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P-3 IMPROVED MAINTENANCE PROGRAM

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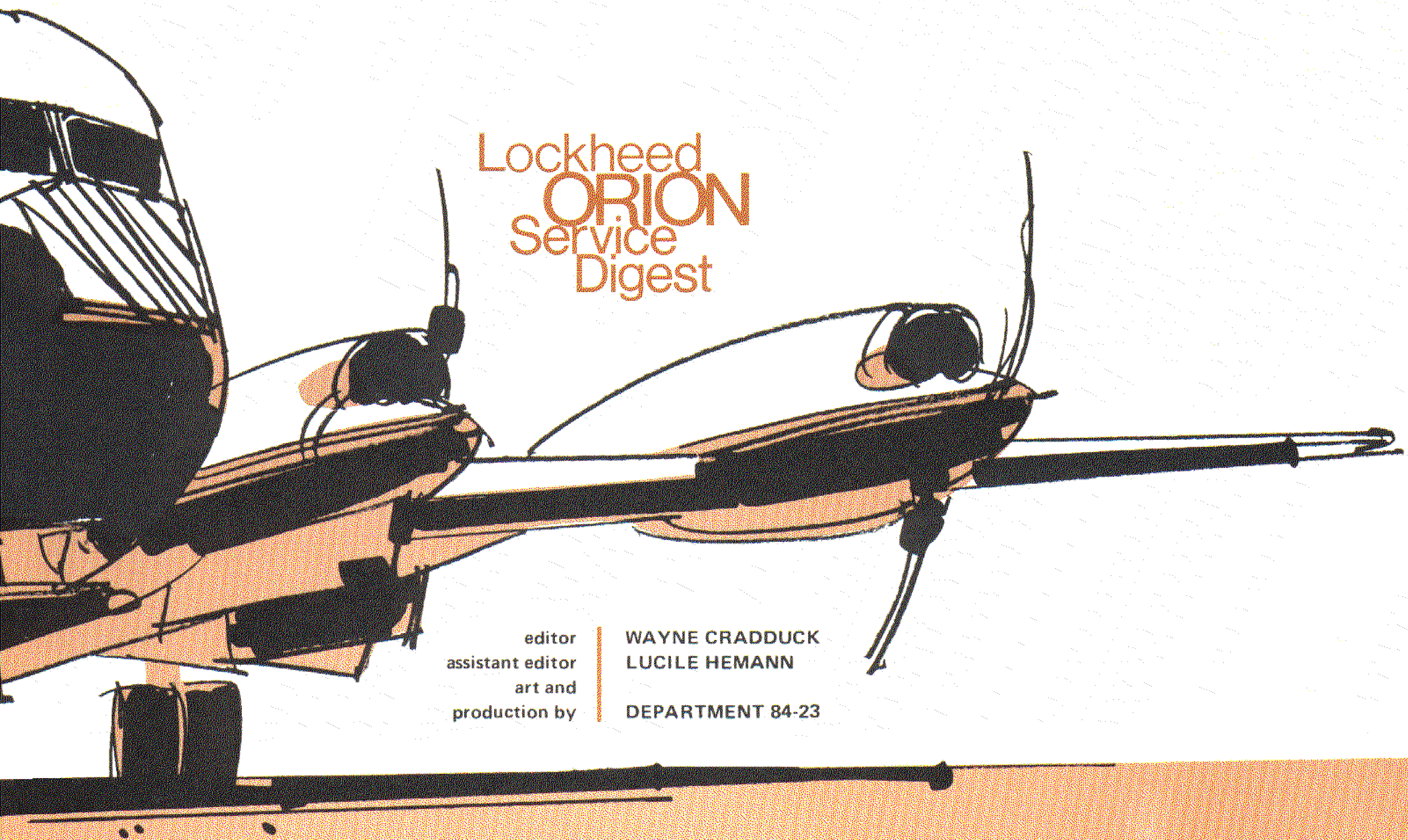

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editor — WAYNE CRADDUCK
assistant editor — LUCILE HEMANN
art and production by — DEPARTMENT 84-23

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FRONT AND BACK COVERS On 16 August 1973, NAS Moffett Field announced that their "Fighting Marlins" of PATRON FORTY had been selected by CNO to evaluate IMP – the Improved Maintenance Program. IMP was hailed as " . . . an entirely new concept in Naval Aviation aircraft maintenance . . .", and VP-40's job was to evaluate this new maintenance system by applying it to their P-3B Orion aircraft in an operational environment for a six-month trial period. The squadron produced such impressive results that the Navy decided to implement IMP fleet-wide on all P-3 aircraft.

Next on the Fighting Marlin's agenda was their transition from the P-3B to the computerized P-3 Charlie. With their skills sharply honed, today VP-40 is participating in a detachment-type deployment to NAS Adak.

P-3 IMPROVED MAINTENANCE PROGRAM

by Frank H. Connell
MILITARY MAINTENANCE PLANNING

INTRODUCTION

An exciting, new maintenance concept is being utilized in the P-3 community these days. It's called IMP – Improved Maintenance Program – now an integral part of the Navy's Analytical Maintenance Program. The Improved Maintenance Program was developed by using advanced maintenance planning techniques generated by commercial airlines for their wide-bodied jets. Application of these techniques to the P-3 Orion maintenance program has reduced scheduled maintenance and increased aircraft availability without adversely affecting flight safety or reliability.

The Improved Maintenance Program concept has realized such success that it has become the pattern for the Navy's Analytical Maintenance Program and all other military maintenance systems. Eventually, similar maintenance techniques and methodologies will be applied to all Navy aircraft under the Analytical Maintenance Program. In this article we shall discuss the background, philosophy and concepts of IMP.

TRADITIONAL IDEAS First, let us dispel any notion that IMP is a warmed-over version of a maintenance system previously used in the Navy. It is not a reshuffle of calendar maintenance requirements into a flight-hour controlled phased maintenance system. Instead, a new concept of scheduled maintenance requirements, analysis and inspection has been applied to the P-3 aircraft, culminating in an efficient minimum maintenance program.

Initially, airplanes were primitive. The engine-airframe combination in early airplanes had only a slight margin of excess power. This slight power margin precluded redundant structure or backup systems because of the weight penalty they would impose upon the aircraft. The lack of systems and structural redundancy required formulation of maintenance programs that were absolutely dedicated to prevent failure of each and every part, because almost every such failure had a direct, adverse effect on flight safety. Experience with early-day aircraft demonstrated that:

- Mechanical Parts Wear Out
- Wear-outs Cause Failures
- Failures Affect Safety

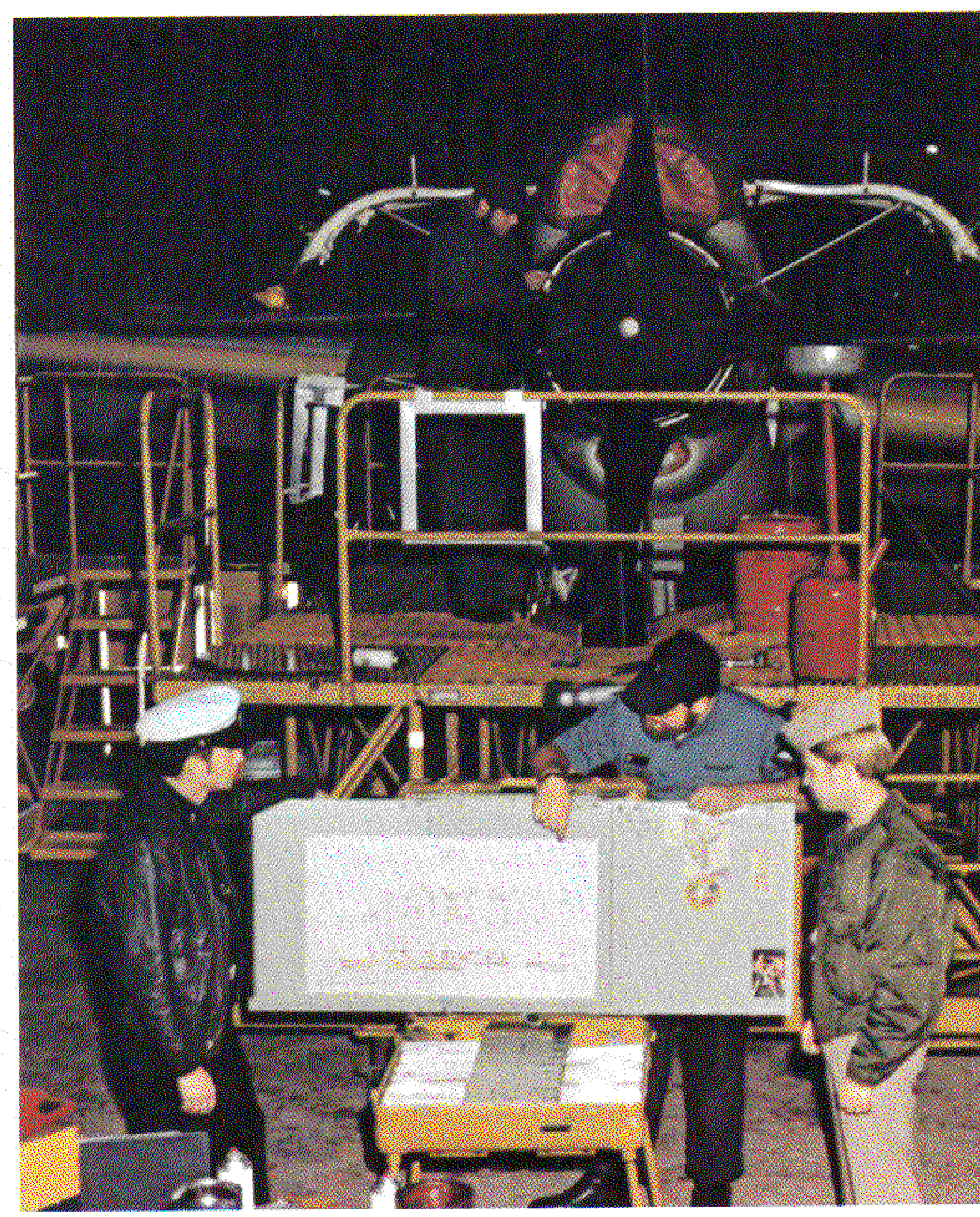


Figure 1. Improved Maintenance Program Phase Check In Progress

These factors dictated the need for a preventive maintenance program that would guarantee, to the greatest possible degree, the reliability of every mechanical and structural component. It was normal to conduct exhaustive inspections before and after each flight, and to practice frequent, extensive preventive maintenance (including periodic replacement and overhaul) regardless of component condition.

These factors, coupled with the fact that things deteriorate with age, led the designers of early maintenance programs to an obvious conclusion: Determine the point in the life of an element when its probability of failure begins to increase at an unacceptable rate, then establish a maintenance action at that time to preclude failure. The typical "bathtub" curve in Figure 2 depicts such an operating life cycle. At point "A" of the bathtub curve the early maintenance planner required maintenance action. For single load-path elements or non-redundant systems and components, such rationale has merit. This philosophy led to the total-overhaul or fixed-frequency maintenance concept used on early aircraft.

BATHTUB CURVE The bathtub curve correlates time versus probability of failure (age vs. reliability), and derives its name from the shape the curve takes when the data are plotted. Usually, early in the life of a component or system the rate of failure is high for several reasons. A few of these are:

- Manufacturing Difficulties
- Operator Inexperience
- Design Difficulties

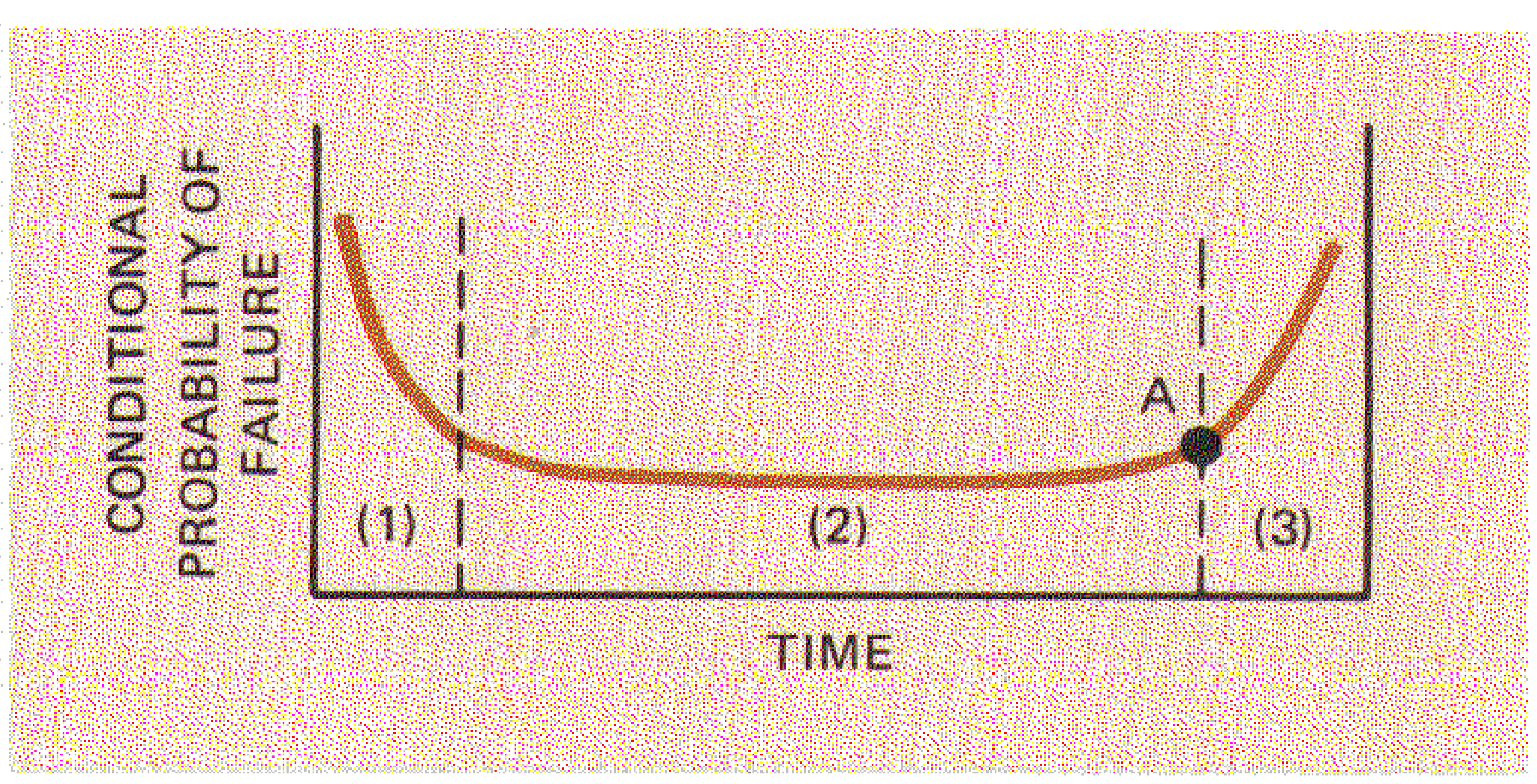


Figure 2. Bathtub Curve, Correlating Component Age vs. Component Reliability

The segment of the curve that reflects these data is referred to as the "infant mortality" region, and is designated on Figure 2 as region "1".

Having passed the infant mortality region, the failure rate usually stabilizes at a more or less lower constant level until wear-out is approached. This region is designated region "2" on Figure 2.

When wear-out is approached, the failure rate begins to increase and the curve swings upward as shown in region "3" of Figure 2 to complete the "bathtub" shape of the curve. All components exhibit characteristics of these three regions to some extent during their life span, even though the curves may have somewhat different slopes and the distance (or time) between the regions may vary.

AGE VS. RELIABILITY It is generally agreed that component reliability deteriorates with operating age. Thus, in time almost any mechanical or electronic component can be expected to have a 100 percent probability of failure. The most important factors are the point at which the probability of failure becomes unacceptable and how the failure occurs. The bathtub curve shown in Figure 2 is the classic graph of age versus reliability, and has almost universal application.

If we accept the relationship between age and reliability, we can categorically state a few things about parts whose operating lives exhibit the characteristics of the bathtub curve:

- If one removes, replaces, or performs scheduled maintenance on an item that is operating satisfactorily in region 1, such action will reduce that item's reliability. This occurs because the new or newly-maintained item must begin the infant mortality stage all over again, and this happens at a higher point on the probability of failure axis of the curve.

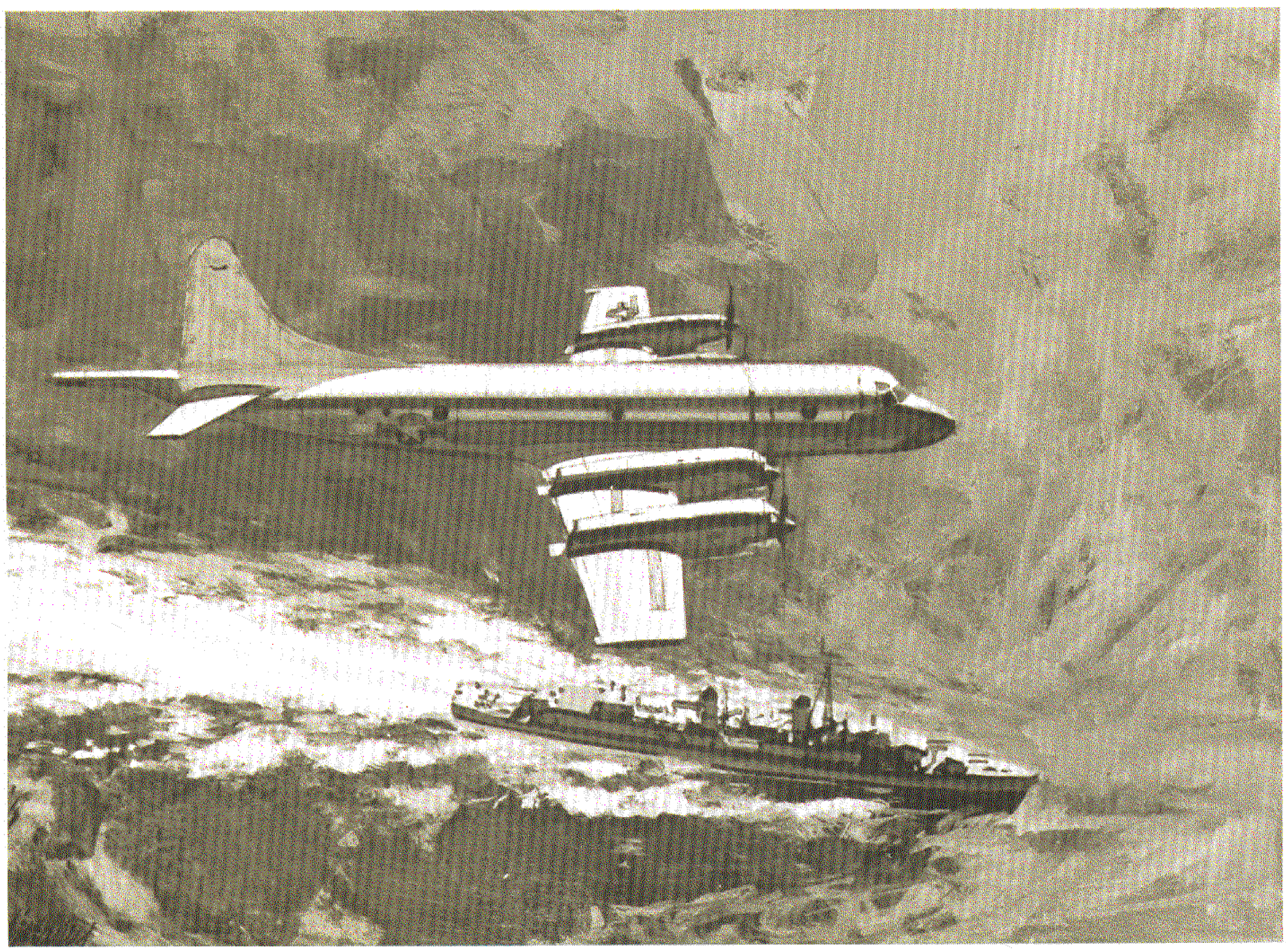
- If a satisfactorily operating part is removed, replaced or given scheduled maintenance in region 2, there will likewise be a reduction in system reliability. Again, replacement or maintenance is, at best, worthless, and it may be injurious.

- If a component exhibits the behavior of region 3 early in its service life and enough of these components survive so that such behavior can be detected, then – and only then – it is rational to remove, replace, or perform scheduled maintenance on that component.

There immediately follows the question, "In the real world, how many aviation parts exhibit wear-out characteristics during their normal operating lives?" An analysis of hundreds of aircraft components by commercial airlines and aircraft manufacturers revealed that most components go through a burn-in stage (region 1) and a stage of low probability of failure (region 2) over some period of their operating lives. However, very few components reach the wear-out stage (region 3) during their normal service lives.

Most electronic parts never exhibit characteristics of region 3. That is, they go through the stage of infant mortality, followed by a constant or slightly increasing probability of failure. Wear-out is so far down the pike that it doesn't enter into reliability calculations.

On the other hand, most reciprocating engines do reach region 3 during their operating life. After the break-in period when material defects are discovered and repaired, their probability of failure is nearly constant until wear-out. Since a large number of these engines survive to the point where the probability of failure increases, maintenance actions at (or near) this point of increased failure probability are logical.



Jet engines, unlike reciprocating engines, do not exhibit the wear-out characteristics of region 3 during their operating lives. After going through region 1, their failure characteristics graph as a gradually increasing failure probability over time. Maintenance inspections and condition monitoring techniques are effective for these engines, and allow the operator to detect the point at which the engine will no longer provide satisfactory operation.

Age-reliability analyses of thousands of aircraft parts revealed that very few components exhibit wear-out characteristics during their operating life. One commercial airline intensively studied 140 aircraft components from all aircraft types in its fleet (Figure 3). Ninety-four percent of these components were found to have no need for a scheduled time limit on maintenance actions.

As the state-of-the-art of aircraft design evolved, fail-safe designs and redundant systems emerged, and the traditional bathtub curve became less meaningful for scheduled maintenance purposes. In complex multiload-path redundant systems, failures became more random and failure of a single element became less important to the safety or reliability of the overall system.

COMMERCIAL AIRCRAFT MAINTENANCE PROGRAM DEVELOPMENT From the outset, one of commercial aviation's most difficult tasks has been to establish and control aircraft maintenance requirements. The economic and safety regulatory factors of aircraft maintenance have stimulated discussions and studies throughout the airline/industry since the inception of airline service.

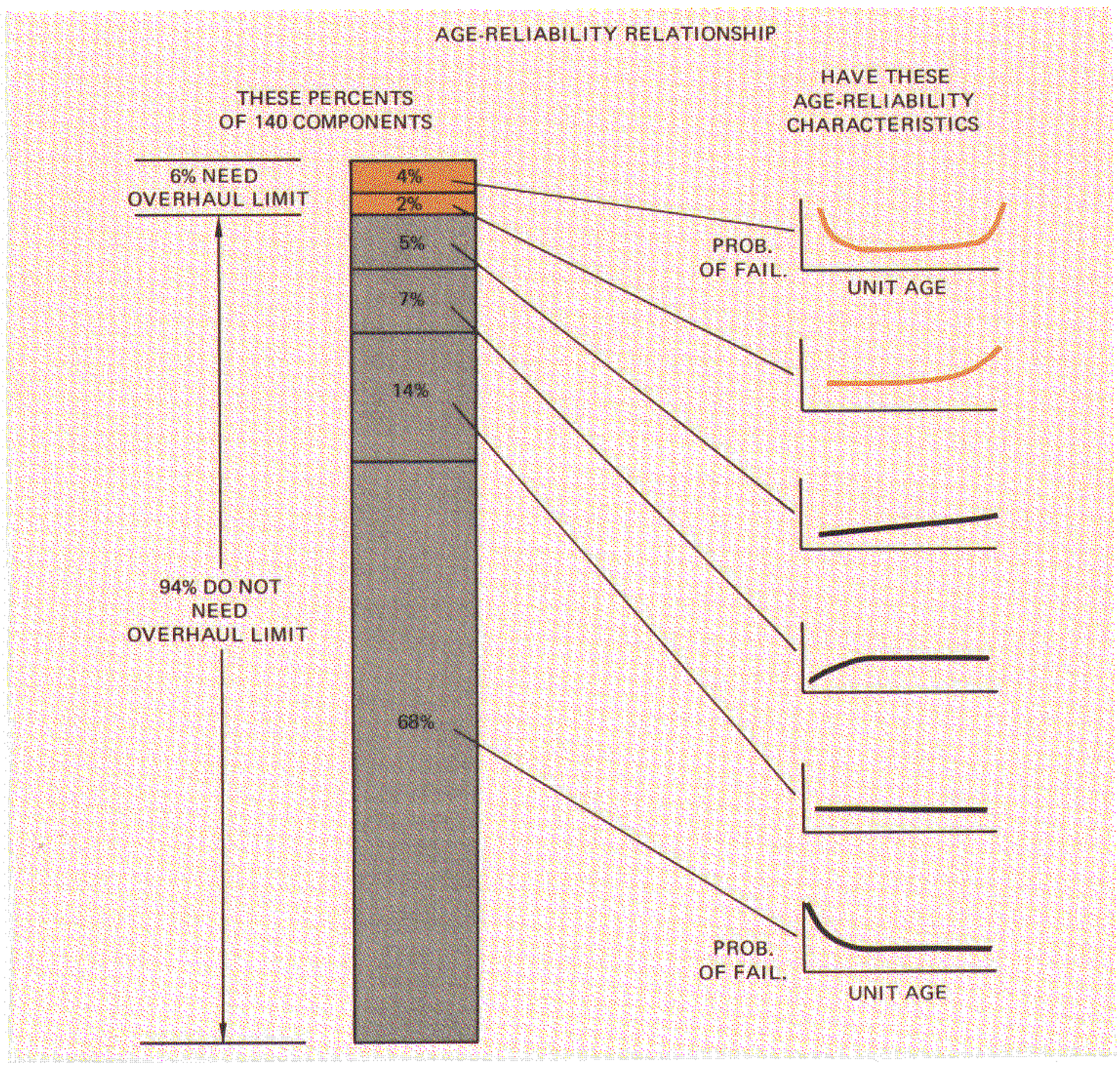


Figure 3. Age/Reliability Analysis of Vital Aircraft Components by a Commercial Airline

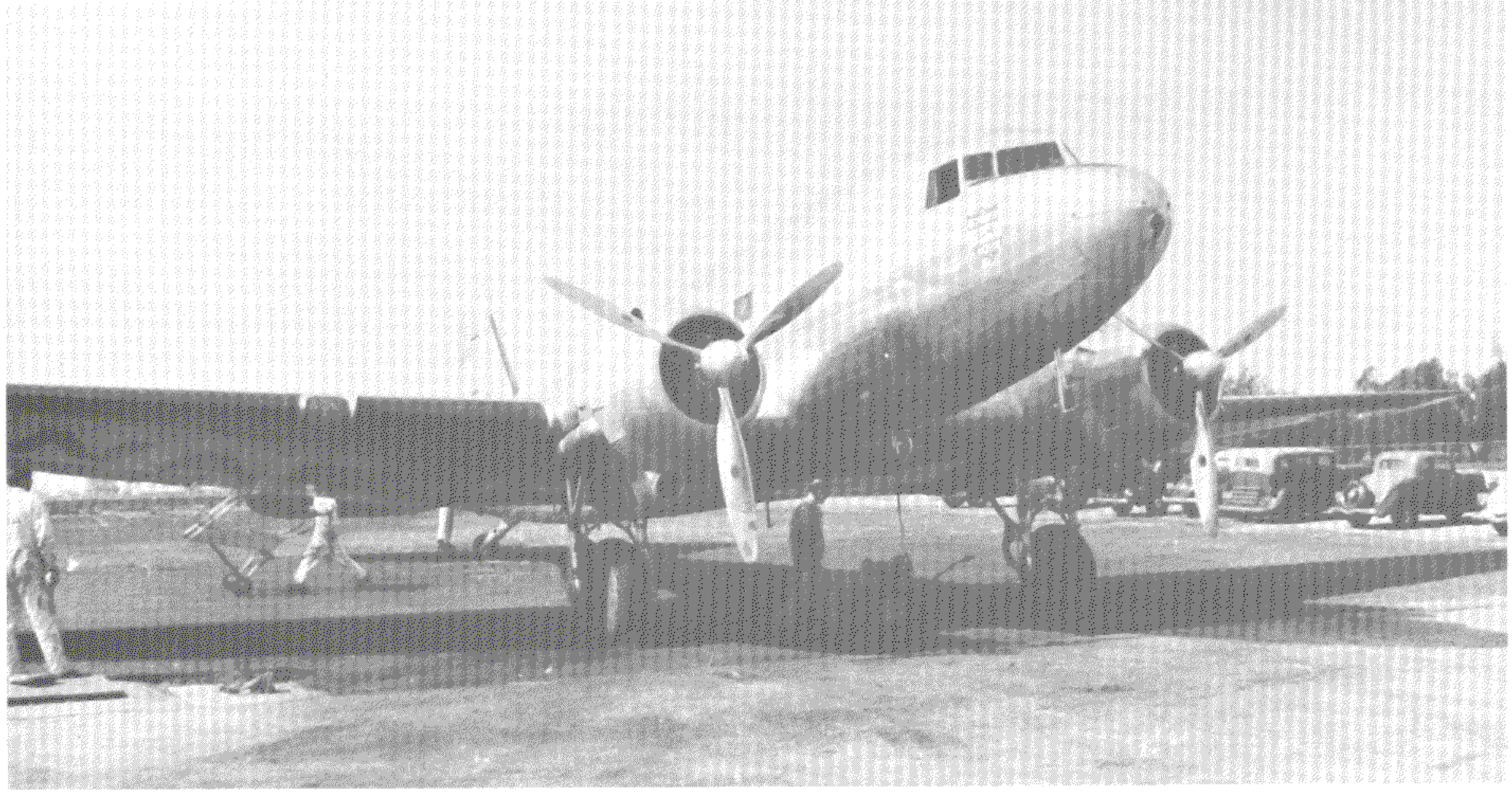


Figure 4. McDonnell Douglas DC-3 Maintenance Programs Evolved from the Concept of Block Overhaul and Disassembly

In the early days of the DC-3 (Figure 4), airline and industry maintenance experts met to establish what inspections were required and when. They had little to base their judgements upon other than their own expertise and experience. As a result, aircraft maintenance programs evolved from the concept of block overhaul and disassembly, a concept that proved satisfactory for relatively uncomplicated aircraft.

Today, expertise and experience remain a vital part of the maintenance requirements analysis process, for history has shown that sound judgement has preserved an extremely high level of safety. However, the complexity and size of today's aircraft have rendered the concept of overhaul and disassembly (with its attendant downtime) not only uneconomical but impractical. Since maintenance requirements are interrelated with "the state of the art," airlines and aircraft manufacturers are constantly seeking methods by which the airframe and its systems can define their own maintenance requirements, rather than imposing arbitrary requirements based only on what has been done on previous aircraft.

In the mid 50's with the Boeing 707 (Figure 5) being readied for the first U.S. jet airline operation,

Figure 5. Commercial Airline Maintenance Procedures were Modernized with the Introduction of the Boeing 707

the operators were faced with a mandatory requirement to change their aircraft maintenance programs. The Federal Aviation Agency (FAA) had established a board to review new maintenance program proposals, and justification for any proposal was necessary. The airlines and aircraft manufacturers met this challenge by establishing a working group to set up maintenance criteria that would satisfy minimum FAA requirements. Their recommendations were based mainly on past service experience supplemented with laboratory test data. This group effort also produced the basis for the first full-scale structural sampling program used in the airline industry.

Figure 6. The Boeing 747 Maintenance Program Employed the MSG-1 Planning Procedure

As introduction of the wide-bodied Boeing 747 (Figure 6) approached, the airline industry was faced with a new set of problems – aircraft size alone dictated use of a step-by-step logical process to designate the selection and frequency of maintenance tasks. The airline operators organized a committee called the Maintenance Steering Group (MSG) to prepare a maintenance requirements planning procedure for this aircraft. The planning procedure was called MSG-1, the "-1" indicating that this procedure was the Maintenance Steering Group's first set of guidelines for the airline industry. These guidelines provided the first formalized breakthrough in establishing new criteria for maintenance programs. They replaced maintenance concepts that had been in use for almost 60 years. The Boeing 747 maintenance program was developed by application of the MSG-1 planning procedure.

Figure 7. The Lockheed L-1011 Tristar Maintenance Program is Based on the MSG-2 Planning Procedure

The Maintenance Steering Group monitored development of the 747 maintenance program, updating the MSG-1 procedure where necessary. The revised procedure was designated MSG-2. Meanwhile, Lockheed was launching the L-1011 production program (Figure 7). In late 1968 the L-1011 customer airlines requested Lockheed's assistance in developing a maintenance program for the TriStar, using the new MSG-2 document as a planning guide. The following year the Air Transport Association of America (ATA) sponsored a joint meeting of Lockheed, McDonnell Douglas, and the L-1011 and DC-10 customers. The participants of this meeting agreed to apply the MSG-2 planning procedure to the maintenance programs of both aircraft. The Federal Aviation Agency (FAA) subsequently approved MSG-2 as a reasonable and practical method for establishing the maintenance requirements of a new aircraft. Therefore, the Air Transport Association adopted the MSG-2 procedure as a standard for *any* aircraft undergoing development during this time frame.

P-3 IMPROVED MAINTENANCE PROGRAM

PROGRAM DEVELOPMENT The U.S. Navy's maintenance concepts followed an evolution similar to that of the commercial airlines, but not in the same time frame nor to the same depth. In the era from WW II to the mid 1950's, the Navy's depot maintenance concept was total overhaul. About 1960 the Navy moved from the total overhaul concept to the interim rework concept. This change was an attempt to minimize the depth of rework between overhauls. By 1962 the interim rework concept had evolved into the Progressive Aircraft Rework (PAR) concept. The PAR concept tailored rework to aircraft/component age, and the depth of rework was based on the judgement of the maintenance engineer. PAR was the Navy's first scientific approach to control the depth of aircraft rework.

Simultaneously, the concepts of organizational-level maintenance were changing. Prior to 1960 the periods between aircraft maintenance checks were controlled on a flight-hour basis. In the 1960's organizational maintenance was based on the premise that a direct correlation could be made between calendar time and flight hours. If such a correlation could be made, workload control would be served more realistically be switching to calendar-controlled maintenance.

Under the calendar system, P-3 aircraft were periodically inspected each 26 weeks. Soon it became apparent that calendar-controlled organizational maintenance was not the ideal answer. Frequently, there was no acceptable correlation between calendar time and flight hours. Aircraft utilization during a 26-week period was as low as 100 flight hours for some aircraft, and over 800 flight hours for others.

The Navy recognized these inequities in the calendar system and looked elsewhere to improve aircraft maintenance. Inquiries were made to determine how the commercial airlines established their maintenance programs. Subsequently, NAVAIR requested Lockheed to investigate the feasibility of adapting the L-1011 TriStar-type maintenance program to P-3 Orion aircraft. These investigations showed that the Air Transport Association of America MSG-2 planning procedure probably could be used as the basis for developing an improved maintenance program for the P-3 aircraft.

IMPROVED MAINTENANCE PROGRAM Development of the P-3 Improved Maintenance Program (IMP) began in November 1972. The program's objectives were to reduce scheduled maintenance and to increase aircraft availability by applying the analytical techniques of MSG-2. Program responsibility was assigned to a development team as follows:

- **Management** – OPNAV/NAVAIR
- **Technical Analysis** – Lockheed
- **Consultant** – United Air Lines
- **Technical Monitoring** – NAILSC/NARF Alameda
- **Trial** – Commander Patrol Wings Pacific/Patrol Squadron 40

The scope of the program included all scheduled organizational and intermediate maintenance activity including: Preflight/Postflight/Turnaround, Daily, Special Periodic, and Fixed Frequency Replacement.

The Improved Maintenance Program's primary maintenance requirements were determined by the application of MSG-2 logic analysis to flight safety, reliability and economic requirements. Maintenance task frequency was determined by system and equipment sensitivity to flight hours, cycles, or calendar time. Those requirements sensitive to calendar time (such as corrosion control) remain on a calendar time basis, and are included in the familiar Daily/Special Maintenance Requirements Cards (MRC). Requirements sensitive to flight hours or cycles are accomplished by phased maintenance – a concept that divides the maintenance inspection workload into several "phase packages" that are more manageable than is one large work package. It has been demonstrated that the IMP phased-maintenance concept results in less maintenance rather than merely restructuring former calendar tasks into phase packages.

The MSG-2 logic analyses were tailored to account for the U.S. Navy environment, mission differences and safety requirements. These analyses were based upon the following premises:

1. Hardware design determines inherent characteristics of safety, reliability, and maintainability.
2. Scheduled maintenance is not always effective, desirable or economical in preserving these inherent characteristics.
3. The aircraft and its components, when properly examined and analyzed, will dictate required maintenance.
4. A large percentage of aircraft components can fly-to-failure without degrading flight safety or economics.

The military environment demands its peculiar treatment in the formulation of any maintenance program. However, the objectives of commercial and military maintenance planning efforts are similar. Common considerations are: flight safety, mission accomplishment, reliability preservation, and economical operation/maintenance. In addition, primary military considerations are: operational environment, personnel factors, and the mission envelope.

The IMP recognizes the factors that are unique to the military maintenance community and utilizes those portions of the commercial analysis method that apply to military requirements. In short:

Military Considerations +

Commercial Techniques = IMP

During program formulation it was determined that, following the analytical effort, the "proof-of-the-pudding" would be evaluation by an operational squadron for six months. PATRON 40 based at NAS Moffett Field, California, was designated by the Chief of Naval Operations (CNO) to evaluate the program. The trial phase began in August 1973 and was successfully completed in January 1974. After trial phase completion, VP-40 was deployed and experienced continued success with the Improved Maintenance Program.

The success of the trial program prompted the Navy to implement IMP fleet-wide on the P-3 aircraft. The Navy then decided to expedite implementation of IMP by employing a transition team similar to that used during the trial period. In this manner, all squadron personnel would be assured a clear understanding of the philosophy and background of IMP. The transition team was composed of Lockheed personnel who had made the original maintenance analyses in the development of the program, and was headed by a U.S. Navy coordinator for AIRLANT or AIRPAC, depending upon where the team was sent. This team provided the IMP indoctrination for the entire P-3 fleet. When program implementation was completed in March 1975, forty-five activities had received indoctrination – all USN and USNR squadrons, and two training activities.

Detailed Engineering Approach Lockheed, under the direction of the Navy Management Team, formed an analysis group to develop maintenance analysis procedures that would be the basis of the Improved Maintenance Program. This Lockheed analysis group was made up of highly experienced former Navy and airline personnel who had first-hand knowledge of the P-3 aircraft, the Navy environment, and the MSG-2 concepts so recently applied to the L-1011 TriStar maintenance program.

The basic engineering analysis began with selection of the functionally significant items (FSI's) on the aircraft. MSG-2 refers to FSI's as maintenance significant items and defines them as follows:

> "Those items that are judged by the manufacturer to be relatively the most important from a safety or reliability standpoint, or from an economic standpoint."

FSI's were chosen on a system-by-system basis. Individual systems and their components were analyzed to determine how they could fail, and the consequences of such failures. Existing maintenance tasks were analyzed to determine if they were effective. High-maintenance action items were extracted from 3M data and analyzed. All of these items were then further analyzed to determine whether scheduled inspection and maintenance were justified. A total of 406 FSI's and 81 systems were thus analyzed.

Analytical Approach MSG-1 and MSG-2 specify a series of questions and responses that can be most easily understood as a decision tree. The following questions are asked to determine what preventive maintenance tasks are required (see Figure 8):

1. Is there a "condition after failure" that has a direct, adverse effect on operating safety?

An analysis must be conducted to determine whether failure would cause an adverse effect upon safety. If the answer is "yes", an effective maintenance task or component redesign is *required*. If the answer is "no", the next question is pursued.

2. Is there a function hidden from the flight crew that has a potential adverse effect on operating safety?

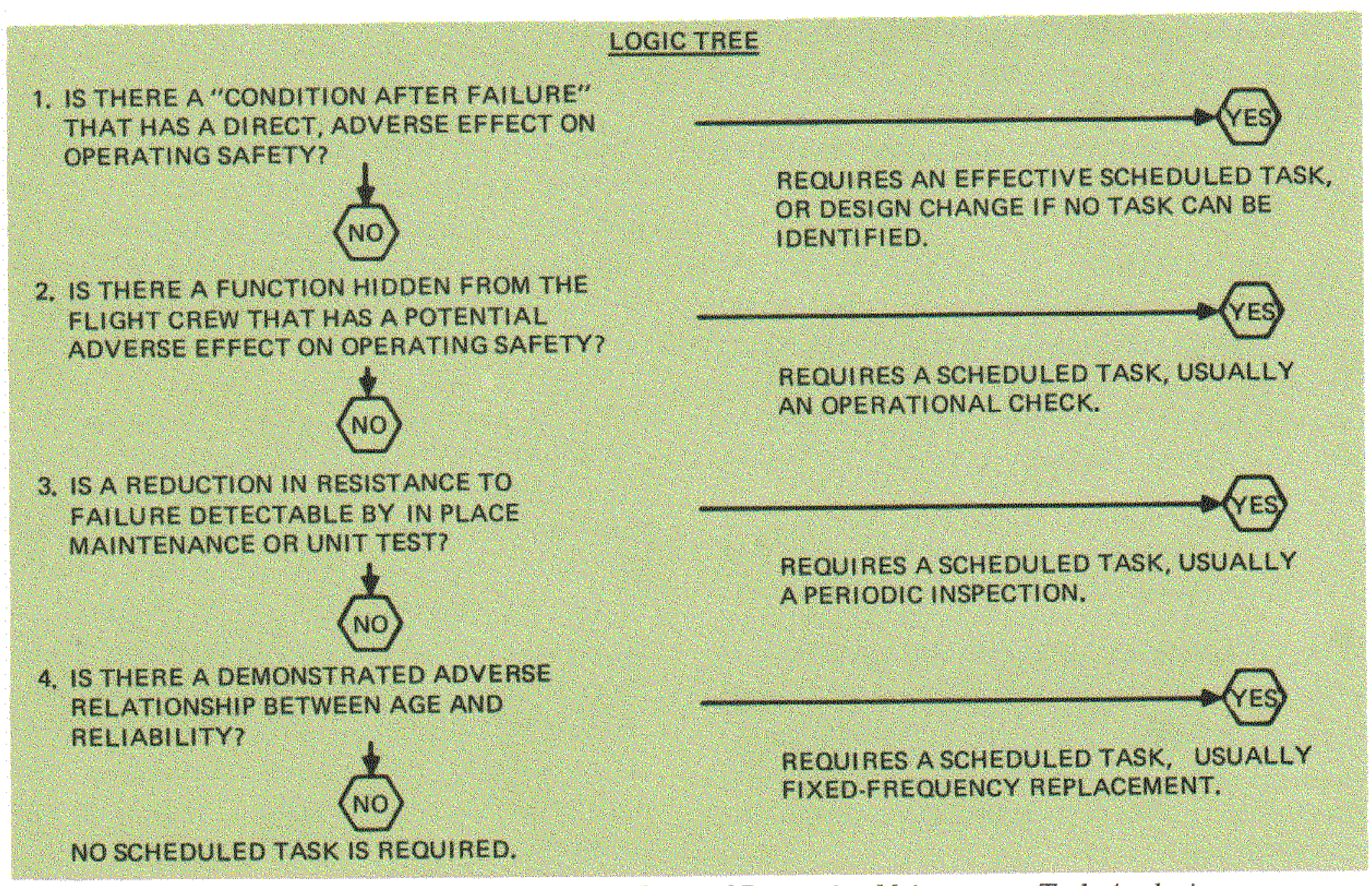


Figure 8. Decision Tree Logic Diagram That is the Basis of Preventive Maintenance Task Analysis

The objective in this question is to determine whether failure of back-up systems that provide safety protection might be hidden from the flight crew. If the answer is "yes", a scheduled maintenance task to test availability of the function is *required*. If the answer is "no" (failure is observable by the flight crew), the next question is asked.*

3. Is a reduction in resistance-to-failure detectable by in-place maintenance or unit test?

The objective in this question is to determine whether incipient failures can be readily detected. If the answer is "yes", a preventive maintenance task should be scheduled *if* economically justified. If the answer is "no", the last question must be addressed.

4. Is there a demonstrated adverse relationship between age and reliability?

This final question is asked to determine whether there is a specific utilization time-limit before failure that can be actuarily predicted. If the answer is "yes", and an effective preventive maintenance task can be prescribed, that task should be scheduled. If the answer to this final question is "no", there are no required or potentially effective maintenance tasks for the unit or system being considered – and none should be scheduled.

The first two questions are addressed to the paramount issue of flight safety. If "yes" is the answer to either question, adverse impact on safety is indicated and an effective preventive maintenance task is required. The alternative is component or system redesign to remove or nullify the hazard.

**MSG-1 and MSG-2 contain the additional question, "Is reduction in failure resistance detectable by routine flight crew monitoring?" Actual analysis experience has shown this question to be redundant when question 2 is answered properly.*

The last two questions involve economics, not safety. Hence, discretionary judgment may be applied by the maintenance planner. Tasks of doubtful effectiveness should be avoided for economic reasons. Such tasks can always be added later if in-service analysis indicates they are desirable. Figure 9 shows the Improved Maintenance Program conceptual model.

By this process, three categories of maintenance are defined:

- **Fixed Frequency Replacement** – An item that demonstrates a predictable reliability relationship between age and degradation.
- **On-Condition** – An item for which an effective maintenance task can be performed to detect degradation or reduction in failure resistance by periodic inspection or testing on the airplane.
- **Condition-Monitoring** – An item which does not require scheduled maintenance. Failure history may be monitored by data surveillance and analysis.

Examples of these items are shown in Figure 10. Fixed frequency replacement items and on-condition (periodic inspection) items are familiar to aircraft maintenance personnel, but the condition-monitoring element is relatively new as defined in the Improved Maintenance Program.

Condition-monitored items require no scheduled maintenance because analyses have determined that no effective maintenance tasks can be applied to them. However, the condition of these items may be monitored by data surveillance and analysis. The level of data necessary to sustain an item in the condition-monitored category may vary in scope. Only those data necessary to determine the item's continuing condition should be gathered. These data should be held to an absolute minimum.

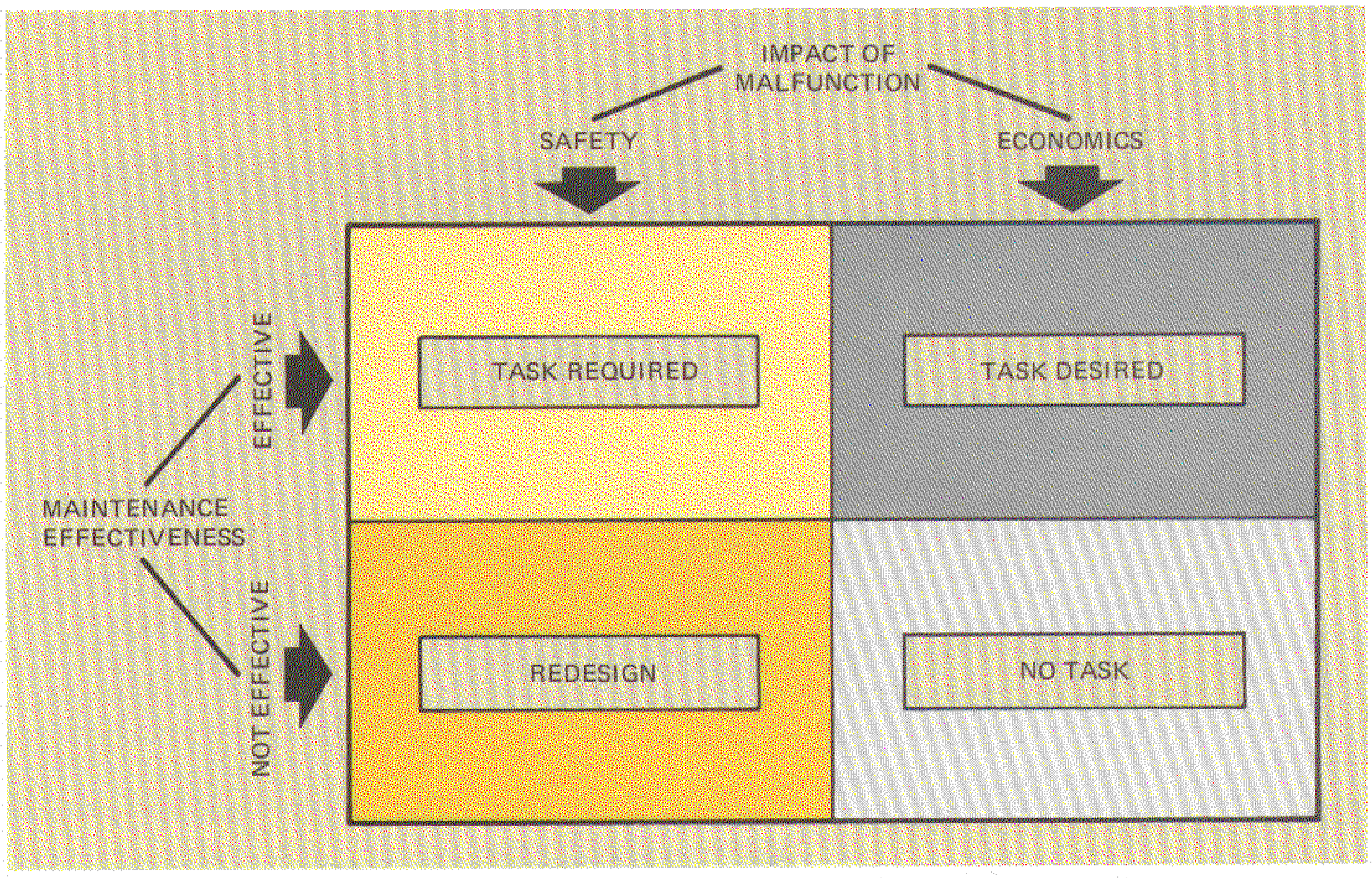


Figure 9. Improved Maintenance Program Conceptual Model

FIXED FREQUENCY REPLACEMENT

ITEM	REMOVAL TIME
1. ROTOR ASSY AND DISC SECOND STAGE TURBINE HUB	7500 FLIGHT HOURS
2. FUEL HOSE ASSY, FIREWALL TO HEATER PN/751376-1	36 MONTHS

ON-CONDITION

ITEM	MAINTENANCE TASK	SCHEDULED MAINTENANCE FREQUENCY
ELEVATOR TRIM TAB CABLES	CLEAN AND EXAMINE CABLES	1600 HOURS
APU DRAIN VALVE	EXAMINE FOR LEAKAGE, CLEAN AS REQUIRED	800 HOURS
PROPELLER NTS BRACKET	REMOVE, CLEAN, LUBRICATE AND OPERATIONALLY CHECK	400 HOURS
MAIN LANDING GEAR WHEEL WELL	ZONAL-EXAMINE FOR CONDITION	200 HOURS
TIRES	EXAMINE FOR CUTS AND WEAR	TURNAROUND

CONDITION - MONITORING

ITEM	SCHEDULED MAINTENANCE FREQUENCY
PROPELLER SYNCHROPHASER OIL COOLER, ENGINE AILERON HYDRAULIC BOOSTER ENGINE INSTRUMENTS	SCHEDULED MAINTENANCE NOT REQUIRED

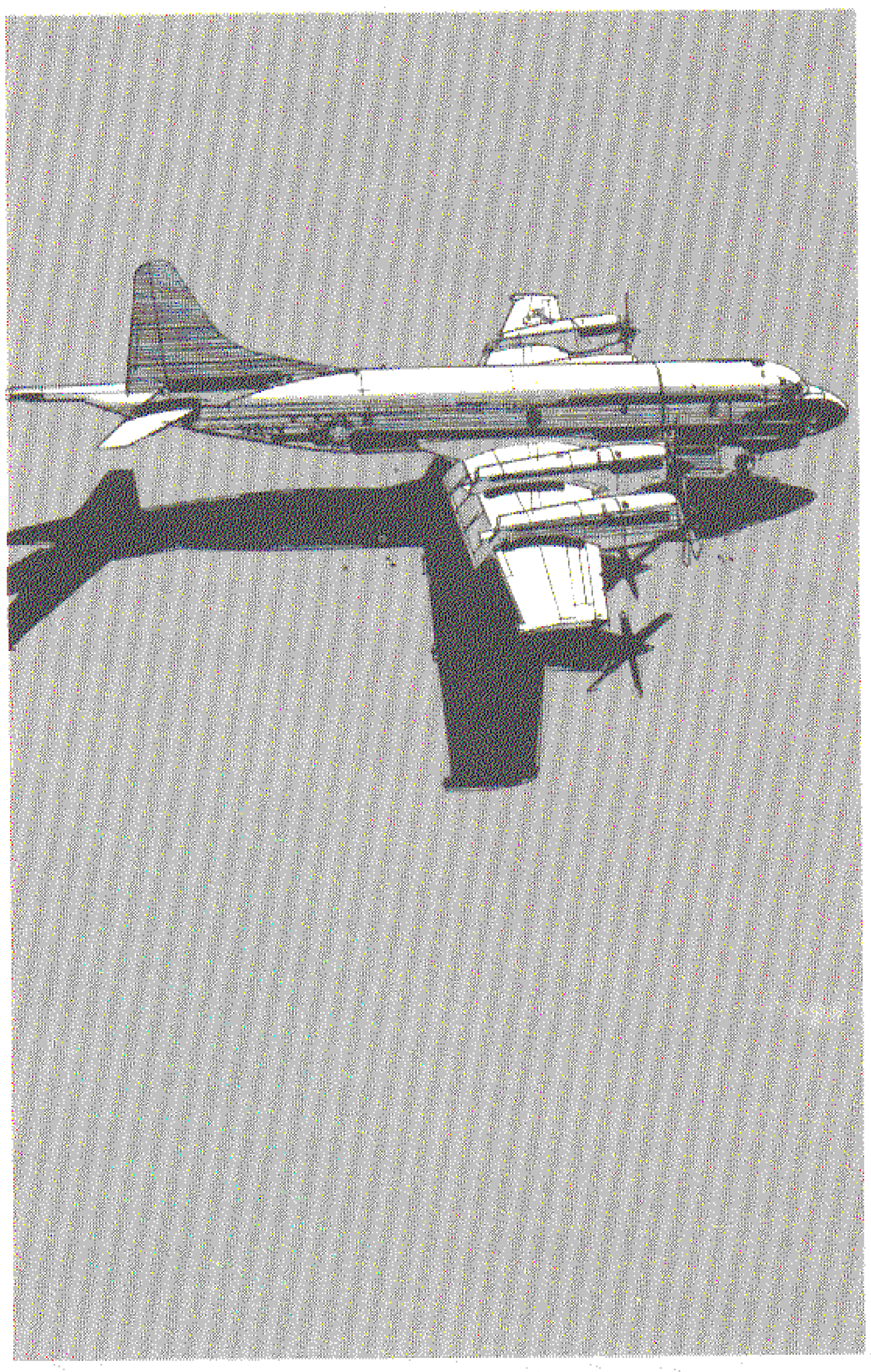


Figure 10. MSG-2 Maintenance Categories: Fixed Frequency Replacement, On-Condition Maintenance, and Condition-Monitoring. Representative Examples of Each Category are Shown.

Figure 11 shows the maintenance task distribution of the previous calendar maintenance program compared to that of the IMP. Of particular interest is the decrease of on-condition tasks from more than 90 percent in the calendar program to less than 47 percent in the IMP. Figure 12 depicts the migration of the tasks analyzed. The bar graph in the calendar column shows that the 795 tasks previously imposed were reduced to 434 tasks.

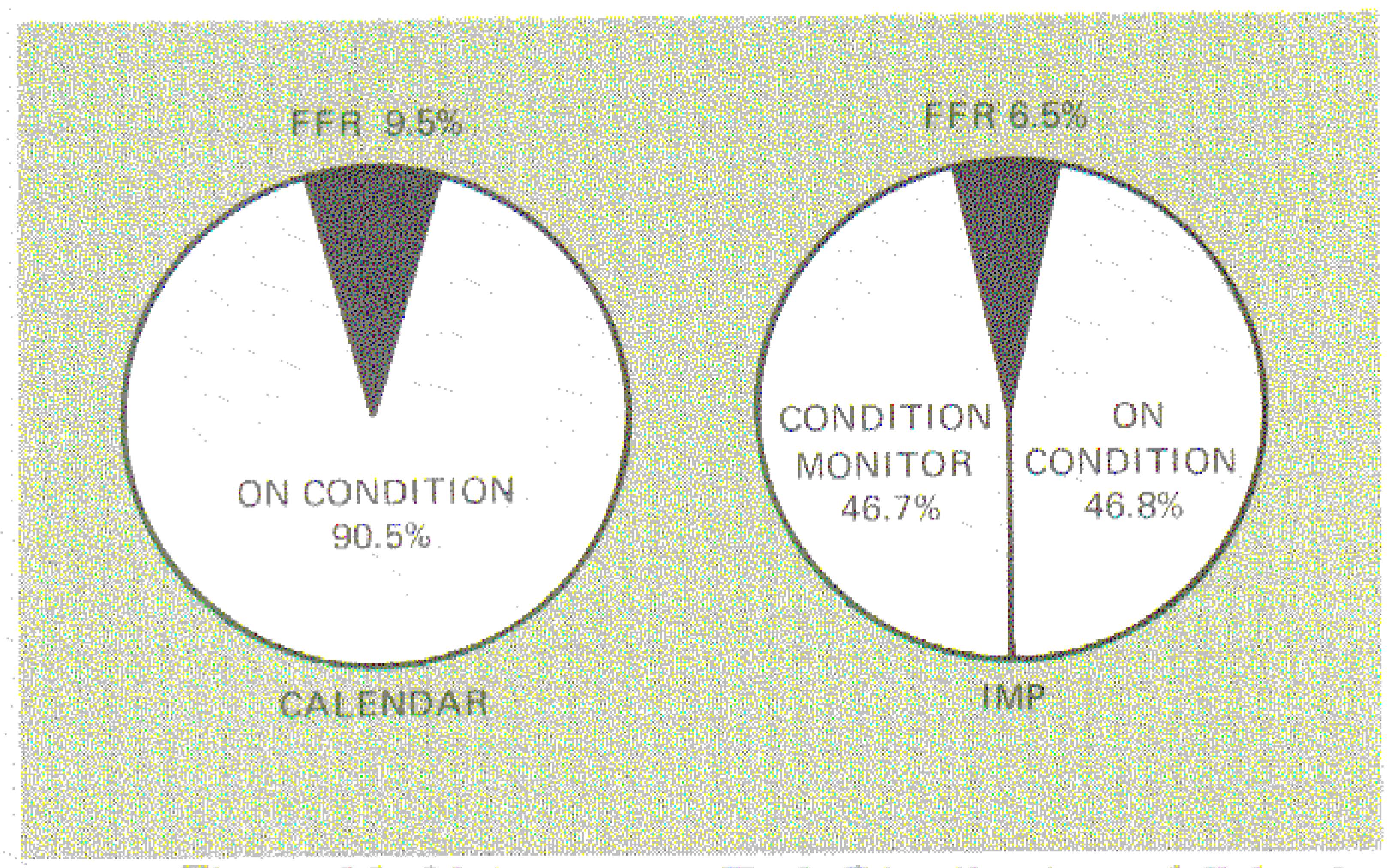


Figure 11. Maintenance Task Distribution of Calendar Maintenance Program vs. IMP

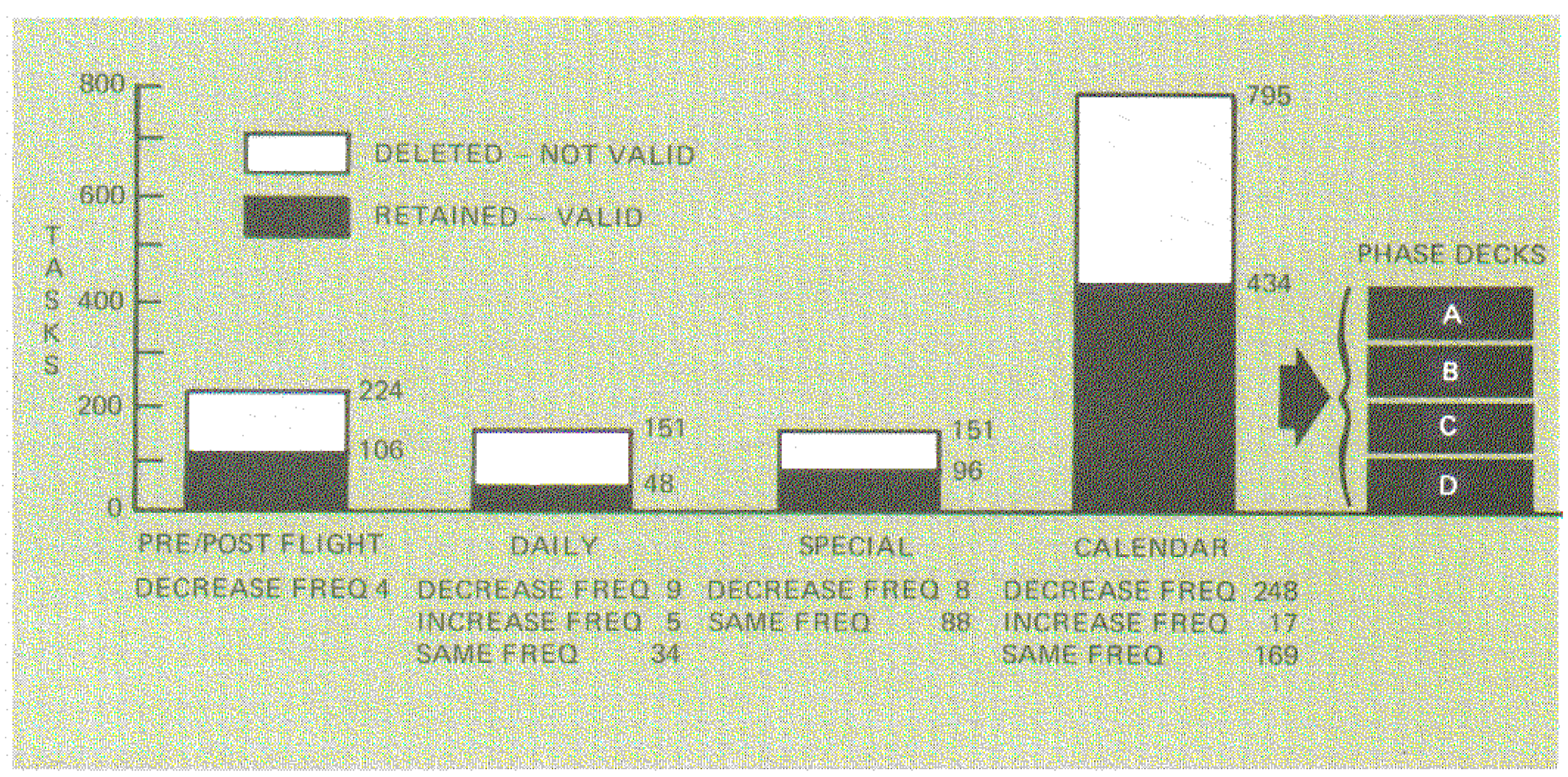
Phased Maintenance In our discussion of program development, we stated that there was no acceptable correlation between hours flown and calendar time accrued when P-3 maintenance was controlled by the 26-week calendar system. Some systems and equipment whose degradation is sensitive to use were over-inspected, while others were under-inspected. Under the Improved Maintenance Program, inspection requirements for systems and equipment whose degradation is sensitive to operational use are assembled into Phase Maintenance Requirement Cards (MRC's) which replace the Calendar MRC's. The maintenance cycle has been established at 800 flight hours instead of 26 weeks. Figure 13 compares the maintenance frequencies in the calendar maintenance system and in the IMP.

The Improved Maintenance Program divides the tasks that constitute a maintenance cycle into four "phase" inspections – one phase inspection to be accomplished each 200 flight hours. The workload has been assembled so that no one phase inspection requires more than eight elapsed hours or one work shift to accomplish the scheduled maintenance (see Figure 14). Obviously, unscheduled maintenance requirements detected and corrected during the inspection may increase this elapsed time.

The basic reason for limiting the phase inspection to one work shift is to preserve continuity of the check – to assure that the crew *starting* the check is the same crew that *completes* the work. This type of control strives to eliminate the work turnover requirement between maintenance crews, and the probability of omissions or misunderstandings. Further, the 8-hour limit tends to reduce overnight downtime.

The primary inspection areas for each phase inspection are designated in Figure 15. This rotational inspection arrangement distributes the workload so that disturbance of critical systems is

Figure 12. Scheduled Maintenance Task Distribution after Application of MSG-2 Logic Analysis to Calendar Maintenance Tasks. Note the Reduction of Tasks in the Four Maintenance Categories, and the Change in Frequency of Those Tasks Retained.



TYPE OF INSPECTION	CALENDAR SYSTEM	IMP
TURNAROUND	PRIOR/AFTER FLIGHT	SAME
DAILY	EACH FLYING DAY	SAME
SPECIAL	CALENDAR TIME INTERVALS (7, 14, 28, ETC. DAYS)	SAME
PERIODIC	26 WEEKS (TOTAL CHECK)	800 FLIGHT HOURS (ONE-FOURTH OF TOTAL CHECK EACH 200 FLIGHT HOURS)

Figure 13. Scheduled Inspection Frequency After Introduction of IMP

PHASE	ELAPSED HOURS	MAN-HOURS
A	6.5	40.2
B	7.0	39.4
C	7.3	41.0
D	7.0	42.0

Figure 14. Phase Inspection Elapsed Hours and Manhours

held to a minimum during a phased maintenance check. Note that No. 1 engine is the prime inspection area during Phase A, No. 3 engine is prime during Phase B, No. 2 engine is prime during Phase C, and No. 4 engine is prime during Phase D.

A maintenance crew of ten or eleven men is required to perform a phase inspection (Figure 16). The crew is kept as small as possible to reduce the expenditure of man-hours during the check, and to enable the check crew coordinator to exercise closer control over the work. In the case of VP-40, the check crew was established as a *permanent* check crew. When they were not performing scheduled checks, they were working off unscheduled maintenance squawks.

ZONAL EXAMINATION A major segment of this new maintenance concept is the Zonal

PHASE	PRIMARY AREAS INSPECTED
A	NO. 1 & 2 ENGINES, FWD FUSELAGE, LH WING & MLG
B	NO. 3 & 4 ENGINES, AFT FUSELAGE & EMPENNAGE
C	NO. 2 & 1 ENGINES, MID FUSELAGE, NLG
D	NO. 4 & 3 ENGINES, FUSELAGE INTERIOR, RH WING & MLG

Figure 15. IMP Primary Phase Inspection Areas

CREW RATING	MAINTENANCE PHASE A	B	C	D
AVIATION MACHINIST'S MATE – JET ENGINE MECHANIC (ADJ)	3	3	3	4
AVIATION STRUCTURAL MECHANIC – STRUCTURAL (AMS)	2	2	2	2
AVIATION STRUCTURAL MECHANIC – HYDRAULICS (AMH)	1	1	1	1
AVIATION STRUCTURAL MECHANIC – SAFETY EQUIPMENT (AME)	1	1	1	1
AVIATION ELECTRICIAN'S MATE (AE)	2	2	2	2
AVIATION ELECTRONICS TECHNICIAN (AT)	1	1	1	1
AVIATION ORDNANCEMAN (AO)	1		1	
TOTAL CREW COMPLEMENT	11	10	11	11

Figure 16. Phase Inspection Crew Composition

Examination: the inspector reports any and all suspected discrepancies within an assigned zone.

In the old calendar system inspections, specific items within a zone were pinpointed for attention, but inspection of the balance of the area was not required. Furthermore, the inspecting party had no obligation to report anything other than the condition of those items that he was specifically directed to inspect. For example, during a calendar-type inspection of the nose landing gear similar to that shown in Figure 17A, the AE, AMS and AMH each were required to inspect certain items within their rating cognizance. However, *no one person was responsible* for a general inspection of the total nose landing gear for evidence of unsatisfactory condition. Carrying this philosophy to the extreme, the AE could push aside leaking hydraulic lines to get at a specified electrical connection *and never be required to report the discrepancy in the hydraulic system.*

The Zonal Examination under the IMP concept is an all-inclusive inspection of all of the equipment, installations, and structure within a specified area (see Figure 17B). The zonal examination is performed by a knowledgeable and experienced technician. The manpower requirement is not rating sensitive – any reliable person with some on-the-job training can be assigned the Zonal Examination task. Specific technical ratings are called upon, as required, to confirm or reject findings of the Zonal Examiner. Figures 17A and 17C draw a comparison of the maintenance tasks required on the nose landing gear under the calendar maintenance program and those tasks required by IMP after implementation of the Zonal Examination Concept. This Zonal concept represents a broader inspection coverage of the aircraft.

The aircraft is divided into finite geographical segments within logical boundaries. The 21 Zones defined under the calendar systems have been expanded to provide more precise Zone definition. For example, the left wing was previously assigned a single zone number (11). Now, under IMP, the left wing is segregated into eight finite sections (Figure 18):

11.1 Left wing box internal

11.2 Left wing upper surface external

11.3 Left wing lower surface external

11.4 Left wing flap internal

11.5 Left aileron and tab internal

11.6 Left wing leading edge internal

11.7 Left wing tip internal

11.8 Left wing trailing edge internal

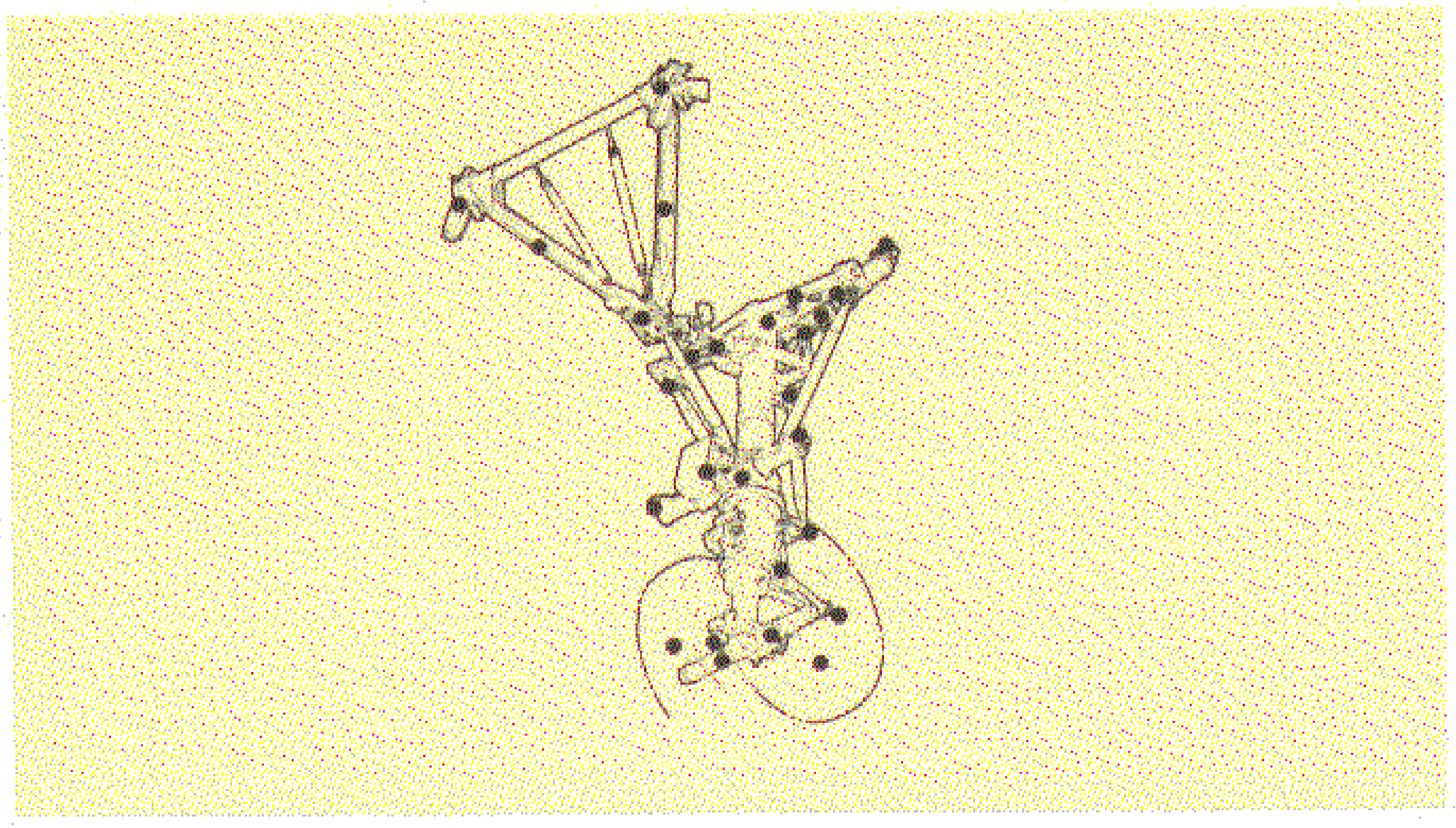


Figure 17A. Calendar Inspection Items on Nose Landing Gear Before IMP and Zonal Examinations

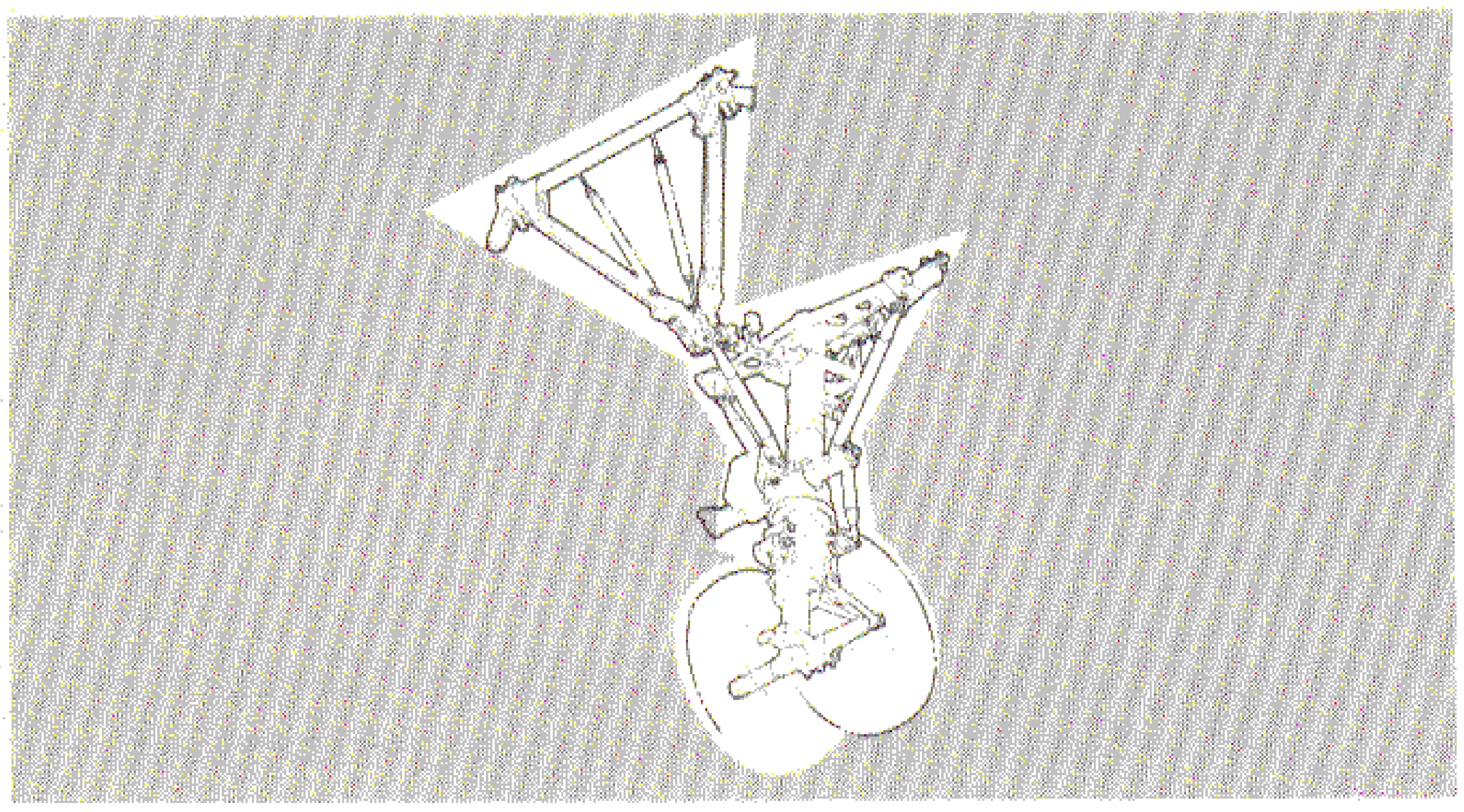


Figure 17B. Typical Zonal Examination Area – Nose Landing Gear

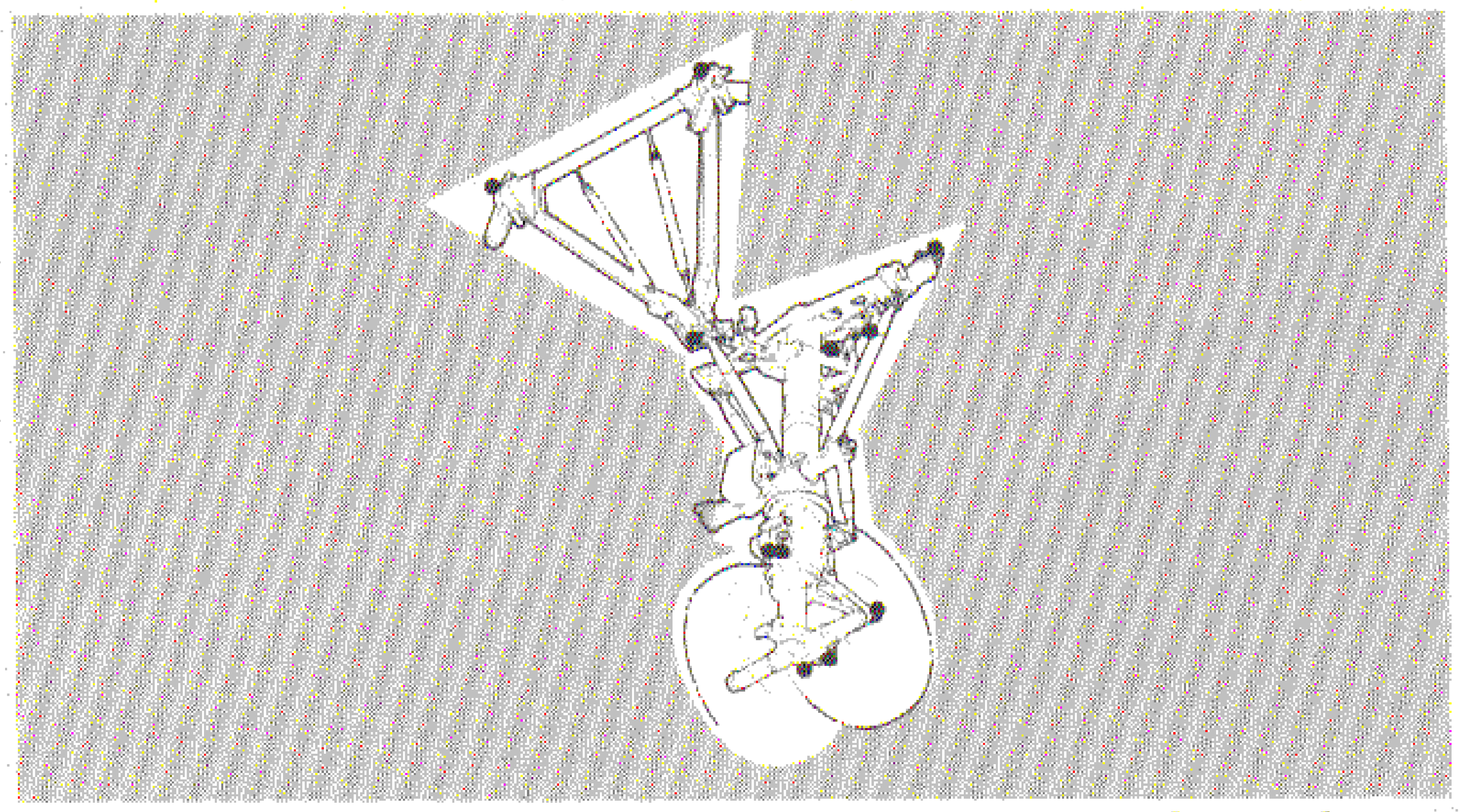
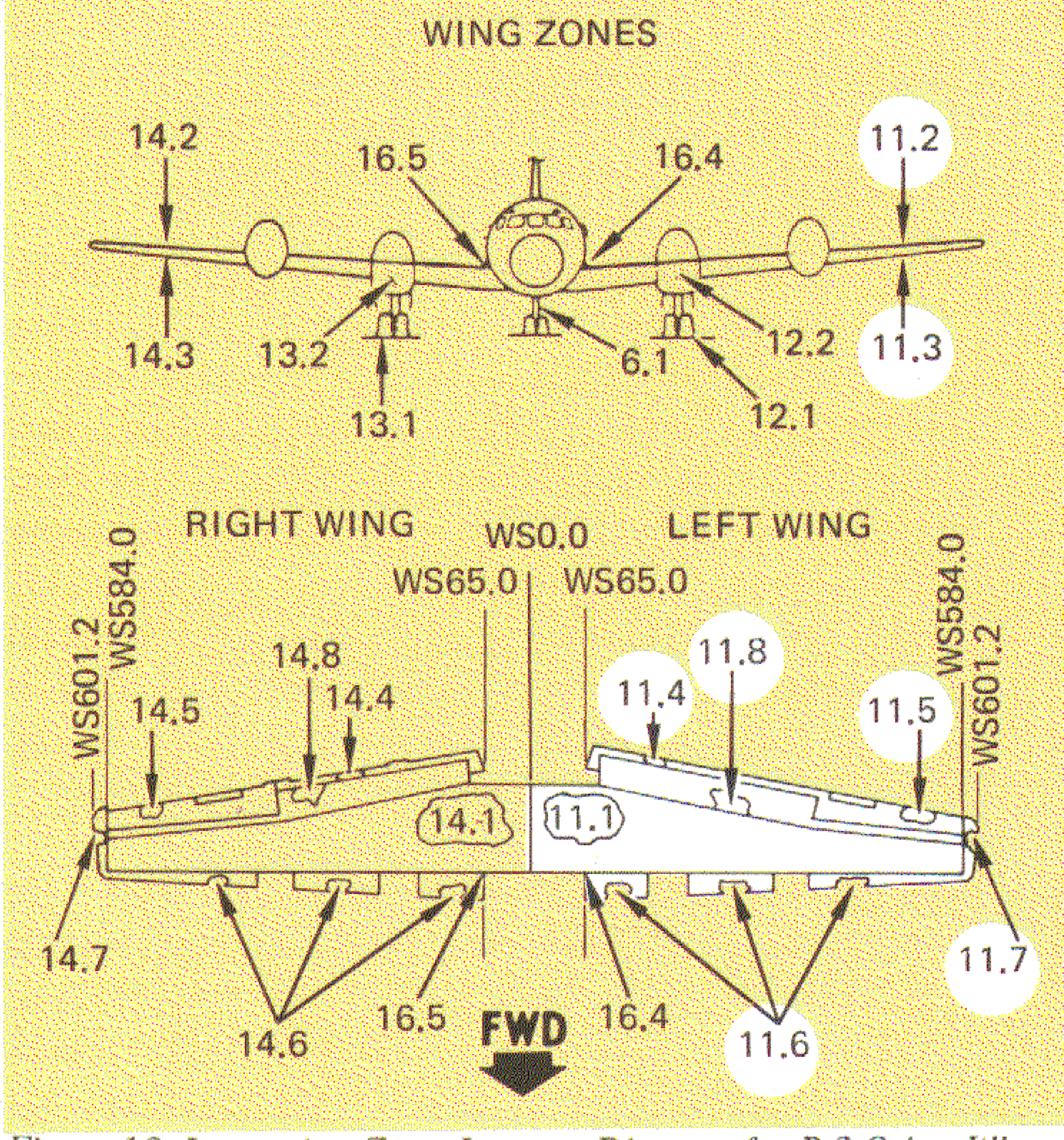


Figure 17C. Inspection Items on Nose Landing Gear after Implementation of IMP and Zonal Examination Concept

CARD	PUBLICATION NUMBER	P-3 ZONES - WINGS	CHANGE NO. 1
xxvi	NAVAIR 01-75PXX-6-X4		15 October 1974



6.1 NOSE LANDING GEAR
11.1 LEFT WING BOX - INTERNAL
11.2 LEFT WING UPPER SURFACE - EXTERNAL
11.3 LEFT WING LOWER SURFACE - EXTERNAL
11.4 LEFT WING FLAP - INTERNAL
11.5 LEFT AILERON AND TAB - INTERNAL
11.6 LEFT WING LEADING EDGE - INTERNAL
11.7 LEFT WING TIP - INTERNAL
11.8 LEFT WING TRAILING EDGE - INTERNAL
12.1 LEFT MAIN LANDING GEAR - EXTERNAL
12.2 LEFT MAIN LANDING GEAR WELL AND DOORS - INTERNAL
13.1 RIGHT MAIN LANDING GEAR - EXTERNAL
13.2 RIGHT MAIN LANDING GEAR WELL AND DOORS - INTERNAL
14.1 RIGHT WING BOX - INTERNAL
14.2 RIGHT WING UPPER SURFACE - EXTERNAL
14.3 RIGHT WING LOWER SURFACE - EXTERNAL
14.4 RIGHT WING FLAP - INTERNAL
14.5 RIGHT AILERON AND TAB - INTERNAL
14.6 RIGHT WING LEADING EDGE - INTERNAL
14.7 RIGHT WING TIP - INTERNAL
14.8 RIGHT WING TRAILING EDGE - INTERNAL
16.4 WING FAIRING LEFT HAND - INTERNAL
16.5 WING FAIRING RIGHT HAND - INTERNAL

PXX-6-X4-1-002

Figure 18. Inspection Zone Locator Diagram for P-3 Orion Wings. Left Wing Zone Sections are Highlighted.

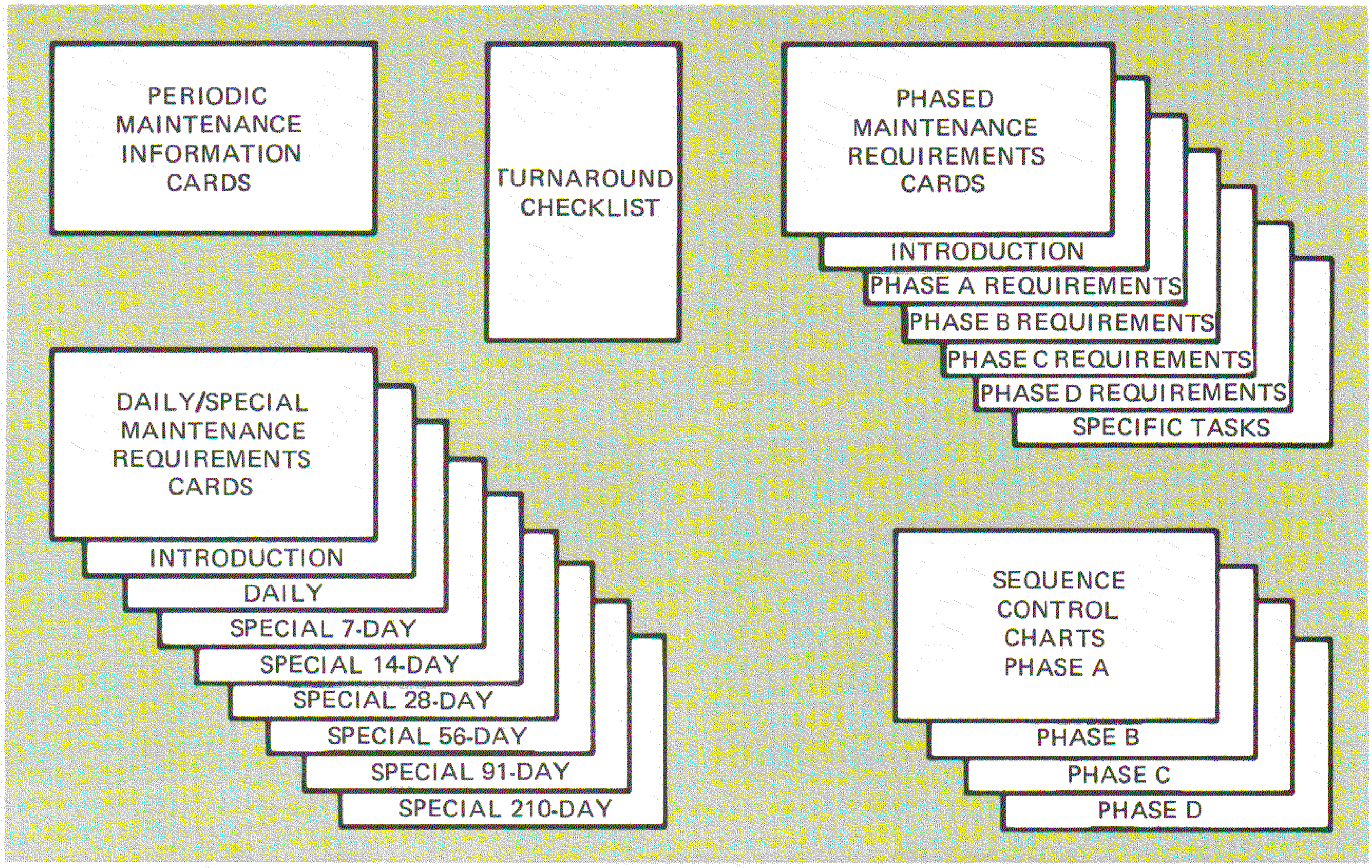


Figure 19. Improved Maintenance Program Elements

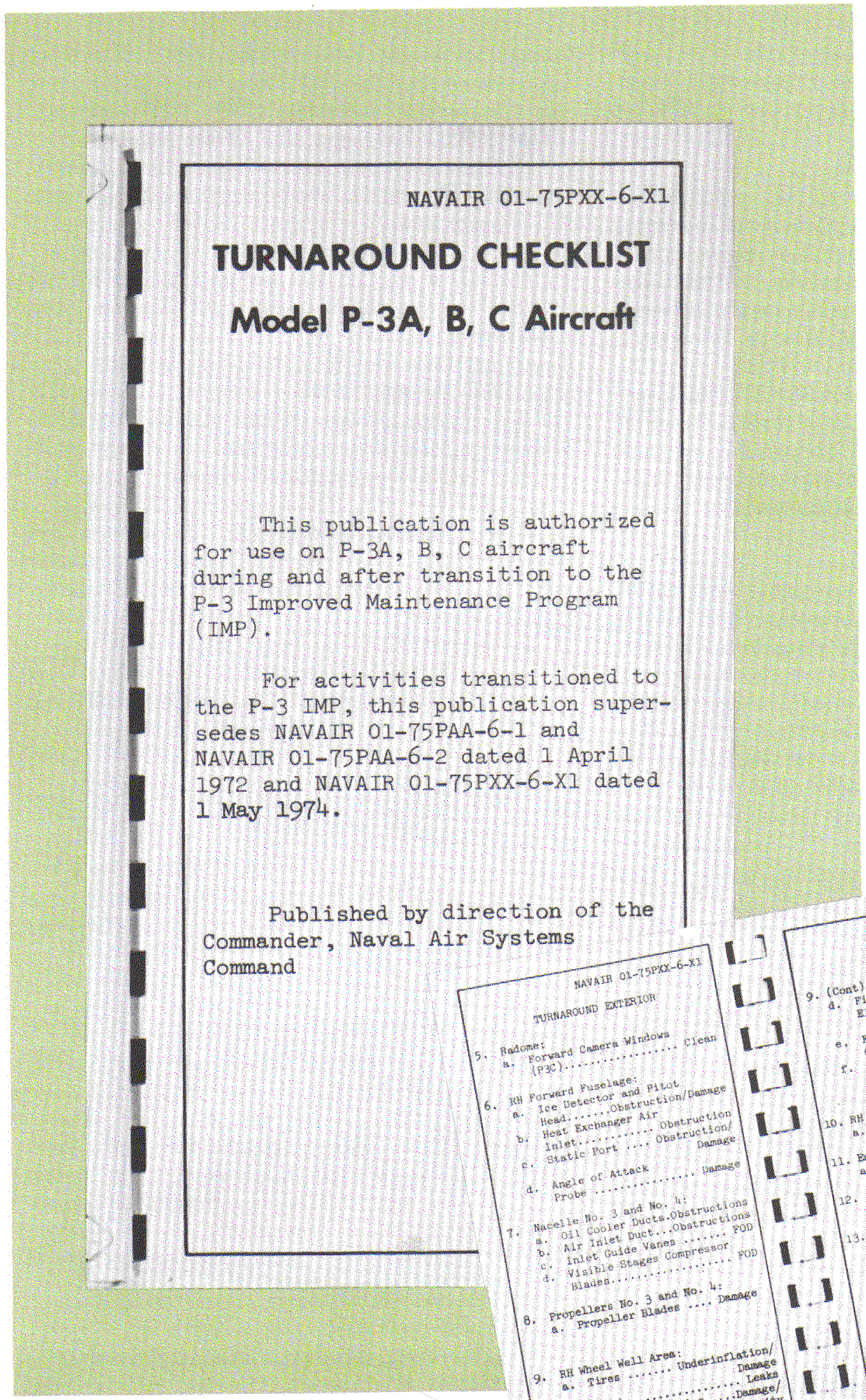
PROGRAM ARRANGEMENT The IMP maintenance requirements are arranged into five publications (Figure 19):

1. Turnaround Checklist
2. Daily/Special Maintenance Requirement Cards (MRC's)
3. Periodic Maintenance Information Cards (PMIC's)
4. Four Phase Inspections
5. Four Sequence Control Charts (SCC's)

Turnaround Checklist – NAVAIR 01-75PXX-6-X1 The turnaround pocket-size checklist (Figure 20) replaces the preflight and postflight checklists. This checklist is arranged as follows: checks required before flight, checks required between flights, and checks required after flight. These minimum requirements for the turnaround check are normally conducted by the flight crew. The turnaround check is valid for 24 hours, provided no flights occur during this period.

Daily/Special Maintenance Requirements Cards – NAVAIR 01-75PXX-6-X3 The Daily/Special Maintenance Requirements Card set (MRC's) contains minimum maintenance requirements that must be performed on a daily basis. These requirements are for items that are calendar-sensitive or that might deteriorate as a function of time. The Special cards schedule less frequently required calendar-sensitive maintenance tasks on a particular day. Various special tasks are performed at 7-day, 14-day, 28-day, 56-day, 91-day, and 210-day intervals.

The Daily/Special MRC's are arranged and numbered to present the required maintenance tasks in the most logical order of performance. Instructions include clearances, pressures, tolerances, illustrations, equipment required, and


NAVAIR 01-75PXX-6-X1

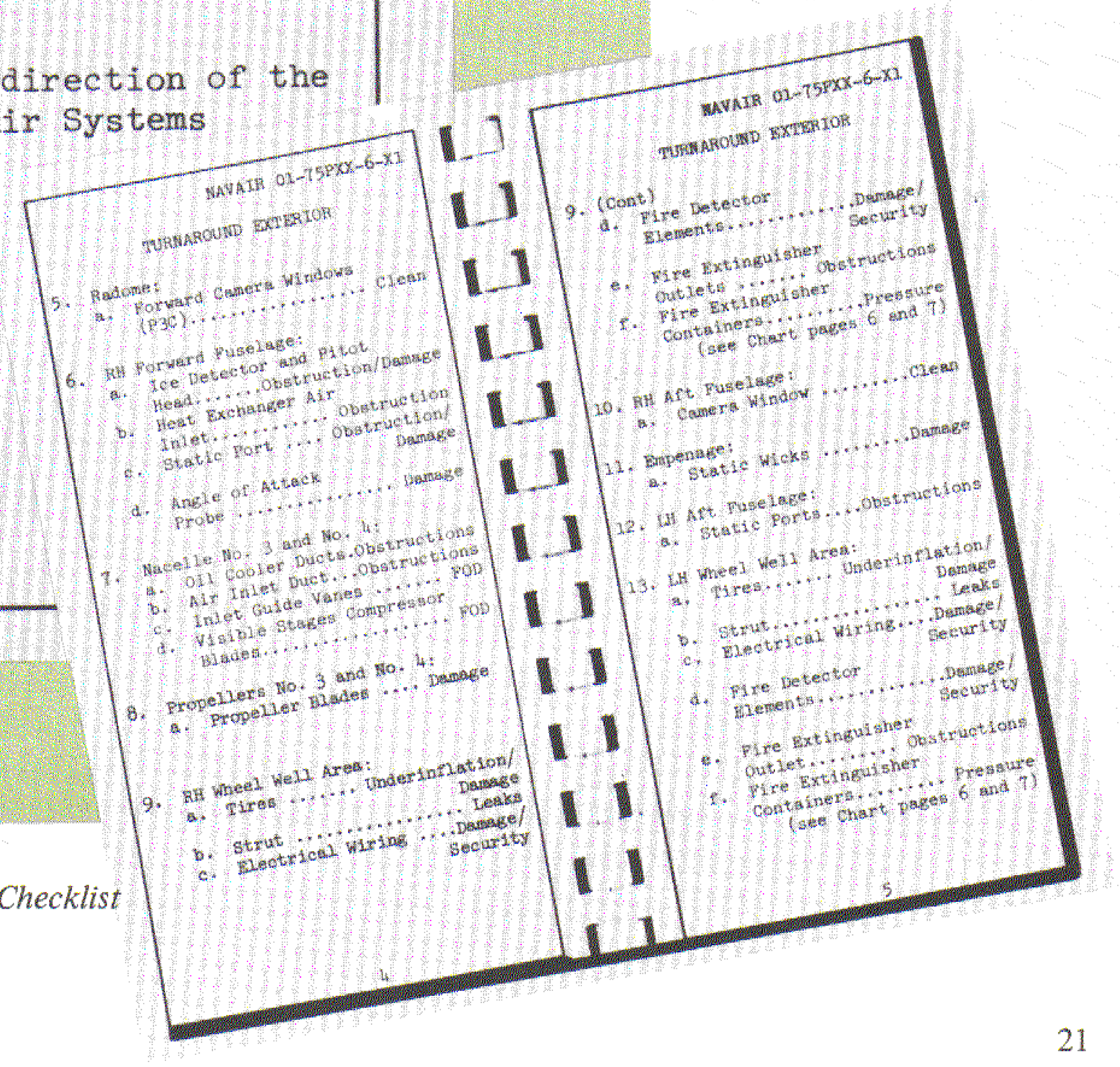
TURNAROUND CHECKLIST

Model P-3A, B, C Aircraft

This publication is authorized for use on P-3A, B, C aircraft during and after transition to the P-3 Improved Maintenance Program (IMP).

For activities transitioned to the P-3 IMP, this publication supersedes NAVAIR 01-75PAA-6-1 and NAVAIR 01-75PAA-6-2 dated 1 April 1972 and NAVAIR 01-75PXX-6-X1 dated 1 May 1974.

Published by direction of the Commander, Naval Air Systems Command


NAVAIR 01-75PXX-6-X1

TURNAROUND EXTERIOR

5. Radome:
   a. Forward Camera Windows (P3C) .... Clean
6. RH Forward Fuselage:
   a. Ice Detector and Pitot Head ...... Obstruction/Damage
   b. Heat Exchanger Air Inlet .... Obstruction
   c. Static Port .... Obstruction/Damage
   d. Angle of Attack Probe .... Damage
7. Nacelle No. 3 and No. 4:
   a. Oil Cooler Ducts.Obstructions
   b. Air Inlet Duct...Obstructions
   c. Inlet Guide Vanes .... FOD
   d. Visible Stages Compressor Blades .... FOD
8. Propellers No. 3 and No. 4:
   a. Propeller Blades .... Damage
9. RH Wheel Well Area:
   a. Tires .... Underinflation/Damage
   b. Strut .... Leaks
   c. Electrical Wiring ....Damage/Security

4

NAVAIR 01-75PXX-6-X1

TURNAROUND EXTERIOR

9. (Cont)
   d. Fire Detector Elements.......... Damage/Security
   e. Fire Extinguisher Outlets ...... Obstructions
   f. Fire Extinguisher Containers .... Pressure (see Chart pages 6 and 7)
10. RH Aft Fuselage:
   a. Camera Window .... Clean
11. Empenage:
   a. Static Wicks .... Damage
12. LH Aft Fuselage:
   a. Static Ports ....Obstructions
13. LH Wheel Well Area:
   a. Tires....... Underinflation/Damage
   b. Strut .... Leaks
   c. Electrical Wiring.... Damage/Security
   d. Fire Detector Elements.......... Damage/Security
   e. Fire Extinguisher Outlet........ Obstructions
   f. Fire Extinguisher Containers........ Pressure (see Chart pages 6 and 7)

5

Figure 20. P-3A/B/C Turnaround Checklist

publication references. The cards have been arranged in Daily and Special groups. Each card is identified by the title of the group to which it belongs.

The Daily/Special card set is organized as follows: format description, definitions, including tasks and applicable card numbers, index, special tools/equipment list, consumable materials list, replacement parts list, P-3 zones, access panels with illustrations and applicable MRC cards.

Daily maintenance requirements are performed after the last flight of the day. No more than 72 hours may elapse between performance of Daily maintenance requirements and the next flight. *Daily MRC's do not contain turnaround requirements.*

Periodic Maintenance Information Cards – NAVAIR 01-75PXX-6 The Periodic Maintenance Information Card set (PMIC's) contains removal/replacement requirements, scheduled removal component requirements, pre-phase inflight check requirements, and conditional inspection listings. This publication also contains those items that are checked by the flight crews, in-flight, on the flight prior to the "D" Phase check or on the first flight after accomplishment of the "D" Phase check. In this manner the hidden-function, safety-of-flight items are checked at an interval of 800 flight-hours, and the requirement for a post-phase check flight is eliminated. However, check flights are still required within the limits defined in the NATOPS Flight Manual and in OPNAVINST 4790.2A.

Phased Maintenance Cards – NAVAIR 01-75PXX-6-X4 The Phased Maintenance Card set contains the minimum requirements for all phased maintenance inspections. The card set is divided into four phase sections (A, B, C, and D) and a general information section. Each phase check is to be performed 200 flight-hours after completion of the previous phase check. At the end of 800 flight-hours, all four phase checks will have been performed to complete one phased maintenance cycle.

Each phase card is identified by a card number. This number is preceded by a letter (A, B, C, or D) that denotes the phase inspection to which the card is applicable. For example, phase card number A8 is used on every "A" Phase check, while phase card number B9 is used on every "B" Phase check. Thus, *all* cards designated "A" are used on every "A" Phase check, *all* cards designated "B" are used on every "B" check, and so forth for the "C" and "D" phase cards.

The cards in the general section apply to all four phase checks, and present the following information:

- **Authorization** – Denotes the authority for usage of the cards, states the effective change date of the card deck, and lists the effective cards.
- **General Description** – Presents a brief description of the phased maintenance program and the phase check arrangement.
- **Format Description** – Describes what information is presented on each card, and how the information is arranged.
- **Definitions** – Specifies key terms used on the cards, and defines these terms.
- **Table of Contents** – Outlines the order in which the card deck sections are arranged.
- **Phase Index** – Designates the phase cards required for the individual phase checks.
- **Task Index** – Designates specific tasks, and indicates the phase at which the task is accomplished. These cards are numbered sequentially, but not necessarily in the order that the tasks are to be accomplished.
- **P-3 Zones** – Presents verbal descriptions of the inspection zones, and includes drawings that show the zone locations, boundaries, and identification numbers.

- **Access Panels** – Presents drawings that show the location and identity of access panels used during phase checks.

The balance of the phase deck is divided into individual sections for Phases A, B, C, and D. The identity number of each card is preceded by the applicable phase letter. Each section is arranged as follows:

- **Application** – Presents a brief description of the use of the phase cards.

- **Special Tools** – Designates special tools and equipment necessary to accomplish the individual phase check.

- **Consumable Materials** – Designates the consumable materials required during the individual phase check.

- **Replacements Parts List** – Designates the replacement parts used during the individual phase check. These parts are contained in the IMP spares kit.

- **Access Open** – Designates the access panels that must be opened in order to accomplish the phase check.

- **Zonal Examinations** – Designates the zones to be examined in the individual phase check, and provides general inspection guidelines.

Sequence Control Charts – NAVAIR 01-75PXX-6-5 Series Four Sequence Control Charts (Phase A, B, C, and D) control the work flow of the phase checks. Each phase check has its individual Sequence Control Chart (SCC). These charts specify the ratings required to perform the phase checks, and list the Maintenance Requirements Cards that each rating must perform in a linear format. These cards are listed in the order that the tasks should be executed, *not in numerical sequence*. Quality Assurance alerts and requirements are designated on the SCC's, as are electrical and hydraulic power "on" and "off" requirements. Figure 21 shows the Phase A Sequence Control Chart, and highlights several of its pertinent features. Note that in some cases, card designations are abbreviated to obviate clutter on the chart.

The Phased Maintenance Requirements Cards have been listed on the SCC's in the order that will result in optimum work flow during the phase check. Thus, the SCC is to be used as the guide to the phase check. Sometimes, deviations from the work flow specified on the chart may be required to expedite the total check. When such deviations occur, care must be exercised to assure that performance of the balance of the check is not unduly compromised.

PROGRAM COORDINATION AND CONTROL Program coordination and control is the keystone to the success of IMP. If the proper management controls are applied, the Improved Maintenance Program runs itself. If they are not, the system will not function to its maximum potential.

Crew Composition The optimum check crew complement is shown in Figure 16. Crew size and rate structure may vary somewhat, according to the deployed squadron's posture and its available manpower. However, if the check crew structure cannot be maintained in this recommended balance, portions of the phase check will reflect this inadequacy.

During the IMP trial phase it became apparent that in order to achieve maximum potential during the program, the check crew should be kept intact for the duration of the phase check. The most successful phased maintenance operations were conducted by a "permanent" check crew, with people rotated into the crew for "on the job" training. The permanent check crew performed the "look" portion of the phase check and those "fix" portions of the phase check that were within their capabilities. They also performed Daily/Special inspections when a phase check was not in work.

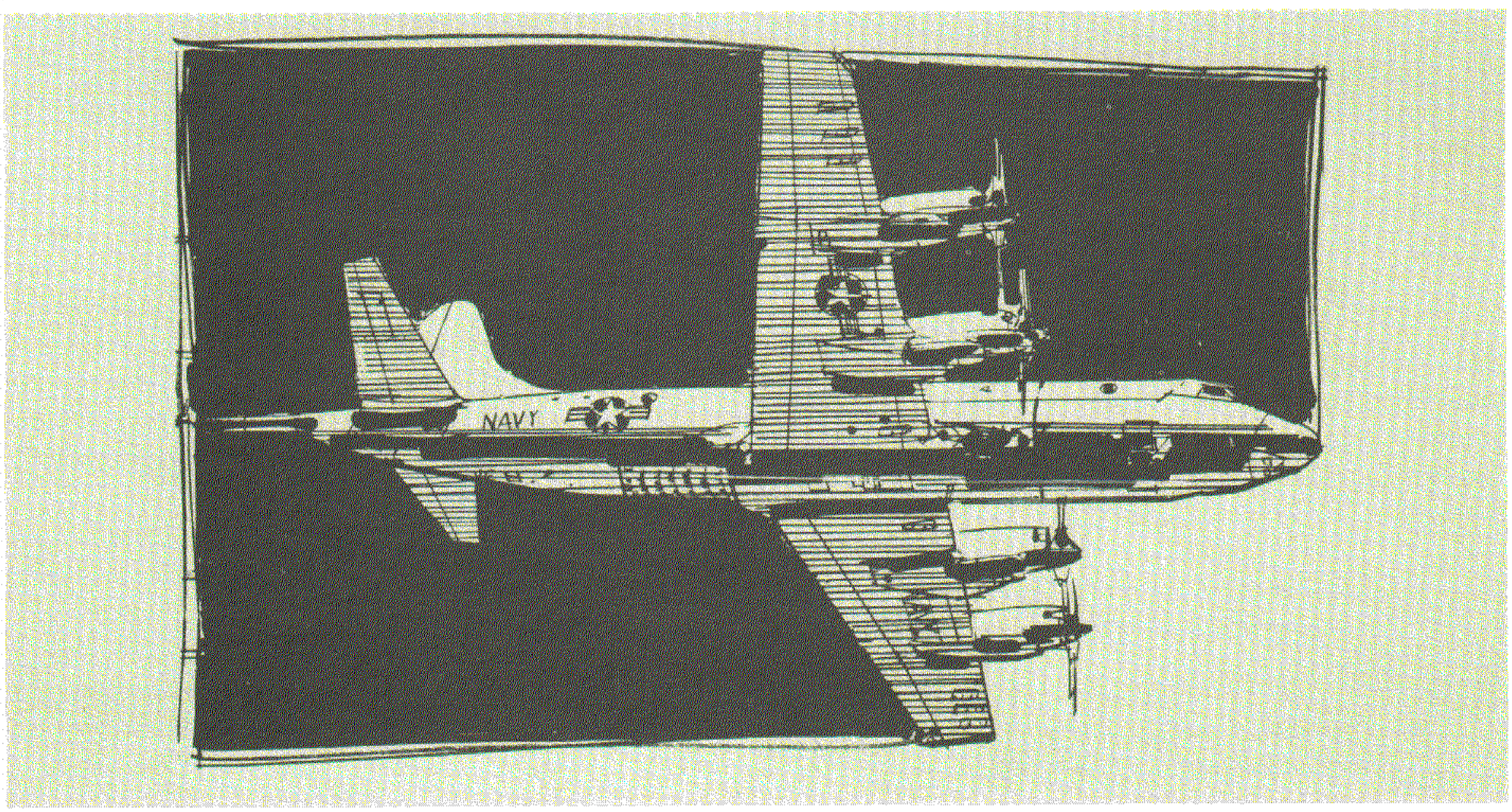


Figure 21. IMP Phase A Sequence Control Chart

The trial phase demonstrated that the check crew works best when it is directly assigned as a scheduled maintenance check crew.

Management Control Because IMP phase control is on a flight-hour basis, a close relationship must be maintained between flight operations and maintenance. It is imperative that operational commitments be scheduled to be consistent with the 200 flight-hour maintenance phases. Most squadrons keep a running schedule chart of the hours-to-check for each aircraft to support their operational commitments. Figure 22 depicts one such control chart currently in use. This schedule is updated daily to maintain this close coordination between the squadron operations and maintenance organizations.

A ±10 percent relief from the time constraint between 200-hour phase checks is permitted by Naval Aviation Maintenance Program Instructions, OPNAVINST 4790.2A. This means that a check can be performed between 180 and 220 flight hours after the last phase check. However, the next phase check must be scheduled to compensate for the deviation that has been exercised. For example: If a ±10 percent (20 hours) deviation is utilized to extend the period since the last phase check, the aircraft will have experienced 220 flight hours since the last check. The next phase check will be due in 180 flight hours.

Spares Kit A spares kit has been created to support the IMP program. This universal kit of parts can be used to perform any single phase A, B, C or D check. Much like a carburetor kit that one would buy at a local auto store, it includes some parts that will not be used for a particular phase check. Parts left over can be returned to stores for future use. The philosophy that determined use of a universal kit in lieu of individual kits for each phase check is simple:

1. One kit part number is easier and cheaper to control.

2. With only one kit, the squadron is assured to have the *proper* kit for the phase that is due.

One kit will provide parts for *one* phase A, B, C or D check; it will not provide parts for *all four* phase checks.

Phase Check Preparation Phase check preparation begins when an aircraft approaches the flight hour limitation following its last phase inspection. The inspection is scheduled, hangar space is assigned, and the IMP phase parts kit is procured. Tools, equipment, and consumable materials are also obtained. Finally, the phase check maintenance requirements card deck is assembled.

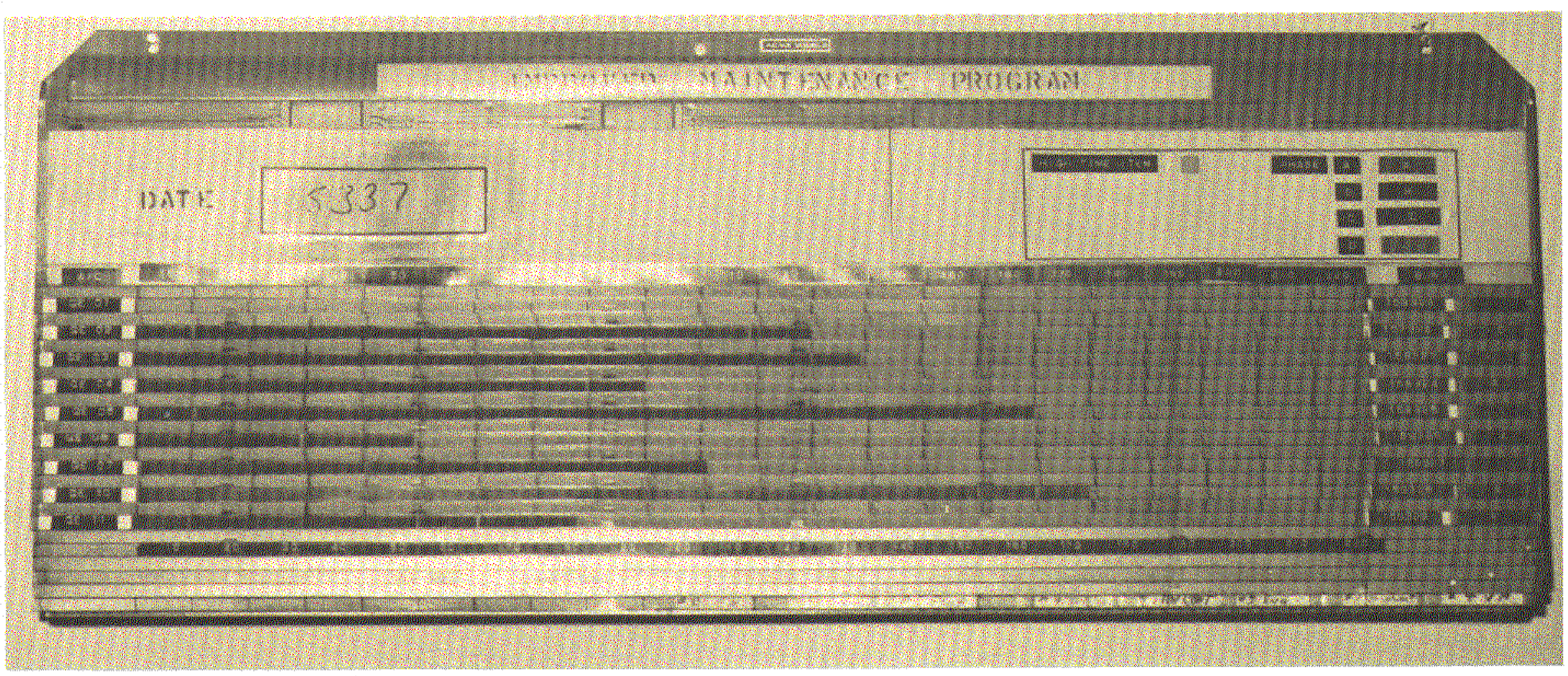


Figure 22. Squadron Maintenance Control Chart Depicting Hours-to-Check for Individual Aircraft

CARD	PUBLICATION NUMBER		CHANGE NO.
xvi	NAVAIR 01-75PXX-6-X4	TASK INDEX	

CARD NO.	TITLE	PHASE A	PHASE B	PHASE C	PHASE D
26-26.4	Generator Spline Lubrication	2	3&4	2	3&4
27	Aircraft Positioning	X	X	X	X
28-28.19	Ground Operational Turn Up	1&2	3&4	1&2	3&4
29-29.1	Entrance Ladder and Lub	X	X	X	X
30-30.3	Hydraulic Fluid Sampling/Analysis	X	X	X	X
31	Cabin Exhaust Outflow Duct	X	X	X	X
32-32.1	Empennage De-icer	X	X	X	X
33	Magnetic Tape Transports	X	X	X	X
34-34.1	P-3C ECM Antenna Lubrication	X		X	
35-35.1	P-3C ECM Antenna Lubrication			X	
36-36.2	LH MLG Uplock Lubrication	X		X	
37-37.2	LH MLG Door Lubrication	X		X	
38-38.4	NLG Door, Uplock and Battery Elev Screw Lub	X		X	

Continued

Figure 23. Typical IMP Phase Inspection Task Index Card

Phase MRC Deck Assembly The Phase check organizer assembles the phase check deck by selecting those cards from the phase MRC deck that apply to the scheduled A, B, C or D phase check. The index at the front of the NAVAIR 01-75PXX-6-X4 phase deck is the key to selecting the appropriate cards (see Figure 23). Simply run down the column under the check required (A, B, C or D), then pull out the cards indicated. Next, the check organizer refers to the appropriate phase check sequence control chart to ascertain if any of the maintenance requirement cards are used in more than one place at the same time. Whenever this occurs, a duplicate card is included in the phase deck assembly. The assembled cards are then issued to the check crew coordinator who reviews the deck to ensure that the set is complete. The phase deck index and the sequence control chart are the key to this review, for once the phase check deck has been assembled the cards are no longer in numerical sequence.

Work Control Center A portable workstand serves as the check crew coordinator's work control center (Figure 24). The check crew coordinator organizes the maintenance requirements cards into groups,

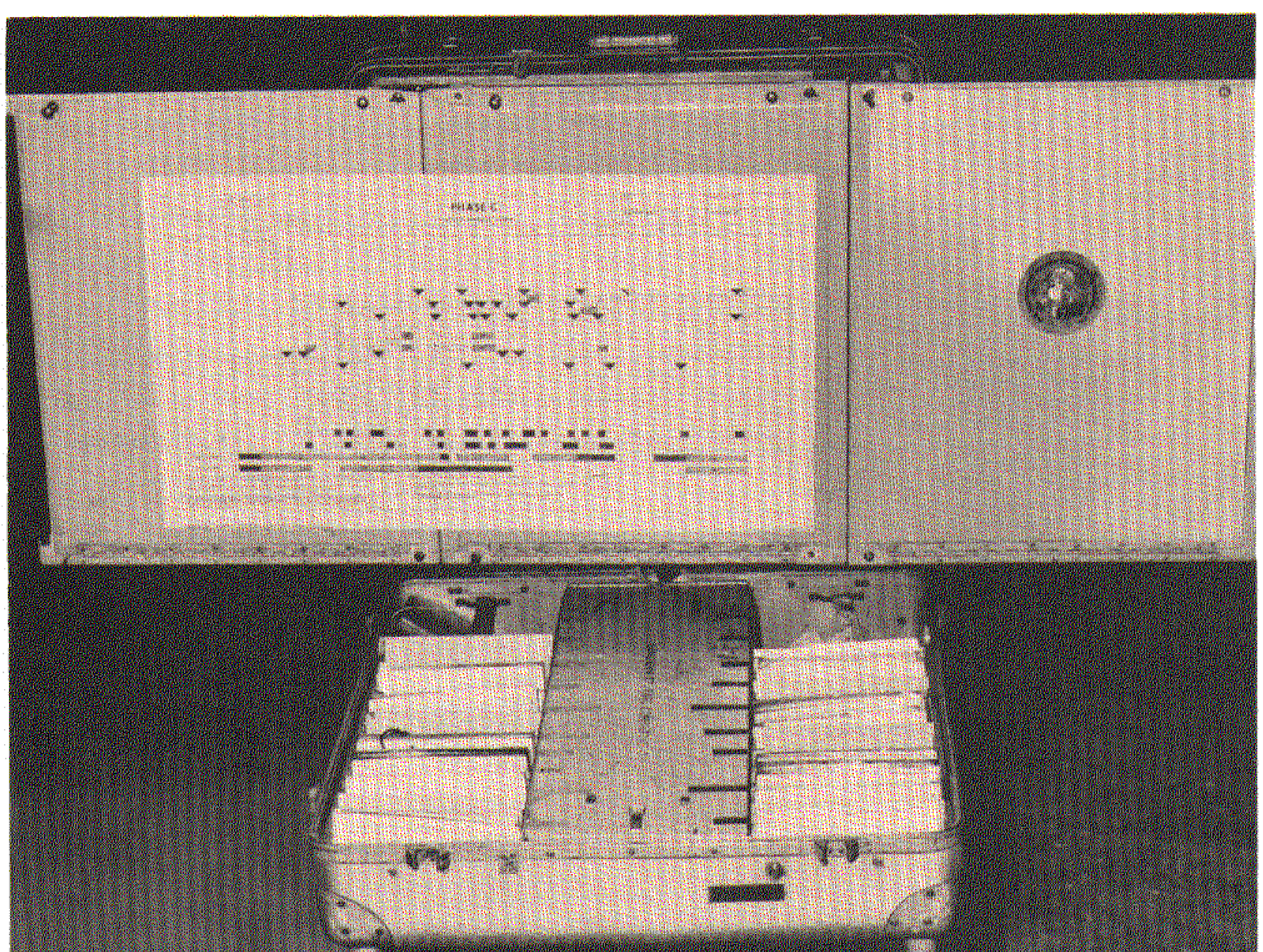


Figure 24. Check Crew Coordinator's Work Control Center with Sequence Control Chart and Task Cards

according to the various ratings that perform the check. The group of cards for each rating are then assembled in the order that they appear on the phase Sequence Control Chart. The card groups are inserted into slots in the portable workstand. The lefthand row of card slots are labeled for each rating in the order that the ratings appear on the Sequence Control Chart. The cards are filed in the righthand row of card slots when the check crew members return the cards after completing their assigned tasks. The Sequence Control Chart is mounted under a clear plastic cover on the back of the portable workstand.

Work Assignment The check crew coordinator is the pivotal force of the phase check – he makes the work assignments. Minimal workloads should be assigned to the individual check crew member, one maintenance requirement card at a time whenever possible. When a card is issued, the check crew coordinator should mark a slash (/) over the appropriate card number on the Sequence Control Chart. When the assignment is completed and the card or worksheet is initialed and returned, the slash is crossed to form an "X," indicating that the task has been accomplished. This provides the check crew coordinator with immediate visibility of check progress and permits him to respond rapidly to obvious delays. The check crew coordinator should also note the time that each card is issued. This action is not intended to monitor individual performance, but rather to permit the coordinator to spot trouble areas and react so that the balance of the check will not be delayed.

Pre-Phase Check When the aircraft is delivered to the hangar for induction into the phase check, a pre-phase check is performed on the aircraft outside the hangar. This check is to ensure that the aircraft's fuel load and oxygen system pressure are within the recommended limits. The aircraft is also checked to make certain that all unexpended stores are removed from the aircraft before beginning the phase check. After the requirements of this check have been satisfied, the aircraft is towed into the hangar and prepared for inspection. Pre-phase check requirements are listed in the Phase Check deck.

Phase Check After the pre-phase check and inspection preparations are completed, the check crew coordinator issues maintenance requirements cards to begin the Phase Check. As mentioned before, a minimum number of cards are released at a time, and the Sequence Control Chart is marked accordingly to record issuance and completion of work assignments.

When a discrepancy is found during the "look" portion of the check, it is recorded and entered on the Visual Display (VIDS) board in Maintenance Control (Figure 25). Corrective action, depending on the severity of the discrepancy, is started as soon as possible without disturbing the balance of the check. Members of the check crew that are qualified to work on the discrepancy are used to fix it when they are not performing other check tasks. If corrective action is beyond the capability of the check crew, a specialist is assigned to correct the discrepancy.

Quality Assurance personnel follow the work flow of the check, providing their services when they are required. Usually a Quality Assurance man is not required on the aircraft at the time indicated on the Sequence Control Chart, unless the maintenance requirements card *specifically* calls out a QA requirement immediately after the task is performed. Generally, QA personnel perform their functions after all work in an area has been completed, just before the access covers are reinstalled. This procedure is employed to minimize the time that QA personnel must spend on or around the aircraft during the Phase check.

When all of the "look" and "fix" portions of the Phase check have been completed in the hangar, the aircraft is towed to the runup area and the prime and secondary engines are checked. Upon satisfactory completion of engine runup, the final

Figure 25. Visual Display (VIDS) Maintenance Discrepancy Board for an Individual Airplane

maintenance requirement cards are signed off, completion of the Phase Inspection is recorded in accordance with Naval Aviation Maintenance Program Instructions, OPNAVINST 4790.2A, and the aircraft is returned to service.

COMPLEMENTARY MAINTENANCE PROGRAMS

INTERMEDIATE LEVEL MAINTENANCE Introduction of the Improved Maintenance Program has had minimal effect on intermediate level maintenance activities. The short time that an aircraft is in the phase check requires a rapid turnaround of replacement parts, a challenge that the Aircraft Intermediate Maintenance Departments (AIMD) have met. Specifically, oxygen regulators and survival equipment inspection requirements were a problem. Wing commands overcame these obstacles by rotating spare units with those removed from the aircraft, thus eliminating the delay in elapsed time that might be required to check out or inspect these equipments.

The basic intermediate level maintenance requirements have been included in the IMP Periodic Maintenance Information Cards (PMIC's). This deck includes the quick engine change (QEC), propeller and control assembly, and auxiliary power unit (APU) tasks for AIMD. Recently, NARF Alameda incorporated these requirements into a separate MRC deck, NAVAIR 01-75PXX-6-02, for the AIMD's.

DEPOT LEVEL MAINTENANCE PROGRAM Following the successful application of MSG-2 concepts to the P-3 at the organizational level, attention was directed to applying the same concepts at the depot level. To this end, NARF Alameda and Lockheed conducted an analysis of depot level maintenance requirements, including a reevaluation of structural inspection requirements. The results of this analysis formed the basis for a new Depot Level Maintenance Program that features the following elements:

- A structural sampling inspection program for P-3 aircraft, the first of its kind prepared for military application.
- Extension of P-3 depot level induction intervals.
- Revision of specific depot level tasks and frequencies.
- Extension of the Zonal Examination concept to depot level maintenance.

The first P-3 aircraft were inducted into the new Depot Level Maintenance Program at NARF Alameda in July 1975. NARF Jacksonville began implementing this program in January 1976. This program is intended to complement the organizational-level Improved Maintenance Program and reduce the time and cost of depot level maintenance.

Frank H. Connell is the Military Maintenance Planning Group Engineer of Lockheed-California Company's Logistics Engineering Department. Mr. Connell supervised development and implementation of the P-3 Improved Maintenance Program (IMP). During the IMP implementation phase, he led the field teams that indoctrinated the P-3 squadrons on the philosophy and background of IMP.

Mr. Connell joined Lockheed in 1961 as a Human Engineering and Design Specialist. Since then he has participated in the proposal and development of the C-141 transport, TFX, XH-51 helicopter, C-5A transport, and the SST. On the L-1011 Tristar, he was in charge of Maintainability Design for all structure, landing gear, and the aircraft interior. During development of the L-1011 maintenance program, Mr. Connell served as chairman of the ATA/MSG-2 Structures Committee, and he wrote the Structural Inspection and Structural Sampling Programs for that aircraft.

Prior to joining Lockheed, Mr. Connell served five years with American Airlines as Assistant Manager of Structures Engineering. He was in charge of developing AA's Structural Maintenance Programs for their Boeing 707 and 720, Lockheed L-188, and Convair 990 aircraft. He also headed their Field Operations Engineering for 707 and 720 aircraft. Before this, Mr. Connell held positions of engineering staff to General Factory Manager at Kaiser/Fleetwing Aircraft on the F-84 and B-57 projects, and he spent four years at NADC Johnsville in the Advanced Aircraft Systems Engineering Division. During World War II, Mr. Connell served four years in the U.S. Navy Submarine Service.

IMP UPDATE

The Improved Maintenance Program is a viable and dynamic program. A key feature of IMP is that it can be adjusted from time to time in order to take advantage of experience gained in P-3 operations and maintenance. NARF Alameda has been given responsibility for monitoring the Improved Maintenance Program. Suggestions on how to refine IMP are solicited from the fleet, and should be forwarded to NARF Alameda.

CONCLUSION

The Improved Maintenance Program has proven to be one of the most significant advancements in the maintenance field. Recently, the program's success was confirmed when the Secretary of Defense directed all military weapons projects to investigate application of IMP's advanced concepts to their maintenance programs.

The Navy has taken the leadership role in adapting these modern maintenance techniques to military aircraft. Today this is evidenced by Naval Air System Command's concentrated effort to apply these techniques to each Navy aircraft under the Analytical Maintenance Program. IMP is here, and will be the benchmark for all future maintenance programs.

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FIELD SERVICE OFFICES

MAJOR LOCATION	MAILING ADDRESS AND BUSINESS TELEPHONE
NARF Alameda F. E. Weaver	P.O. Box 1363 Alameda, CA 94501 *(415) 521-2283*
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CNAVRES New Orleans G. A. Seipp	P.O. Box 189 Gretna, LA 70054 *(504) 948-1226*
NS Naples K. M. Prideaux	Lockheed-California Co. COMFAIRMED/NSA FPO New York, NY 09521 *Naples 081-7605400*
NAS Norfolk A. W. Barber	P.O. Box 15148 U.S. Naval Base Norfolk, VA 23511 *(804) 423-8321*
NAS North Island R. B. Calvin	NAS Box 5 San Diego, CA 92135 *(714) 435-8910*
NATC Patuxent River M. D. Garino	P.O. Box 218, NATC Patuxent River, MD 20670 *(301) 863-8186*
USNAF Sigonella A. H. Parker	USNAF P.O. Box 1032 FPO New York, NY 09523 *Sigonella 27-88-21, Ext. 434*
NADC Warminister J. Harris	P.O. Box 220 Warminster, PA 18974 *(215) 672-9000, Ext. 2977*
Washington Navy Yard J. R. Mercer	P-3 Project Control Center, Bldg. 220, Washington Navy Yard Washington, DC 20374 *(202) 433-4524*
Bonn, Germany G. C. Lauffenburger*	Box 205 APO New York, NY 09080 *Bonn-Bad Godesberg 356621*
Teheran, Iran E. C. Joslen*	P.O. Box 66-1516 Niavaran, Iran *Teheran 843940 or 848878*
Madrid, Spain F. E. Kiewert	USAF Section MAAG APO New York, NY 09285 *234-2800, Ext. 255 or 360* *(Air Ministry Madrid)*

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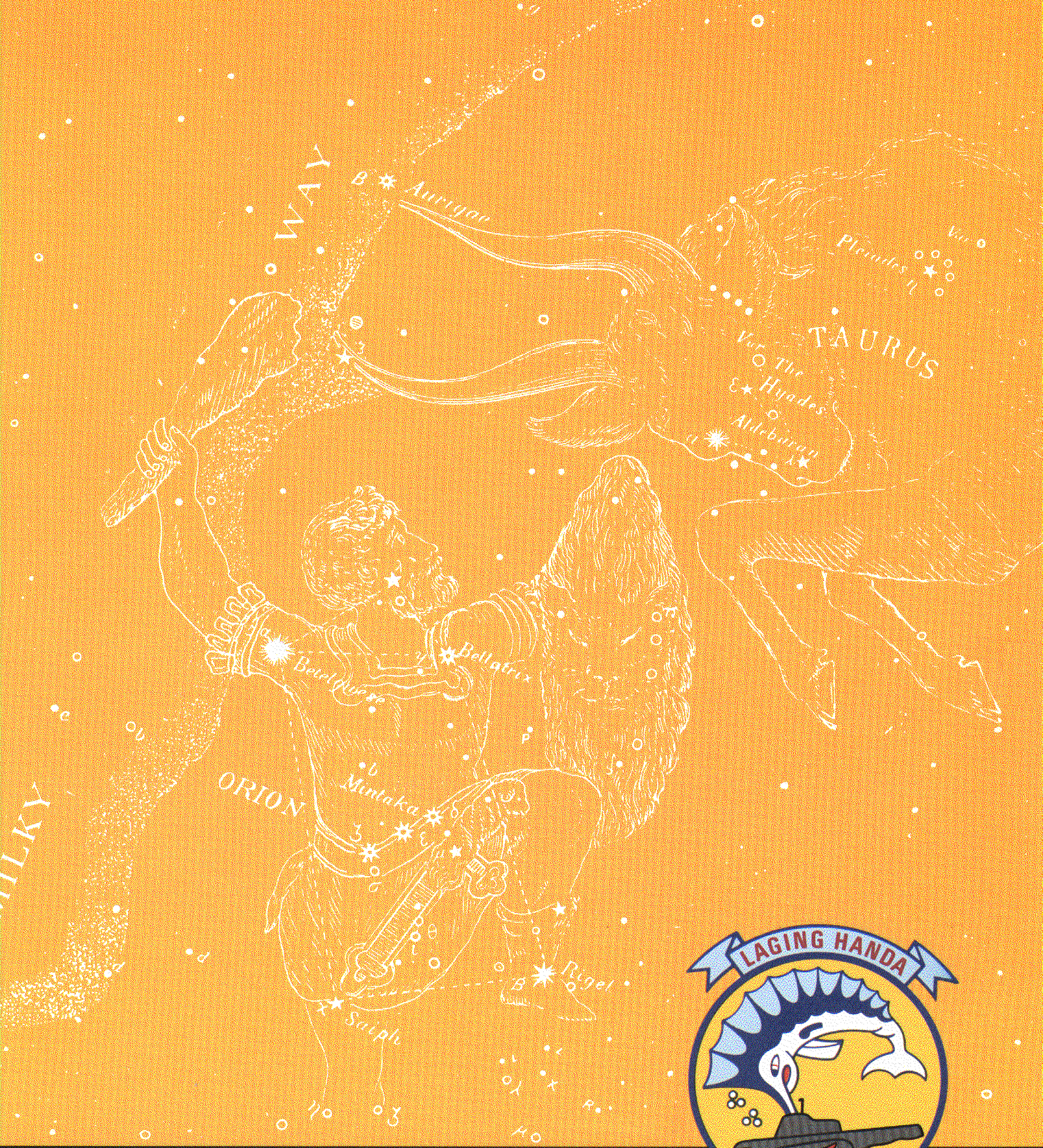

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