequence valve prevents extension of the vertical jack cylinder until the outriggers are fully extended in the horizontal direction.

When the vehicle is fully leveled and stabilized, hydraulic fluid is "locked in" the jack cylinder by check valves in both the extend and retract lines. Thermal expansion of the "locked in" fluid could move the cylinder piston and unlevel the platform. To prevent this, a counterbalance valve is installed between the extend and return lines to allow equalization of the pressures in the cylinder.

Form F1 Feb. 13/84 Prepared by: Date:

FUNCTIONS/FUNCTIONAL FAILURE

IDENTIFICATION NUMBER	ITEM
58-10-20 SYSTEM/SUBSYSTEM	HYDRAULICS - STABILIZATION

FUNCTION(S) (Identify each by no.)	FUNCTIONAL FAILURE(S)	FAILURE EFFECT(S) (Only one effect per failure)	FAILURE CAUSE(S) (Identify each by no. and letter
1. Jack up & level vehicle platform.	1. Fails to jack up & level vehicle bed.	1. Loss of vehicle use.	1.A Solenoid operated control valve(s) inoperative. 1.B Aft outrigger locking cylinder inoperative. 1.C Aft outrigger sequence valve fails open. 1.D Outrigger extension binding. 1.E Counterbalance valve failed open.
2. Maintain stable vehicle platform under all load conditons & directions.	2. Fails to maintain stable vehicle platform under all load conditions & directions.	2. Possible vehicle upset with personnel injuries.	2.A One or more jack cylinders bypassing or leaking. 2.B One or more check valves leaking. 2.C Counterbalance valve fails open.

Form F2 Feb. 13/84

Prepared by: ____________________ Date: ____________

FAILURE EFFECT CATEGORY

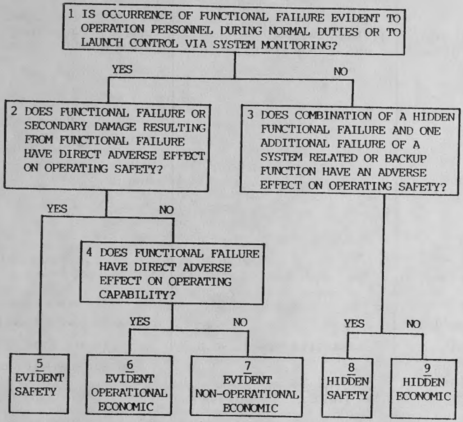
ITEM: HYDRAULICS - STABILIZATION

FAILURE: Fails to jack up and level vehicle platform.

FAILURE EFFECT: Loss of vehicle use.

IDENTIFICATION NO.
58-10-20
FUNCTION: 1.
FAILURE: 1.

FAILURE EFFECT CATEGORY



QUESTION NO. (Answer and explain)

1. Yes - Operator has to visually monitor each jack position to properly level and stabilize vehicle platform.

②/3. No - Aerial platform would still be in a stowed position.

4. Yes - Aerial controls cannot be operated until vehicle level & stabilized. Use of vehicle is lost until discrepancy corrected

CATEGORY: 6, Evident Operational Economic

Form F3 Feb. 13/84

Prepared by: ____________________ Date: __________

SELECTED TASKS/FREQUENCY DETERMINATION

ITEM: HYDRAULICS - STABILIZATAION

FAILURE CAUSE: 1A. SOLENOID OPERATED CONTROL VALVE INOPERATIVE

IDENTIFICATION NO. 58-10-20

EFFECT CATEGORY					QUESTION	YES/NO	DESCRIBE/STATE WHY (see note)
5	[✓ 6]	7	8	9			
o	o	o	o	o	A. IS LUBRICATING OR SERVICE TASK APPLICABLE AND EFFECTIVE?	NO	No consumables to replenish.
o	o	o			B. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY OPERATING PERSONNEL MONITORING APPLICABLE AND EFFECTIVE?	NO	Reduced resistance to failure is not detectable nor is rate of resistance to failure predictable.
			o	o	B. IS CHECK TO VERIFY OPERATION APPLICABLE AND EFFECTIVE? (FAILURE FINDING TASK).		
o	* o	* o	o	* o	C. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY ON-UNIT OR OFF-UNIT TASK(S) APPLICABLE AND EFFECTIVE?	NO	Reduced resistance to failure is not detectable nor is rate of resistance to failure predictable.
o	* o	* o	o	* o	D. IS RESTORATION TASK TO REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o	* o	* o	o	* o	E. IS DISCARD TASK TO AVOID FAILURES OR REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o			o		F. IS THERE A TASK OR COMBINATION OF TASKS WHICH IS APPLICABLE AND EFFECTIVE?		

* Use only if answer to previous question is "NO".

Note: If answer to question is "YES", describe; if "NO", state why.

SELECTED TASK None

FREQUENCY: None

REDESIGN: ☐ MANDATORY ☐ DESIRABLE ☒ NOT REQUIRED

SELECTED TASKS/FREQUENCY DETERMINATION

ITEM: HYDRAULICS - STABILIZATION

FAILURE CAUSE: 1B. AFT OUTRIGGER LOCKING CYLINDER INOPERATIVE

IDENTIFICATION NO. 58-10-20

EFFECT CATEGORY					QUESTION	YES/NO	DESCRIBE/STATE WHY (see note)
5	[✓ 6]	7	8	9			
o	o	o	o	o	A. IS LUBRICATING OR SERVICE TASK APPLICABLE AND EFFECTIVE?	YES	Lubricate mechanical portion of lock.
o	o	o			B. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY OPERATING PERSONNEL MONITORING APPLICABLE AND EFFECTIVE?	NO	Reduced resistance to hydraulic failure is not detectable nor is rate of resistance to failure predictable.
			o	o	B. IS CHECK TO VERIFY OPERATION APPLICABLE AND EFFECTIVE? (FAILURE FINDING TASK).		
o	* o	* o	o	* o	C. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY ON-UNIT OR OFF-UNIT TASK(S) APPLICABLE AND EFFECTIVE?	NO	Reduced resistance to hydraulic failure is not detectable nor is rate of resistance to failure predictable.
o	* o	* o	o	* o	D. IS RESTORATION TASK TO REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o	* o	* o	o	* o	E. IS DISCARD TASK TO AVOID FAILURES OR REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o			o		F. IS THERE A TASK OR COMBINATION OF TASKS WHICH IS APPLICABLE AND EFFECTIVE?		

* Use only if answer to previous question is "NO".

Note: If answer to question is "YES", describe; if "NO", state why.

SELECTED TASK: Lubricate mechanical portion of aft outrigger locking cylinder.

FREQUENCY: Every six months.

REDESIGN: ☐ MANDATORY ☐ DESIRABLE ☒ NOT REQUIRED

SELECTED TASKS/FREQUENCY DETERMINATION

ITEM: HYDRAULICS - STABILIZATAION

FAILURE CAUSE: 1C. AFT OUTRIGGER SEQUENCE VALVE STUCK OPEN

IDENTIFICATION NO. 58-10-20

EFFECT CATEGORY					QUESTION	YES/NO	DESCRIBE/STATE WHY (see note)
5	[✓ 6]	7	8	9			
o	o	o	o	o	A. IS LUBRICATING OR SERVICE TASK APPLICABLE AND EFFECTIVE?	NO	No consumables to replenish.
o	o	o			B. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY OPERATING PERSONNEL MONITORING APPLICABLE AND EFFECTIVE?	NO	Reduced resistance to failure is not detectable nor is rate of resistance to failure predictable.
			o	o	B. IS CHECK TO VERIFY OPERATION APPLICABLE AND EFFECTIVE? (FAILURE FINDING TASK).		
o	* o	* o	o	* o	C. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY ON-UNIT OR OFF-UNIT TASK(S) APPLICABLE AND EFFECTIVE?	NO	Reduced resistance to failure is not detectable nor is rate of resistance to failure predictable.
o	* o	* o	o	* o	D. IS RESTORATION TASK TO REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o	* o	* o	o	* o	E. IS DISCARD TASK TO AVOID FAILURES OR REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o			o		F. IS THERE A TASK OR COMBINATION OF TASKS WHICH IS APPLICABLE AND EFFECTIVE?		

* Use only if answer to previous question is "NO".

Note: If answer to question is "YES", describe; if "NO", state why.

SELECTED TASK None

FREQUENCY: None

REDESIGN: ☐ MANDATORY ☐ DESIRABLE ☒ NOT REQUIRED

SELECTED TASKS/FREQUENCY DETERMINATION

ITEM: HYDRAULICS - STABILIZATION

FAILURE CAUSE: 1D. OUTRIGGER EXTENSION BINDING

IDENTIFICATION NO. 58-10-20

EFFECT CATEGORY					QUESTION	YES/NO	DESCRIBE/STATE WHY (see note)
5	[✓ 6]	7	8	9			
o	o	o	o	o	A. IS LUBRICATING OR SERVICE TASK APPLICABLE AND EFFECTIVE?	YES	Lubricate mechanical portion of outriggers.
o	o	o			B. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY OPERATING PERSONNEL MONITORING APPLICABLE AND EFFECTIVE?	YES	Noisy or "chattering" extension of outrigger will be obvious to operator.
			o	o	B. IS CHECK TO VERIFY OPERATION APPLICABLE AND EFFECTIVE? (FAILURE FINDING TASK).		
o	* o	* o	o	* o	C. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY ON-UNIT OR OFF-UNIT TASK(S) APPLICABLE AND EFFECTIVE?		
o	* o	* o	o	* o	D. IS RESTORATION TASK TO REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?		
o	* o	* o	o	* o	E. IS DISCARD TASK TO AVOID FAILURES OR REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?		
o			o		F. IS THERE A TASK OR COMBINATION OF TASKS WHICH IS APPLICABLE AND EFFECTIVE?		

* Use only if answer to previous question is "NO".

Note: If answer to question is "YES", describe; if "NO", state why.

SELECTED TASK Lubricate mechanical portion of outriggers.

FREQUENCY: Every six months.

REDESIGN: ☐ MANDATORY ☐ DESIRABLE ☒ NOT REQUIRED

SELECTED TASKS/FREQUENCY DETERMINATION

ITEM: HYDRAULICS - STABILIZATION

FAILURE CAUSE: 1E. COUNTERBALANCE VALVE FAILED OPEN

IDENTIFICATION NO. 58-10-20

EFFECT CATEGORY					QUESTION	YES/NO	DESCRIBE/STATE WHY (see note)
5	[✓ 6]	7	8	9			
o	o	o	o	o	A. IS LUBRICATING OR SERVICE TASK APPLICABLE AND EFFECTIVE?	NO	No consumables to replenish.
o	o	o			B. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY OPERATING PERSONNEL MONITORING APPLICABLE AND EFFECTIVE?	NO	Reduced resistance to failure is not detectable nor is rate of resistance to failure predictable.
			o	o	B. IS CHECK TO VERIFY OPERATION APPLICABLE AND EFFECTIVE? (FAILURE FINDING TASK).		
o	* o	* o	o	* o	C. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY ON-UNIT OR OFF-UNIT TASK(S) APPLICABLE AND EFFECTIVE?	NO	Reduced resistance to failure is not detectable nor is rate of resistance to failure predictable.
o	* o	* o	o	* o	D. IS RESTORATION TASK TO REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o	* o	* o	o	* o	E. IS DISCARD TASK TO AVOID FAILURES OR REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o			o		F. IS THERE A TASK OR COMBINATION OF TASKS WHICH IS APPLICABLE AND EFFECTIVE?		

* Use only if answer to previous question is "NO".

Note: If answer to question is "YES", describe; if "NO", state why.

SELECTED TASK None

FREQUENCY: None

REDESIGN: ☐ MANDATORY ☐ DESIRABLE ☒ NOT REQUIRED

FAILURE EFFECT CATEGORY

ITEM: HYDRAULICS - STABILIZATION

FAILURE: Fails to maintain stable vehicle platform under all load conditions & directions.

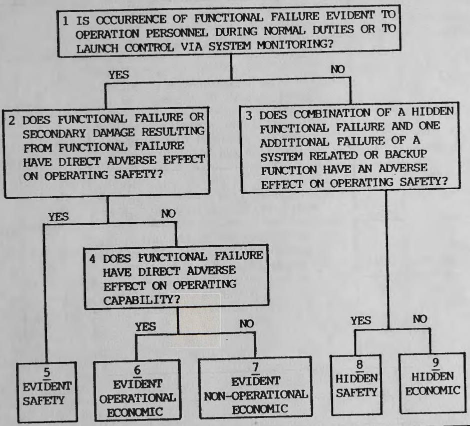
FAILURE EFFECT: Possible vehicle upset and personnel injuries.

IDENTIFICATION NO. 58-10-20

FUNCTION: 2.

FAILURE: 2.

FAILURE EFFECT CATEGORY



1 IS OCCURRENCE OF FUNCTIONAL FAILURE EVIDENT TO OPERATION PERSONNEL DURING NORMAL DUTIES OR TO LAUNCH CONTROL VIA SYSTEM MONITORING?

2 DOES FUNCTIONAL FAILURE OR SECONDARY DAMAGE RESULTING FROM FUNCTIONAL FAILURE HAVE DIRECT ADVERSE EFFECT ON OPERATING SAFETY?

3 DOES COMBINATION OF A HIDDEN FUNCTIONAL FAILURE AND ONE ADDITIONAL FAILURE OF A SYSTEM RELATED OR BACKUP FUNCTION HAVE AN ADVERSE EFFECT ON OPERATING SAFETY?

4 DOES FUNCTIONAL FAILURE HAVE DIRECT ADVERSE EFFECT ON OPERATING CAPABILITY?

QUESTION NO. (Answer and explain)

1. No - There are no hydraulic pressure gauges or sensors in jack struts. A loss of pressure in any strut would not be known until it failed to hold load.

2. ③ Yes - Loss of vehicle stability in conjunction with a Stability Warning System failure could result in vehicle upset and personnel injuries.

4.

CATEGORY: 8, Hidden Safety

Form F3 Feb. 13/84

Prepared by: ____________________ Date: __________

SELECTED TASKS/FREQUENCY DETERMINATION

ITEM: HYDRAULICS - STABILIZATION

FAILURE CAUSE: 2A. ONE OR MORE JACK CYLINDERS BYPASSING OR LEAKING

IDENTIFICATION NO. 58-10-20

EFFECT CATEGORY					QUESTION	YES/NO	DESCRIBE/STATE WHY (see note)
5	6	7	⑧	9			
o	o	o	o	o	A. IS LUBRICATING OR SERVICE TASK APPLICABLE AND EFFECTIVE?	NO	No consumables to replenish.
o	o	o			B. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY OPERATING PERSONNEL MONITORING APPLICABLE AND EFFECTIVE?		
			o	o	B. IS CHECK TO VERIFY OPERATION APPLICABLE AND EFFECTIVE? (FAILURE FINDING TASK).	YES	A test to demonstrate unit can lift and hold the rated load would be effective. Also, a visual inspection for external leaks during procedure.
o	* o	* o	o	* o	C. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY ON-UNIT OR OFF-UNIT TASK(S) APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o	* o	* o	o	* o	D. IS RESTORATION TASK TO REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o	* o	* o	o	* o	E. IS DISCARD TASK TO AVOID FAILURES OR REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o			o		F. IS THERE A TASK OR COMBINATION OF TASKS WHICH IS APPLICABLE AND EFFECTIVE?	YES	Perform rated load test and visually inspect for leaks.

* Use only if answer to previous question is "NO".

Note: If answer to question is "YES", describe; if "NO", state why.

SELECTED TASK
1. Perform "Stab. Test" in accordance with Calavar. Maint. Manual.
2. Perform visual inspection for external leak.

FREQUENCY:
1. Every six months
2. Once each use

REDESIGN: ☐ MANDATORY ☐ DESIRABLE ☒ NOT REQUIRED

Form F4

Prepared by: ____________________ Date: ____________

SELECTED TASKS/FREQUENCY DETERMINATION

ITEM: HYDRAULICS - STABILIZATION

FAILURE CAUSE: 2B. ONE OR MORE CHECK VALVES LEAKING

IDENTIFICATION NO. 58-10-20

EFFECT CATEGORY					QUESTION	YES/NO	DESCRIBE/STATE WHY (see note)
5	6	7	[✓ 8]	9			
o	o	o	o	o	A. IS LUBRICATING OR SERVICE TASK APPLICABLE AND EFFECTIVE?	NO	No consumables to replenish.
o	o	o			B. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY OPERATING PERSONNEL MONITORING APPLICABLE AND EFFECTIVE?		
			o	o	B. IS CHECK TO VERIFY OPERATION APPLICABLE AND EFFECTIVE? (FAILURE FINDING TASK).	YES	A test to demonstrate unit can lift and hold rated load would be effective.
o	* o	* o	o	* o	C. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY ON-UNIT OR OFF-UNIT TASK(S) APPLICABLE AND EFFECTIVE?	NO	Reduced resistance to failure is not detectable nor is rate of resistance to failure predictable.
o	* o	* o	o	* o	D. IS RESTORATION TASK TO REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o	* o	* o	o	* o	E. IS DISCARD TASK TO AVOID FAILURES OR REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The item does not show functional degradation characteristics at an identifiable age.
o			o		F. IS THERE A TASK OR COMBINATION OF TASKS WHICH IS APPLICABLE AND EFFECTIVE?	YES	Perform rated load test.

* Use only if answer to previous question is "NO".

Note: If answer to question is "YES", describe; if "NO", state why.

SELECTED TASK: Perform "Stab. Test" in accordance with instructions in Calavar Maintenance Manual.

FREQUENCY: Every six months.

REDESIGN: ☐ MANDATORY ☐ DESIRABLE ☒ NOT REQUIRED

SELECTED TASKS/FREQUENCY DETERMINATION

ITEM: HYDRAULICS - STABILIZATION

IDENTIFICATION NO. 58-10-20

FAILURE CAUSE: 2C. COUNTERBALANCE VALVE FAILS OPEN

EFFECT CATEGORY					QUESTION	YES/NO	DESCRIBE/STATE WHY (see note)
5	6	7	[✓ 8]	9			
o	o	o	o	o	A. IS LUBRICATING OR SERVICE TASK APPLICABLE AND EFFECTIVE?	NO	No consumables to replenish.
o	o	o			B. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY OPERATING PERSONNEL MONITORING APPLICABLE AND EFFECTIVE?		
			o	o	B. IS CHECK TO VERIFY OPERATION APPLICABLE AND EFFECTIVE? (FAILURE FINDING TASK).	YES	A test to demonstrate unit can lift and hold rated load would be effective
o	* o	* o	o	* o	C. IS ABILITY TO DETECT DEGRADATION OF FUNCTION BY ON-UNIT OR OFF-UNIT TASK(S) APPLICABLE AND EFFECTIVE?	NO	Reduced resistance to failure is not detectable nor is rate of resistance to failure predictable.
o	* o	* o	o	* o	D. IS RESTORATION TASK TO REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The unit does not show functional degradation characteristics at an identifiable age.
o	* o	* o	o	* o	E. IS DISCARD TASK TO AVOID FAILURES OR REDUCE FAILURE RATE APPLICABLE AND EFFECTIVE?	NO	The unit does not show functional degradation characteristics at an identifiable age.
o			o		F. IS THERE A TASK OR COMBINATION OF TASKS WHICH IS APPLICABLE AND EFFECTIVE?	YES	Perform rated load test.

* Use only if answer to previous question is "NO".

Note: If answer to question is "YES", describe; if "NO", state why.

SELECTED TASK: Perform "Stab. Test" in accordance with instructions in Calavar maintenance manual.

FREQUENCY: Every six months.

REDESIGN: ☐ MANDATORY ☐ DESIRABLE ☒ NOT REQUIRED