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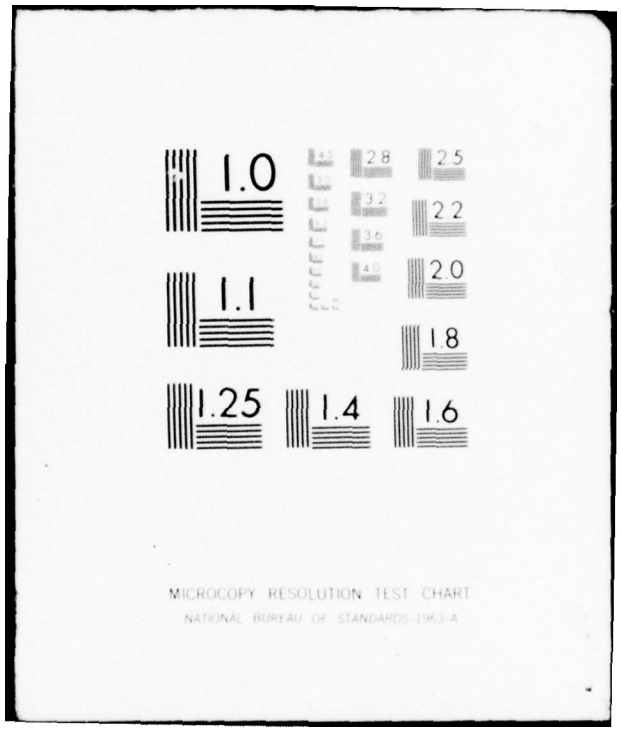
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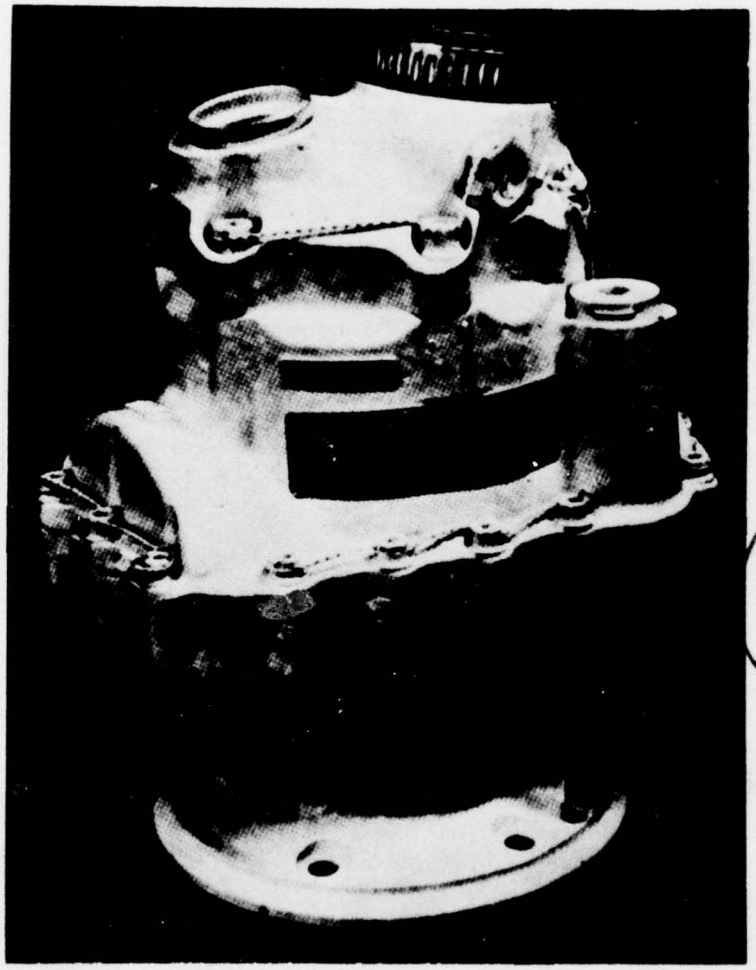


MID CONTRACT EVALUATION

ASO CONTRACT NO. NOO383-73-C-3318

WITH ABEX CORP

REPORT NUMBER:- ASO-TEE-2-77

Prepared by: Oscar Markowitz PE, CPL

Date: October 15, 1977

ACKNOWLEDGEMENTS

The material within this report comes from many sources. All these sources cooperated on an exceptional basis in response to ASO requests. Particular thanks belongs to Abex Corporation, the RIW contractor, who went way beyond any specific contract requirement to support the analytic endeavors for this report in researching for information and providing required inputs. Note must be made of Mr. Fred Anderson's contributions in his original marketing of the new concepts both within his own company and with the Navy. His continuous dedication and responsiveness throughout the RIW contract were very significant contributions. Also within Abex were Mr. Joe Moletti who added much through his forward engineering thinking, Mr. Dick Moreland who heightened field response to the RIW, and Mr. Charles Miller, the current RIW administrator who learned rapidly and has become very effective.

This report could not have been as comprehensive without the assistance and direct support of Mr. Pat Ahern, Mr. Joseph Giordano, Mr. John Volpe, and Mr. Harry Furlong, my able engineering assistants involved in this project. The economic analysis of inflation provided by Mr. Giordano, is an exceptional innovative piece of work in direct support of this report. A most difficult task was to evolve most probable return rates for the Abex pump should the Abex RIW not have become a reality. This difficult task was performed well by Mr. Volpe and Mr. Giordano to provide a viable and credible cost analysis for a non-RIW alternative.

Many Navy personnel in the field within F-14 operations have recognized the potential of RIW toward improved fleet support and have given of themselves in many ways; my personal thanks to them for their large contribution toward the program's unusual success. The program is afterall designed to support them, thus, their positive reaction is most appreciated.

I would also like to thank the ASO Command for providing the opportunity to utilize innovative RIW and LCC techniques within ASO's procurement practices. It should not be forgotten that my able secretary, Ms. Ruth Donahue, handled the various drafts and prepared excellently the final draft ready for printing.

Thanks to all,

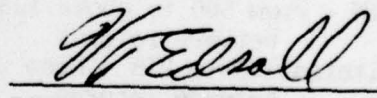
Oscar Markowitz

Oscar Markowitz

FOREWORD

ASO considers the Abex RIW contract a second generation RIW since it contractually combined supply support with reliability improvement. This report shows the interrelationships and documents the real life experiences to surface the advantages of such an intimate combination. Our experiences to date with RIW have indicated its viability in meeting the broad DOD goal of lowering the life cycle costs of military weapons while at the same time satisfying the ASO goal of improved aircraft readiness through improved supply support. It is our opinion that it was the RIW contract's inherent contractor incentives which produced the results documented in this report.

RIW, still in its infancy, has proven itself to be an effective procurement tool which ASO intends to utilize more in the future.



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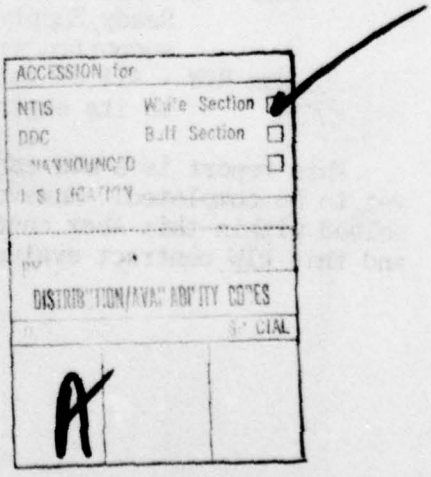
COMMANDING OFFICER



EXECUTIVE BRIEF

The Abex RIW contract was the first RIW contract in DOD which included logistics considerations as well as priced out continuous reliability growth. The terms of the contract forced the contractor to become vitally interested in the influences of field maintenance operations and fleet support, both in terms of cost per return as well as rate of returns. The Navy has always had this interest but is usually frustrated when trying to change design of deployed hardware for the sole purpose of lowering life cycle costs in response to real life operational conditions. The Abex RIW has become a showcase example of the synergistic benefits when logistics/support and design control ("know-how") are vested within a single organizational entity having real dollar incentives to lower life cycle costs.

The report details the Abex RIW case history to date. The division of this report into specific areas follows to some extent jurisdictional elements of the Navy, i.e., Program, Administrative, Engineering, Logistics and Finance. The report also provides numerous illustrations of synergistic benefits achieved when a single organizational entity strives for overall low costs while vitally involved in both the engineering and logistics of fleet support.

Significant results to date of the Abex contract are:

A. Cost effectiveness (1973-1983):

RIW cost - $1,595,344
Alternative to RIW - $3,535,842

B. Reliability Growth (1973-1977):

RIW - From 500 to above 1250 hours of pump operation between returns
Alternative to RIW - From 500 to 590 hours of pump operation between returns

C. Fleet Support (1977):

RIW - 2.4% of total hydraulic systems NORS (Not Operationally Ready, Supply) allocated to its engine driven pumps supported with 25% spares
Non-RIW - 41% of total hydraulic system NORS (A7-E) allocated to its engine driven pumps supported with 75% spares

This report is a mid-contract review and thus the final story is yet to be completed. However, many general questions of RIW are resolved within this Abex contract. The contract will be monitored closely and this RIW contract evaluation report updated at the end of the contract.

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ABSTRACT

RIW (Reliability Improvement Warranty) is considered by DOD (Department of Defense) as being in a trial phase during which the philosophies, techniques and applications can be wrung out. The Abex RIW contract, about which this report deals, innovated features of no exclusions, support, as well as early timing in the sequence of the life of an item. Thus, the report on this Abex RIW contract is meaningful in terms of evaluating RIW results against other most likely results should an otherwise normal support mode have been selected rather than RIW.

The pre-contract history is provided as well as the main conditions and terms of the RIW contract itself. Each area of interest (Program, Administration, Engineering, Logistics and Economics) is reviewed and quantified from data developed for the RIW contract purposes as well as data from other Navy sources obtained for evaluation purposes. Throughout the report, results obtained within the Abex contract are compared against non-RIW alternatives as well as other experiences obtained with other equivalent engine driven hydraulic pumps supported without benefits of RIW.

Conclusions to date can be made that the RIW goals anticipated were more than met and the RIW contract has, in fact, resulted in a most cost effective support alternative available to the Navy. Additionally, the RIW alternative has provided superlative support to the fleet within a Navy investment considerably less than other comparative units used in other front line Navy aircraft. The report provides considerable supportive detail and analysis to back up the above conclusions.

A final Navy report on the Abex RIW contract will be made during 1981 in anticipation of contract completion and orderly phasing in of Navy organic depot support to replace the Abex support provided within this RIW contract.

INTRODUCTION

On 3 April 1973, the contract, reference a, between Abex Corporation and ASO was signed with the purpose of continuously growing reliability of the F-14 engine driven hydraulic pump for a period of 6 years as well as providing key elements of support during that period. The contract had the following features:

A. Reliability growth, as measured by return rates, from 500 pump operating hours per return to Abex to 750 hours per return.

B. One day turn around at depot level (Abex in Oxnard, CA) from receipt at Abex dock, supported with a depot pool of 25 units.

C. All returns, regardless of cause, remain Abex responsibility to repair with no exclusions.

D. Firm Fixed Price predicated on the reliability growth indicated in A. above.

E. A defined contractor controlled reliability program with dedicated engineering effort operating throughout the contract period.

F. No government cost for engineering changes which are proposed to upgrade reliability, survivability, and maintainability of the pump. Each Class I change requires approval from Grumman Aircraft.

G. Orderly transition to organic depot maintenance during final year of the contract.

H. Pay as you go annual payment schedule in advance for each spare pump delivered to the Navy and for each installed pump when an aircraft is accepted by the Navy.

I. Reporting to the Navy at regular intervals of inventory status, reliability status and program evaluations.

J. Contract coverage included 258 pumps for 154,000 aircraft flight hours equal to 387,000 pump operating hours or 5 years after the delivery of the last pump (whichever occurs first) for a total price of $846,444.

The contract was the first long term warranty contract in DOD which also included 1 day turn around time and a defined involvement for the contractor to systematically phase in at the end of contract transfer of support to an organic depot. This original contract has been amended 4 times to extend the same RIW support to later lots of F-14 production aircraft. The latest amendment provides for total warranty coverage for all F-14 aircraft including Lot VIII equating to 982,560 pump operating hours and having a cut-off date in April, 1983.

During the course of the contract, ASO has made engineering reviews periodically. The last review was made during September 1976. Since

the contract is at an approximate midpoint, it was considered vital that the latest review should result in the Navy documentation of events and progress to date, evaluate achievements to date against those anticipated within the terms of the contract, provide conclusions relative to new concepts applied to the contract and compare life cycle costs of this RIW alternative against a non-RIW normal mode of support.

BACKGROUND

The F-14 aircraft engine driven pump has almost twice the pumping capacity of engine driven pumps previously applied to military aircraft. It was considered a state of the art pump with no history of prior service use. H-2 of reference b provides the basis for considering this pump as an advance of the "state of the art." The pump, as an integral and key part of the two F-14 hydraulic systems, was contractor furnished by Grumman Aircraft, the aircraft manufacturer. Grumman has the system integration responsibility during the production portion of the F-14 life and therefore had qualification responsibility for the pump. The military specification MIL-P-19692 and Grumman control specification A51DCVBH015 provide the requirements for this qualification. The Abex pump was selected by Grumman and Abex was required to run the qualification tests at Abex and Ogden Technology Laboratories under Grumman supervision. The first Navy F-14 was accepted for fleet operation during May 1971, the qualification tests were initiated during October 1971, and the RIW contract was signed on 3 April 1973. At the time of signing the RIW contract, the qualification of the pump was still in progress, not being completed until October 1976.

The Abex pump in operation on the F-14 aircraft is rated to deliver 200 HP continuously and is capable of 300 HP for intermittent peak loads. Thus, to adequately test the pump, a drive stand must be capable of at least controlled 400 HP input shaft power to the pump. Thus, logistic support of the pump required planning lead time to provide the F-14 maintenance community with an adequate 400 HP test stand. When this RIW contract was under consideration, such a test stand was being considered for development and planned to be made available for IMA (Intermediate Maintenance Activities) and Navy depot support of the pump. A specification was prepared by the government and was used as the requirement to develop the required 400 HP test stand. This test stand was neither available at that time nor considered adequate by Abex. Thus, to perform under the RIW contract, Abex was permitted to provide their own test stand at an additional RIW cost of $106,000 included in the RIW contract. The test stand anticipated under the RIW contract was developed by Abex and installed in their plant within the first 6 months of the contract and has been in use successfully since that time. The Navy has now dropped its first test stand development effort and has entered into a contract for a subsequent development to the requirements of a later specification.

At the time staff efforts were concentrating on exploring new ground in preparation for this RIW contract, normal provisioning, as part of the integrated logistics plan, was in process. The provisioning followed the existing maintenance plan in providing supply support with future Navy

spares inventories of required parts and assemblies. Thus, the consequent procurements for those parts and assemblies were made from Abex. However, at the time of the RIW contract execution, the spares ordered were no longer required by the Navy but were required by Abex for operation within the RIW contract. An equitable agreement between the Navy and Abex continued the manufacture of the spares for use in the RIW contract with the benefit of having gained about 4 months in manufacturing lead time.

Two prior reviews (1974 and 1975) were made by ASO of this RIW contract. The first review established a firm liaison between Abex and ASO and provided Abex with required support in their integration of 3M data. The second review provided the Navy with assurance that the contractor had a fully operative RIW organization with documented early positive results of reliability achievements. A technical paper resulted from this second review which was presented at the 1976 Annual Reliability and Maintainability Symposium (reference c).

A third and current review is the subject of this report which has the purpose of updating the previous reviews, evaluation of logistics, assess reliability as well as providing results to date (15 August 77) and to make required analytical flying hour projections for the future.

Future areas of emphasis will be placed on longer range improvements by extending wear out life of various components for which field experience and laboratory testing reveal long term life limitations and on the Abex data system to provide outputs with additional management indicators, i.e., average number of days installed in aircraft and world traffic.

FLIGHT HOUR PROGRAM

A. Predictions:

During the period that the RIW was being contemplated, analyses were made of F-14 flying hours projected into future years. The base for the flying hours was straightforward, i.e., 30 hours per month for each aircraft introduced into fleet operations up to and including Lot IV production, the Navy commitment as of that date. The program plan provided the basic information of when each aircraft was anticipated for fleet introduction. This approach is shown in Figure 1.

This was an optimistic approach which did not consider delays in F-14 deliveries to the Navy and the inhibition of flying hours due to start up problems inherent with introduction of a new weapon. The difference between flying hours planned and achieved was considered when an additional production (Lot V) was contracted for the Navy. The amendment to the RIW contract (MOD P00007) provided coverage for the pump and flying hours to be achieved by the Lot V production aircraft. That modification to the contract increased the estimate of total pump operating hours from 387,000 to 513,000.

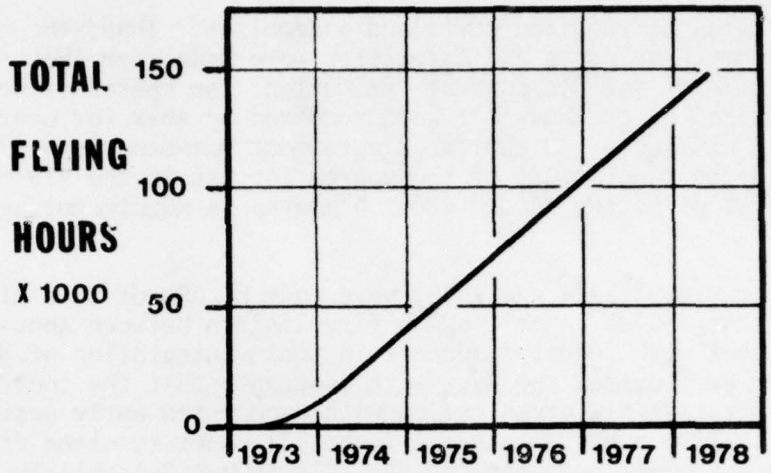


FIGURE 1: 1972 Flying Hour Program Planned Base

B. Contracted:

The F-14 aircraft has 2 engines and each engine drives one Abex hydraulic pump. The pumps for both engines are identical and interchangeable between engines. Each engine pump supplies hydraulic power to an independent hydraulic system and therefore reacts to different loads and cycles of operation. A translation is required between aircraft flying hours and engine operating time (equivalent to pump operating time). Until the point in time of this review, the weapon operational patterns and accumulated flying hour experience were not sufficient to stabilize the relationship between flying and engine hours. Past experience with other aircraft was used to establish a ratio which included 15 minutes of engine ground operation for each aircraft flight hour providing a ratio of 1.25 between flight and engine hours. This translates for both engines as 2.5 total pump hours of operation for each aircraft flight hour. Table 1 provides relating information for the basic contract and later modifications. The past year of engine log hours, when compared with the aircraft flying hours, shows a ratio of 2.42 engine hours for each aircraft flying hour. This ratio should be reviewed annually during the course of the contract to insure including this factor in the assessment of pump reliability growth.

C. Obtained:

The F-14 flying hours obtained to date are indicated as the solid line in Figure 2.

The first prediction and subsequent predictions are also shown in Figure 2. 3M data indicates that current flying hour experience is 18 hours per month per inventory aircraft or 27 per month per active aircraft. The modification of the contract (P00012 of 3 May 76) procured the RIW coverage for Lot VII production F-14 aircraft. This modification

extended to 1982 RIW total system coverage with a new total of 352,200 aircraft flying hours. The Navy was recently committed to Lot VIII aircraft with delivery which started in March 1977. Correspondingly, amendment P00013 has recently been negotiated. This most recent action extended the contract to a final cut-off time of 15 April 1983 and aircraft flying hours to 393,024. This takes into account the most recent analysis of flying hours/aircraft/month.

TABLE I: PUMP AND AIRCRAFT HOURS

	A/C FLYING HOURS	PUMP FLYING HOURS	PUMP OPERATING HOURS
Factors	1	2	2.5
Basic Contract Lot I to IV	154,800	309,600	387,000
Amendment P00007 Lot V	212,400	424,800	531,000
Amendment P00009 Lot VI	292,200	584,400	730,500
Amendment P00012 Lot VII	352,200	704,400	880,500
Amendment P00013 Lot VIII	393,024	786,048	982,560

The flying hour program analysis requires a dynamic continuing assessment of aircraft inventory in order to show trends of flying hours per month. These trends can be used to bias future predictions made analytically from past history and current experience. The 3M data provided Abex includes aircraft inventory change in status information to assess what part of the fleet is actively flying and the specific aircraft which are stricken from the inventory. Figure 3 shows the growth of the F-14 inventory overlapping the period of the RIW contract and adjusts for aircraft lost to the inventory due to strikes.

It should be noted that the standard approach for the prediction of F-14 flying hour programs was overly optimistic. This is the conservative approach for all logistics purposes. However, for RIW this optimistic prediction is a risk to the buyer when that program isn't realized, thus not fully exercising the contractor's liability within the RIW contract. With each amendment made the contract was extended in time for that portion previously under contract at no specific increase in cost. This extension in time permitted that previous portion of the population to more fully utilize the flying hour program up to the contractual limits

The extension of time also provided the advantage of one warranty

completion date for the entire population. The most current amendment for Lot VIII aircraft has extended the calendar limit of the contract to March 1983. This new data is based on achieving the flying hour program (393,024 flying hours) by March 1982 and thus, fully exercising the Abex warranty obligations for the entire population.

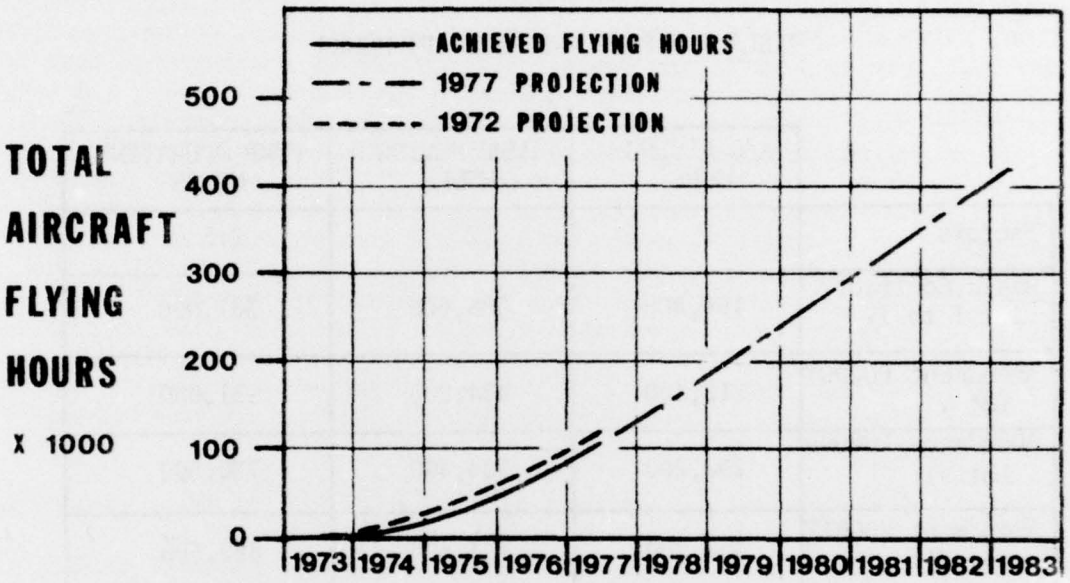


FIGURE 2: Flying Hours Achieved and Projected

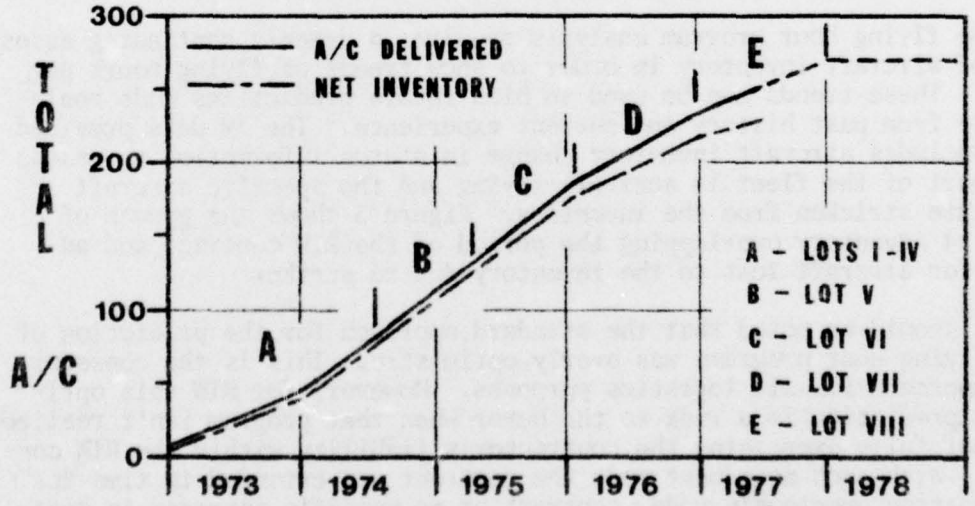


FIGURE 3: Growth of F-14 Inventory

ADMINISTRATION

A. Abex:

Abex has established a close knit RIW group which performs physical work on the pump, testing, engineering and administration of all paper work. With a current average return rate of 8 pumps per month, not more than 1 program manager, 1 engineer, and 3 shop personnel are required full time. All other functions such as, contract administration, parts and inventory control, receipt and shipment, design, quality, and test, are on a part-time basis. The company is small enough that the operations between departments, such as between engineering and overhaul shop do not require specific formal communication channels. Thus, an alert program manager can insure that the company analysis and the action-reaction cycles occur without delay. This has actually happened within the administration of the Abex contract. It has been observed during the review that there was no occasion when information made available, for example, in the shop to engineering, required routing up the shop departmental hierarchy and down the engineering departmental hierarchy in order to get to the point of action relative to that information. Thus, engineering response to shop information has been outstanding. Even though the RIW responsibilities have been divided between departments, the work between departments is being accomplished within an efficient matrix operation.

Quality assurance has been accepted fully by Abex as their responsibility. Quality control and inspection has been sensitized to a level of responsiveness beyond that normally obtained in their production and commercial overhaul functions. They have expanded the concept of rejects due to quality defects under RIW to include as well, the failed units returned from the field. Each unit returned from the field is critically examined by an engineer to determine mode and cause of failure as well as any positive or negative contribution quality has made to that failure. Response to what that engineer finds can effectively change and/or improve conditions very quickly. One measure of quality control in a repair process can be the number (or percentage) of units which do not pass a final test and must repeat the overhaul shop process. During the review Abex records did not show that type of action and from memory of the shop and test personnel, they could recall such reject occurring only rarely. There was a promise made to research previous travelers (records of repair and test) to see if such rejects are noted and count them as well as correcting the process to clearly identify such reject occurrences for count and control.

Interview with the government Quality Assurance Representative who is resident in the Abex plant revealed that in his opinion, Abex has been putting forth extra quality assurance efforts on the RIW contract. In the beginning there was confusion about the role of a government resident Quality Assurance Representative in administration of a RIW contract. ASO sent a letter in the early phase of the RIW to definitize that role. The letter is included as enclosure I to this report. After 3 years of experience, the government Quality Assurance Representative feels that the letter was good and that the operation within the Abex RIW, from his quality viewpoint, is going so well that he now has additional time for his in-plant quality assurance efforts on other government contracts.

It is the normal shop practice in the repair/overhaul of returned pumps to insure that the same person is involved in the disassembly, repair and assembly of a given pump. Specific wear standards and limits have been established for each component within the pump. Thus, a decision to replace a part is not just dependent on qualitative aspects determined by the technician doing the task. The RIW engineer is the only one who can authorize the replacement of a spare part. His examination of the worn or failed part is the final authority. Should the technician later observe any unusual wear, the RIW engineer is brought back for closer examination and assessment of the condition. This pivotal information obtained by that engineer is the strongest input to the RIW design reviews held at periodic intervals.

There are 2 shop shifts with 2 repair technicians for each shift assigned to RIW returns. All these technicians report to one shop lead man who insures total continuity between the work in the overhaul shop and other supporting activities such as; testing, plating, machining, dry lubrication, painting, etc.

Final testing of all returned units occurs during the same 2 shifts under the intimate supervision of one test supervisor. The time of a final test runs from 1 hour, for a unit that required no disassembly or "test good" unit, to about 9 hours for a unit which required major part replacements. All final testing is done on the special drive stand procured and used for the RIW returns.

The Abex organization relative to RIW administration and operation is provided in Figure 4.

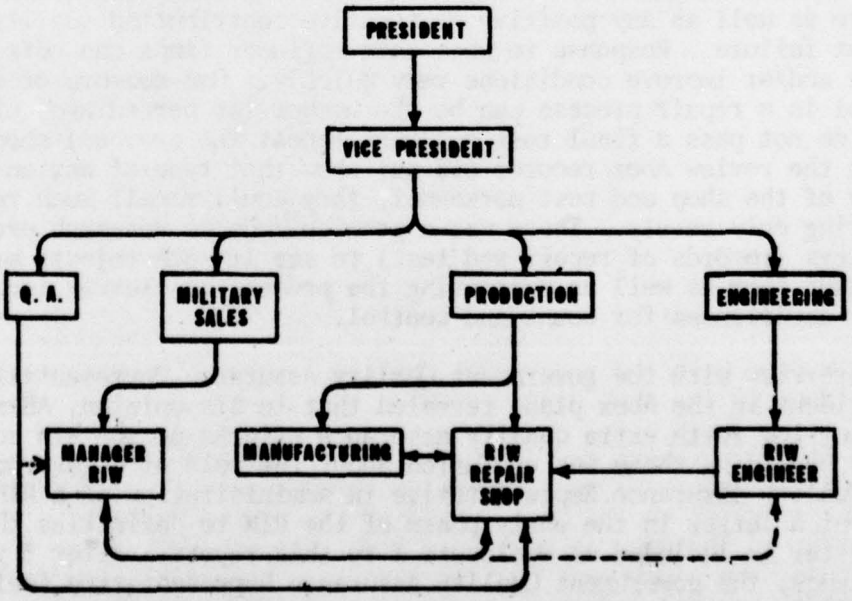


FIGURE 4: Abex Administration for RIW Operations

It should be noted that direct responsibility for RIW results is vested at a level which reports to the Abex Vice President. Also important is the engineering support to RIW, which remains a part of the entire engineering department rather than an independent engineering effort (see Enclosure II).

B. Navy

Administration by the Navy of this contract has consisted mostly of contract reviews made periodically (3 to date) with the purpose of determining how well the RIW contract was operating, coordinating support of the contractor with Navy data inputs and determining if action is required by the Navy or the contractor to enhance successful pursuit of the contract. This review and coordination responsibility has rested with the Engineering Assistance Branch of the Technical Division in the Aviation Supply Office. Inputs were made by the Engineering Assistance Branch to the Purchasing Division, ASO, to support the basis for contract modifications. These specifications provided continuity of the RIW program with each new Navy production commitment. Table II charts those modifications made to the basic contract. Design Change Approvals were a function of Grumman Aircraft during the aircraft production phase because the pump is contractor furnished equipment.

There is a direct line of communication between the ASO Inventory Manager for the pump and the Abex RIW contract administrator. Because of the partial CLAMP (Closed Loop Aeronautical Management Program) operation (1 for 1 exchange with one day turn around), there has been very little attention required of the ASO Inventory Manager during the course of the contract to date.

The contractor has been assisted in his development of a data system by the available Aviation Supply Office expertise in the use, interpretation and editing of Navy 3M source data. This 3M source data has been authorized for release from MSO (Maintenance Support Office) directly to Abex on tape with monthly updates (Enclosure III). A full description of the information flow and details of the Navy data inputs are provided in the Data Chapter of this report. Since the program had a relatively slow start (low volume of returns), problems in development of the ADP data system did not inhibit the ability to provide Navy or Abex management with significant information. The problems of crystallizing what is required in data analysis and outputs have not been fully resolved to date. Since there are only approximately 251 returns to date, there was no urgency to develop an automated information and analysis system. Thus, the lead time has been utilized to plan, program and debug the ADP system. Navy reviews have been used by Abex to provide the critiques and to build the system on a long-range basis step by step. There remain, at this time, a number of steps to be completed and Navy inputs are still required.

The Navy has maintained one contact point for this RIW contract administration. That point has been the Engineering Assistance Branch of the Technical Division in ASO. Abex has provided regular monthly inputs to this point for analysis of achieved flying hour program and returns. The periodic contract reviews have been made by this Branch and reports prepared as required. One such report was in the form of a Technical Paper, reference c. NAVAIR has continuously cooperated and provided inputs when required by ASO.

TABLE II: BASIC CONTRACT & MODIFICATIONS

	TOTALS			DATES		
	PRICE (Note 1)	UNITS	PUMP HOURS (Note 2)	SIGNED	CONTRACT TERMINATION	INCREMENTAL COST/PUMP OPER. HOUR
Basic Contract - Lot I to IV	846,444	258	387,000	Apr 73	6 Yrs. (Note 3)	$2.19 (Note 4)
MOD 00007 Lot V	1,061,772	354	531,000 (Note 5)	Aug 74	6 Yrs. (Note 3)	$1.50 (Note 4)
MOD 00009 Lot VI	1,308,847	487	730,500 (Note 5)	Aug 75	6 Yrs. (Note 3)	$1.29 (Note 4)
MOD 00012 Lot VII	1,488,247	587	880,500 (Note 5)	May 76	30 June 1982	$1.20 (Note 4)
MOD 00013 Lot VIII	1,595,344	674 (Note 6)	982,560 (Note 5)	Aug 77	15 Apr 1983	$1.05 (Note 4)

NOTES:

1. The reliability on which the sell prices are based are as follows: BASIC, 500 to 750; MOD 00007, 600 to 850; MOD 00009, 650 to 900; MOD 00012, 800 to 1175; MOD 00013, 920 to 1300 hours pump operation between returns to Abex.
2. Pump operating hours are listed. For conversion to aircraft flying hours see Table I.
3. End of contract (changed by later MODS) would have been 5 years after the last pump was delivered to the Navy. Subsequent to basic contract signing that last delivery on the contract less MODS was made on 21 August 1974.
4. This contract includes $106,000 for the Abex test stand. That fixed cost is amortized over the total basic contract (Lot I to IV). If it were considered a sunk cost invested for the duration (20 yrs.) of F-14 pump support and thus, not included in cost per current pump operating hour, the figure shown would reduce to $1.91 and be more directly comparable to the subsequent cost per operating hour of $1.50 for MOD 00007 increment, $1.29 for MOD 00009 increment, $1.20 for MOD 00012 increment, and $1.05 for MOD 00013 increment. The lower cost per operating hour for subsequent MODS is due to decreasing return rate (increase in reliability) as the RIW contract progressed, overcoming increases in cost per return due to escalation.
5. Increase in flying hours is due to:
   (a). larger aircraft population
   (b). extension of time for older aircraft population to obtain one RIW cut-off date for complete population
   (c) increase because of maturing F-14 support
6. The exact number of pumps within RIW is not critical since contract obligations cease with obtaining either flying hour limit or calendar limit, whichever is obtained first.

ENGINEERING

A. Returns:

The ultimate measurement of achievement within a RIW contract is the rate of returns. For each return there is a removal from the aircraft which initiates a complete sequence of support actions culminating in a successful replacement of that removal. There are more reasons for removals than a specific internal failure of a hydraulic pump. The total logistic support posture, if adequate, will mitigate need for removals. Conversely, inadequate logistic support will increase removals. One of the prominent features of this RIW contract was the avowed purpose to continuously reduce removal rate of this pump during the course of the contract as the primary vehicle in lowering return rates to Abex. Reliability of the pump is a large factor contributing to its removal rate. However, it is not the only factor influencing the need to remove a pump.

Removals have been closely observed. Removals and returns to Abex have a very close correlation. There is no field support equipment available which can test a removed pump, thus, a large percentage of removed pumps in fact, have been returned to Abex for test and/or repair which otherwise would not have been returned to Abex.

A continuous plot of pump removals from aircraft and returns to Abex is shown in Figure 5. Removals not returned to Abex could, for example, occur during an engine replacement.

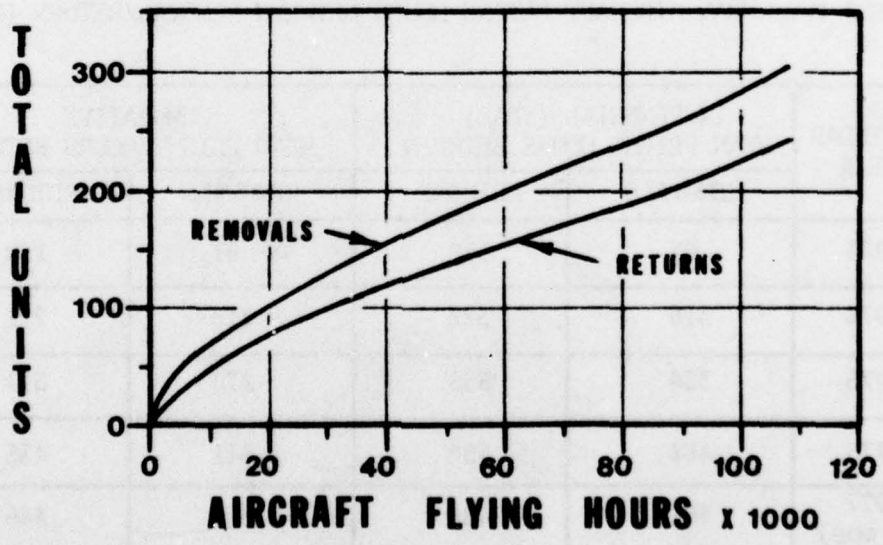


FIGURE 5: Removal/Returns History

Flight hours are shown in Table III for comparison purposes. Active aircraft excludes those aircraft which are not actively flying as determined by 3M reports of inventory status.

TABLE III: FLYING HOUR RATES

Calendar Year	Per Month Total Flying Hours	Per Month Per Inventory Acft.	Per Month Per Active Acft.
1973	424	17	22
1974	1422	19	26
1975	2095	15	23
1976	3094	16	21
1977 (6 mos.)	4147	18	27

When the removals or returns are related to flight hours, the following table is obtained:

TABLE IV: MEAN AIRCRAFT FLYING HOURS BETWEEN REMOVAL/RETURN (MFHBR)

CALENDAR YEAR	INCREMENTAL (YEAR) MEAN FLIGHT HOURS BETWEEN		CUMULATIVE MEAN FLIGHT HOURS BETWEEN	
	REMOVALS	RETURNS	REMOVALS	RETURNS
1973	91	159	91	159
1974	316	322	218	271
1975	354	535	276	371
1976	482	554	341	435
1977 (6 mos)	401	488	353	446

The contract was priced on the basis of a starting mean pump operating hour between returns of 500 hours and at contract completion having an end incremental mean pump operating hour between returns of 750 hours.

Results shown in Table IV, when multiplied by the conversion factor of 2.5, show that the negotiated starting return rate was a reasonably accurate prediction and that growth in reliability has been much better than anticipated by either buyer or seller at the contract negotiation stage. Figure 6 is a graph of the continuous relationship between returns and pump operating hours. Slopes are shown to indicate return rates relative to pump operation hours.

It should be noted that each contract MOD covering production aircraft subsequent to the basic RIW contract was based on a then current experience of return rate and projected growth from that return rate.

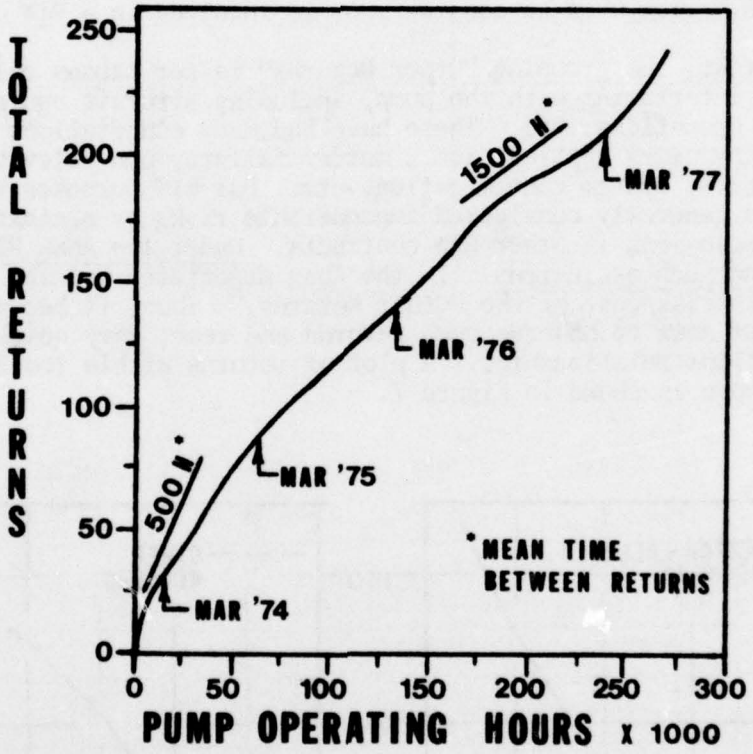


FIGURE 6: Pump Operating Hour Experience

B. Analyses:

All returns to Abex are classified into the two generic groups of "Design Related Returns" and "Other Returns." These two categories are basic to the concepts and evaluation of RIW. A definition for each grouping follows:

1. "Design Related Returns": These removals are for causal reasons of internally induced pump failures which are basically traceable to design or manufacturing aspects required to be considered by Abex through the pump's form, fit, function specification requirements imposed on Abex for qualification.

2. "Other Returns": These are all the other removals for cause or not for cause of pump operability which do not fit into the grouping of "Design Related Returns."

It is important to recognize clearly that "Design Related Returns" are generally related to the type of failure normally obtained in laboratory qualification, reliability assessment, or evaluation processes prior to acceptance of material. Such failures are generally thought of as non-excludable in a RIW contract and thus, the contractor's basic priced out RIW risk when he considers or is involved in a RIW contract.

In contrast, the grouping "Other Returns" is for causes related to the systems interfacing with the pump, including aircraft operations, maintenance operations, etc. These have had many connotations in the past with many names applied, i.e., murder failure, non-relevant failures, test good units, system contamination, etc. For RIW purposes these are the removals generally considered imponderable risks by a contractor, and therefore exclusions in other RIW contracts. Under the Abex RIW contract there were no such exclusions. In the Abex negotiated pricing there was included this risk/cost of the "Other Returns." Thus, it became most important for Abex to observe such returns and react very quickly to causal field operations relationships. A plot of returns within the 2 groupings described above is shown in Figure 7.

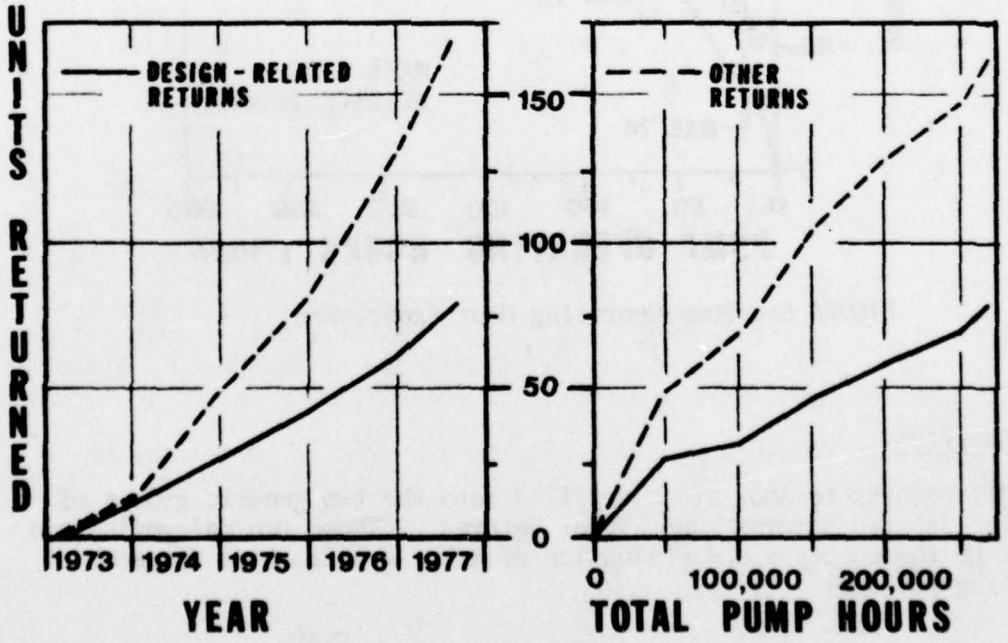


FIGURE 7: Returns to Abex by Two Groupings

TABLE V: Analysis of Return by Group

YEAR	SYSTEM MFHBR*	INCREMENTAL RETURNS						RETURNS TO DATE					
		DESIGN RELATED			OTHER			DESIGN RELATED			OTHER		
		#	MTBR**	% TO TOTAL	#	MTBR**	% TO TOTAL	#	MTBR**	% TO TOTAL	#	MTBR**	% TO TOTAL
1973	159	11	868	46	13	734	54	11	868	46	13	734	54
1974	322/271	16	2666	30	36	1185	70	27	1933	35	49	1065	65
1975	535/371	16	3928	34	32	1964	66	43	2676	35	81	1420	65
1976	554/435	18	5157	27	49	1894	73	61	3408	32	130	1599	68
1977 (6 mos.)	488/446	18	3456	35	33	1885	65	79	3419	33	163	1657	67

* System MFHBR is the mean time (flying hours) between returns taken from Table IV.

** MTBR is the mean time (pump hours) between return to Abex.

Table V is the assessment of rates when the "Design Related Returns" are separated from the "Other Returns."

It should be noted that "Design Related Returns" and "Other Returns" each were initially approximately 50% of the total returns. This is normal and usual operational experience known to exist with military aircraft equipment generally continuing throughout the life of aircraft operations. The significance and effectiveness of the RIW concept in this contract is aptly demonstrated by the very quick improvement in the "Design Related Returns" from the initial increment of 868 MTBR to the measured increment of 3456 MTBR. Corresponding degree of improvement is not demonstrated for "Other Returns." What is most dramatic for RIW evaluation purposes is that the deterioration of "Other Returns" usually observed during the "learning curve" process when a new weapon is introduced into fleet operations, never materialized. In fact, it has been the opposite, generally a decreasing return rate for "Other Returns" is an outstanding achievement which can be directly traced to Abex field efforts and design changes under the RIW contract.

"Design Related Returns" have been separated into categories as follows:

Category	Units Returned
Other leaks	40
Front Seal leaks	26
Pressure low or fluctuating	12
Cracked housing	3

"Other Returns" have been separated into categories as follows:

Category	Units Returned
Test Goods (no failure)	77
Ran dry/overheating	25
Quick disconnect problems	17
System contamination	14
Sheared shaft	14
Modification or update	8
Test	5
Stripped threads	4
System leaks	3
No reason reported	2
Elongated mounting hole	1

All the above categories have been assigned to remain consistent with 3M (Material Maintenance Management System) field reporting from the aircraft operations level. All returns are not included in the above.

C. Design Reviews:

Abex has made periodic design reviews of the pump under the RIW contract. These design reviews utilized data from returned units, results of field trips, and failures from the concurrent qualification testing as primary inputs for decisions toward improved design effort. Enclosure IV are sample reports from such design reviews. Design, engineering or reliability reaction did not necessarily remain dormant until a design review triggered action. Many situations called for direct action. The changes made to the pump will be described in a following paragraph. Approximately 30% of the changes were made as a result of the formal RIW design review procedure. The balance of changes were made through expedited internal engineering proposal and approval procedures. This flexibility in Abex internal operations shortened considerably their internal lead time once the need for a change was recognized.

D. Design Changes:

To date, during the course of the RIW contract, the configuration has changed from a basic P/N 65070 to P/N 65070-01 to P/N 65070-02 and to P/N 65070-03.

Details of the changes are as follows:

Pump from P/N 65070 to P/N 65070-01

The holdown plate P/N 52963 was changed overcoming a wear problem and increasing reliability.

Pump from P/N 65070-01 to P/N 65070-02

A number of parts were changed to both improve heat rejection characteristics and to react to field experience for general improvement of reliability. The following parts/assemblies are the replacements of new

designs:

Assy #	P/N	Description
15	61081	Port Cap Assembly
21	61046	Helical Compression Spring
22	61049	Guide Spring
23	61082	Compensator Plug
25	61050	Compensator Sleeve
49	63498	Piston and Shoe Assembly
49	63496	Wear Plate

Pump from P/N 65070-02 to P/N 65070-03

The change involved changes to the pressure regulating system to improve stability characteristics of pump pressure regulation. The following are the new parts as a result of the change:

Assy #	P/N	Description
31	61338	Stroking Piston Subassembly
34	61342	Front Housing Subassembly
59	61341	Mounting Flange Subassembly

Additionally, other parts have been changed for improved wear characteristics, better survival capabilities in field operations and improvement of maintenance capability. These changes are listed below and are incorporated when the -03 version is returned to Abex:

Washer P/N 61569
Mating Face P/N 61496
Retainer Ring P/N 61635
External Drive Shaft P/N 69513
Stroking Piston Plug P/N 69549
Front Housing P/N 61340
Mounting Flange P/N 69488
Seal Mating Face P/N 61496
Port Cap P/N 61080
Port Plate P/N 69404
Thrust Pad P/N 69561
Helical Torsion Spring P/N 69535
Helical Torsion Spring P/N 69536
12 Pt. Bolt P/N NAS 624H6

Assessments were made of the primary causes for returns over time to provide measures of RIW performance. Selected causes for returns are listed below. Each cause of return is discussed to assess impacts of RIW upon the situation.

1. "Test Good" (77 returns): It is the nature of hydraulic systems to have problems with contamination. When the system becomes contaminated, the major components with no filter protection must be cleaned/purged and tested for damage. Since there is no field test stand available for this pump, then the pump must be returned to Abex for cleaning/purging and testing. The change in "Test Good" returns per flying hour becomes a measure of the general operation and maintenance performances within the fleet relative to the pump

and its interconnecting hydraulic systems. Figure 8 shows returns of "Test Goods" as related to flying hours. When a pump is removed for any other reason than direct knowledge of pump malfunction, the pump is returned to Abex for testing. Considerable confidence of pump performance has been built up by fleet operational and intermediate maintenance personnel because of the RIW contract field operations and high reliability. Thus, in most situations of hydraulic system inadequate performance, the pump would be among the last rather than the first component to be removed.

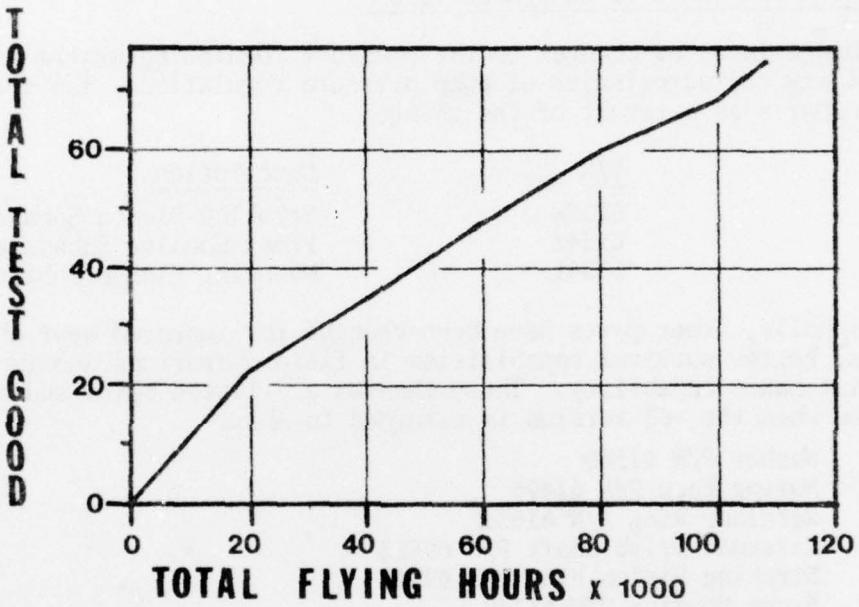


FIGURE 8: Flight Hours and Test Good Returns

2. Front Seal Leak (26 returns): The normal characteristic of an engine driven pump is to leak at the front seal by a very small amount. From a design point of view, this minor leakage is necessary to provide lubrication to that rotating seal. The Abex pump specification permits 2 drops per hour of pump operation. It has also been normal history for all aircraft that a major reason for engine driven pump removals has been excessive leakage at a front seal. The Abex pump has not been an exception to this generic condition. This problem of returns was evident at the early stages of the RIW. Under the RIW, Abex critically reexamined the front seal design and quickly implemented changes to improve seal reliability. Figure 9 plots the returns due to excessive front seal leakage as a function of flying hours. This leaking seal problem has been complicated by potential front seal damage each time a drive spline is sheared when the output port quick disconnect coupling pops off (due to improper fastening during maintenance). The number of hours on a returned pump (average, to date) is estimated to be 576 hours. There are many pumps which are flying and have never been removed. Thus, if the front seal is

in fact life limited, there can occur later a rash of returns for leaky front seals, within the time frame of the RIW. This characteristic will be monitored closely during the RIW contract to determine the actual long term improvements in this critical area.

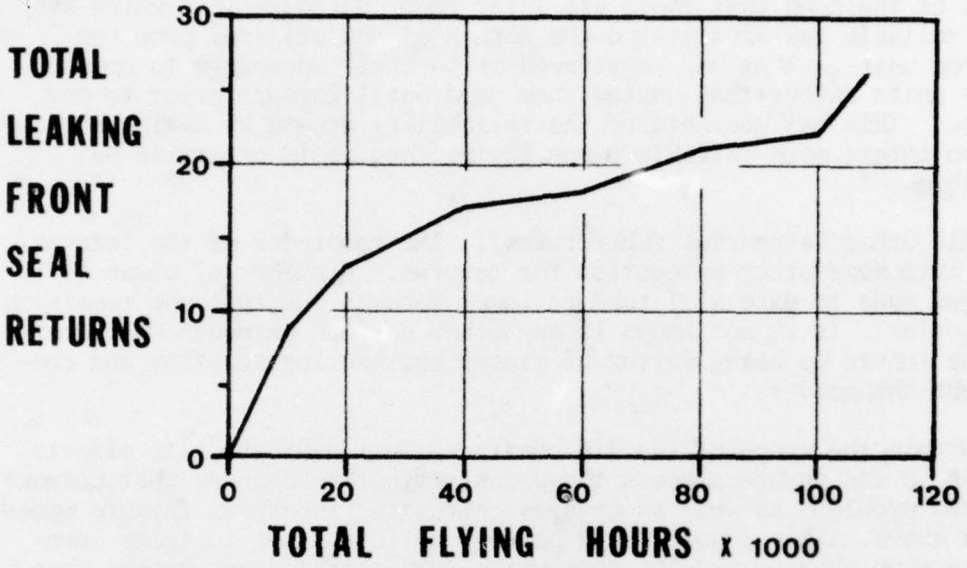


FIGURE 9: Flight Hours and Leaking Front Seal Returns

3. Sheared Shafts (14 returns): The first pump returned with a sheared input shaft presented a problem to Abex because the purpose of the shear section was to be a mechanical fuse should the pump become so bound up as to reflect damaging torque levels into the engine driven train. However, when this pump was disassembled and examined there was no internal evidence of damage and thus, it was difficult to understand the reason for shaft shearing. It took an Abex field trip to the activity returning the pump and subsequent engineering investigation to determine the cause. The Abex report is included as enclosure V providing the details of their field trip and investigation. The investigation revealed a field problem during hydraulic system check out or maintenance procedures. The problem was that the quick disconnect fitting to the output port of the pump could not be connected with positive indication of a complete connection. When that connection was made incompletely, subsequent engine start up would blow open the connection, the pump output port valve would automatically close the port making it impossible to pump out any hydraulic liquid and pumping torque would go up excessively, consequently shearing the input spline shaft. Once the field problem was identified, it was a matter of educating all maintenance personnel involved. Abex, having a financial interest in minimizing returns within the RIW contract, embarked on a campaign to inform all F-14 squadron maintenance

personnel on the importance of insuring proper reconnection of the quick disconnect. Abex also took action to induce the aircraft manufacturer and the Navy to change the quick disconnect to one having a positive feel to indicate when the fitting was placed in the proper closed and locked position. To date, this has not produced positive results.

4. "Return for Modification" (8 returns): Recognition by fleet users of the pump that there are later pump configurations which are more reliable has accelerated the return of the original pump configured units. Abex has considered it to their advantage to update these units rather than having them used until failure prior to any update. This has accelerated the reliability growth by having more of the latest more reliable pumps flying then would otherwise be possible.

5. All Other Categories (126 returns): The remainder of the returns fall into many other categories for returns. A number of class II changes made to date will tend to lower returns due to these remaining categories. It is not known if any other defined category will emerge in the future as being worthy of closer engineering scrutiny and consequent changes.

Within the scope of the RIW contract, Abex dedicated its efforts to include in its change process those cost effective changes that correct anticipated problems as well as changes correcting the known failure modes described above. This report would be very deficient not to fully identify those pump changes made by Abex which were anticipatory rather than reactive in nature. These are described as follows:

1. Regulator: As described fully in reference c, Abex took the initiative to correct a potentially serious impasse between Grumman and Abex when an area of pump operation discovered by Grumman could produce oscillations of pump pressure. The correction was made through an increase in the pump's servo loop forcing function by increasing the size of the pump pressure regulating stroking piston. The Abex cooperation motivated by their RIW responsibilities made possible a solution and start of retrofit within 6 weeks after the problem surfaced, a phenomenally short time.

2. External Drive Shaft: Peculiar wear patterns, shown in Figure 10, alerted Abex to the incomplete engagement of the spline between the pump and the engine. Abex took the initiative with Grumman, identified an error in the Grumman pump-engine interface requirement. The error was corrected by making the spline shaft 1/4" longer fully engaging the spline. Abex very quickly backfitted all splines before the first failure due to poor engagement.

3. Port Plate: The port plate showed on some returns minor cavitation wear. Abex made computer studies which identified that a minor change in the shaping and location of ports would increase dynamic efficiency of the port plates valving action. The required change was made. This change will reduce the future requirements to change the port plate at a time when pumps have been in use many hundreds or thousands of hours.

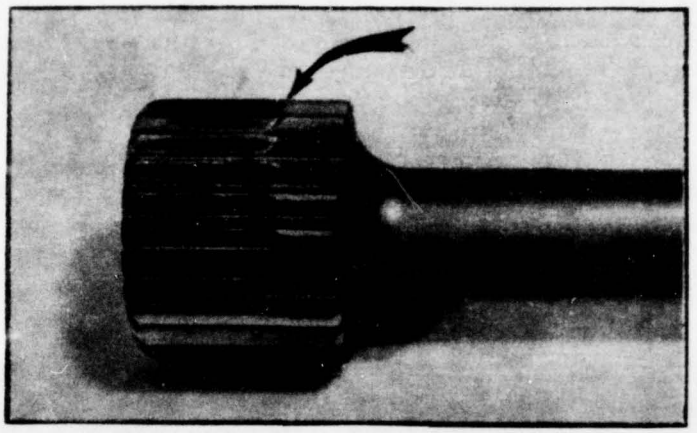


FIGURE 10: Wear Pattern on Engine Engaging Spline

4. External Assembly Bolts: The original design used internal wrenching bolts which cost less initially ($0.13 per unit), but after being torqued and later removed, lose their ability to be torqued accurately and must be replaced with new bolts. When the RIW became operative, Abex was quick to recognize that the more expensive ($0.28 per unit), externally wrenched 12 point bolt was stronger, would wrench to a given torque in less time, more accurately and without requiring replacements after maintenance. Thus, Abex replaced the external assembly bolts to improve maintainability of the pump. The old and new bolts are shown in Figure 11.

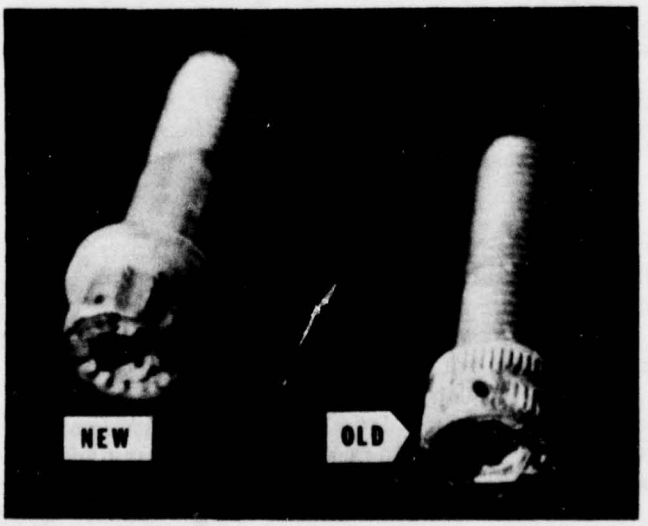


FIGURE 11: Old & New External Assembly Bolts

5. Seal Mating Face: The original part showed signs of wear in the field returns. Although no pump failures were attributed to this wear, Abex initiated changes in material and heat treat to lower the rate of wear to be inconsequential.

6. Helical Torsion Springs: Returning pumps showed wear on the springs and on the hanger that the spring contacts. Figure 12 is a picture of the wear patterns generated.

FIGURE 12: Wear Pattern Between Contact Surfaces of the Helical Torsion Spring and Hanger

This wear indicates the potential of contaminating wear particles getting into the pump and hydraulic system as well as potential long term failure of the spring. Abex changed the contour of the spring's contacting surface and added dry lubricant to the hanger contacting surfaces to reduce the wear.

7. Dry Lubrication: Dry lubrication was applied to the Inlet and Outlet ports to avoid seizure of quick disconnects by the threads within these ports. The spline of the external drive shaft was also coated with dry lubricant to insure minimum wear over long life

periods. The thrust pad was also coated with a dry lubricant to improve its wear characteristics.

8. Retainer Ring: This ring used in the pump assembly was added to reduce "O" ring compression and thus prevent "O" ring nibble. A change of this sort under an RIW contract is very cost effective to make. By comparison, in a non-RIW environment of organic support of Contractor Furnished Material, this change would be very difficult to obtain.

9. Stroking Piston Plug: Returning pumps showed wear on the internal face of this plug. Abex, with a very simple change, reduced the interface of the mating parts and improved the wear characteristics.

10. Mounting Flange: An early RIW return showed a crack in the mounting flange. This information plus a failure of the flange in the qualification testing prompted a serious Abex engineering investigation. The result was to change the casting design for improved strength in the area as well as better castability. Additionally, inspection levels of the castings were heightened to more positively reveal porosity and flaws. There has been no return since with a cracked casting.

11. Hanger Arm: Returns indicate a slight interference problem through a wear pattern. A change eliminated the interference between the mounting flange and part of the delivery mechanism.

E. Field Visits:

Abex has, from the initiation of the RIW contract, made 19 visits to F-14 field operation activities. Of these, 13 were for education/communication purposes. Abex has made it an important issue to insure that squadrons preparing for deployment aboard a carrier be informed directly by them about the RIW contract; Abex desire to insure adequate spares support through their 24 hour turn around of received units; and the importance of filling out the Abex maintenance forms which were included as enclosure VI to this report. This initial contact has had a tremendous impact in the fleet operators' positive reaction and operations maintenance discipline applied to the Abex pump. As a result, there has been little, if any, damage to returning pumps and the forms have been included with almost every pump returning from the aircraft operations level.

The completed forms returned to Abex have added considerable intelligence toward Abex's understanding of the field problems and to their ability to quickly attack field problems before they become widespread and catastrophic. Abex has made 6 field visits in response to recognition of these field problems and at the same time provide field indoctrinations. Enclosures VII and VIII are reports of such visits. Although Abex is not in a position to directly solve field problems not related to the pump per se, they have been a strong factor in making Grumman Aircraft and the Naval Air Systems Command (NAVAIR) recognize those field problems and initiate corrective action. In addition, Abex has invited, on a number of occasions, fleet personnel to Abex for familiarization indoctrinations on the pump and the RIW contract. Enclosure

IX is a letter of one such invitation.

Review was made of typical field problems exercised by Abex to determine their effect and current status. A short description and status of each is provided below.

1. Port Quick Disconnect: Special fittings are used to connect the pump to its hydraulic system. These fittings are intended to make possible easy disconnection of the "in" and "out" lines from the pump and reconnection to an external hydraulic system on the ground. When the test/servicing actions are completed the connections are remade to the pump. The reconnection is in a relatively blind restricted area; thus, it depends on feel to assure that the reconnections are completely made. Since the connecting fitting has no positive feel or detent as it goes into its final locked position, the maintenance personnel could leave the connection in a partially locked position thinking it is closed and locked. When left in that position (not fully closed), an engine start will blow off the output port fitting, quickly shearing the pump's input spline shaft. This situation was first surfaced by Abex who very quickly covered all the current bases having F-14 squadrons, and spoke with the maintenance people providing information about this situation. Abex then contacted fitting manufacturers and encouraged one to propose a new fitting, with a positive locking feel, to both NAVAIR and Grumman for a more permanent cure. Enclosure V is a letter from Abex on this subject. Additionally, Abex has attached a tag, Figure 13, to each pump as a reminder to maintenance personnel of the potential of incorrect fitting attachment.

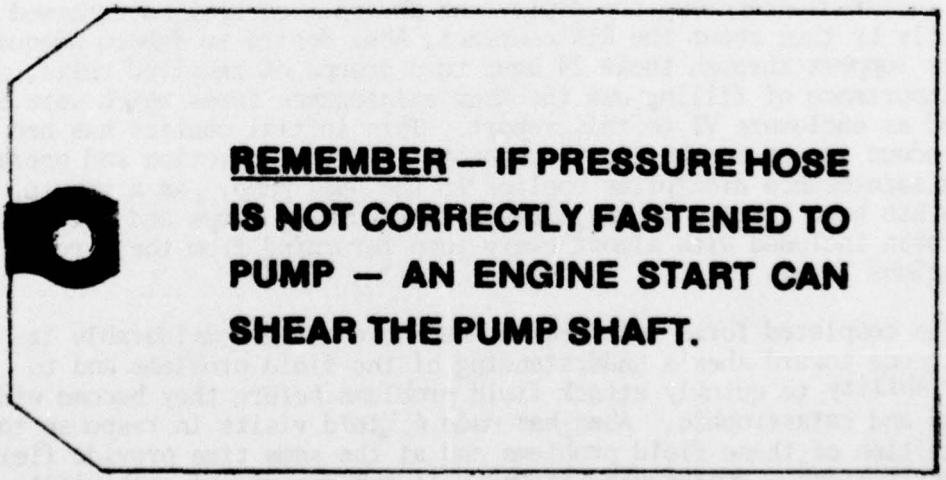


FIGURE 13: Warning Tag

Grumman action has contributed to the manufacturer of the coupling submitting a new design which is being flight tested at NAS Miramar. When approval of a design change to a new coupling with the positive locking indicator is obtained, new production aircraft will include the change and backfit will become a NAVAIR decision driven by economics. Enclosure X is a good illustration of the contractor's effort to consummate this change.

2. Thermal Relief Valve: A thermal relief valve downstream from the pump has had serious reliability problems. Although the problem with this valve was recognized by the field and Grumman Aircraft, the correction has not been pursued aggressively. The internal assembly of this thermal valve would break and its small broken parts would go with the hydraulic fluid through the system. Thus, its broken metal parts would enter the pump and generally seriously score the port plate. During the past program review at Abex, one pump just received was disassembled and heavy port plate scoring was evident. The Abex form returned with the pump indicated that the pump was removed because of hydraulic system contamination due to a broken thermal relief valve. This verified the reason for the heavy scoring inside the pump. An Abex call was made on the spot and an engineer was sent the next day to the base to investigate the situation.

It is this kind of response, motivated by an RIW contract, that makes the field activities very responsive and cooperative and even more disciplined in their operations relative to the maintenance of the pump. The field maintenance chief was very happy to give Abex the failed valve for their analysis. As a result of consequent Abex communication with the vendor of the valve, Grumman Aircraft and NAVAIR, efforts were accelerated to replace the valve with an interim "fix" and a later replacement with a better valve.

3. Supply Support: The USS America deployed with 7 pump spares (initial allowance) for replenishment purposes during its cruise. When the first pump was required during USS America operations, the replacement pumps could not be located aboard the ship. This created a NORS (Not Operationally Ready due to Supply) condition, the first to date for the pump. When Abex learned of the condition from ASO, a replacement pump was immediately shipped from Abex. Additionally, Abex lost no time in tracing the shipment of the 7 lost pumps. Abex very aggressively assisted the Navy until the lost 7 pumps were located aboard the USS America. It was Abex's concern to maintain its unusual record of no NORS. Enclosure XI is one letter of the many Abex communications during the search. Enclosure XII is the final communication from USS America.

F. Reliability Testing:

It was the Abex engineering position at the time of signing the RIW contract that the then current qualification testing program being performed under contract with Grumman Aircraft would be considered as the Abex reliability test bed for RIW. Thus, there was an added spirit of cooperation with Grumman to make changes as a result of qualification

test failures which would not only correct the failure per se, but also contribute to a longer pump life in service. Upon completion of qualification, Abex would then go into a RIW testing program designed to reveal, as early as possible, those pump parts which are life limited on a long term basis.

1. Qualification Testing: The qualification was initiated by Abex under Grumman contract on October 8, 1971, and completed on August 16, 1976 with a report issued by Abex to Grumman. It was started with the initial pump design P/N 65070 and completed with the current configuration P/N 65070-03 as updated by virtue of qualification failures as well as the field failures observed because of the RIW. Without a concurrent RIW program, field failures would have been independently considered from qualification failures and 2 configurations would have emerged at the end of qualification. One configuration would have been that which obtained a final qualification approval from Grumman which would, of necessity, be different than the configuration delivered for fleet operation. Since fleet operation of the pump would have been satisfactory, as established prior to and during the initial phase of RIW, then it holds that any updating to the newly qualified configuration would have occurred most likely as a phasing into F-14 aircraft production during or after Lot VIII. The consequence would be 2 configurations to support and maintain for many years after qualification. By contrast, with the RIW as the focal medium of action, there is but one configuration to maintain. Any units in the 3 older configurations were or will be automatically updated to the latest configuration.

During qualification the following failures required new design and retesting by Abex:

a. Mounting Flange - Failure was during vibration test. Investigation revealed excess porosity. The cure was a quality control program to ensure meeting requirements of Class 1B, Grade C castings. X-ray inspection criteria were also added.

b. Shoe Flange - Shoe flange broke in fatigue. Investigation showed a crack starting with a corner radius. Cure was a revised shoe design with a larger corner radius plus shot peening to provide better stress patterns at the corner radius.

c. Stability - There was no failure due to stability. Stability was a problem with production units. Qualification testing was stopped while changes were made to the front housing and stroking piston. This changed the 02 pump configuration to the 03 pump configuration.

Whenever questions arose about the test methods and other engineering aspects of the qualification, Abex was able to draw directly from the real life experiences being obtained within the RIW contract. This potent source of information was of considerable assistance to both parties (Abex and Grumman) in resolving engineering differences during the qualification process.

2. Further Testing: With the completion of the qualification testing, Abex proposed to accomplish, within the RIW contract, a new test program. It was their purpose to accelerate simulated flight hours on a sample pump for long life cycle and wear analysis. The data from this testing would be continuously monitored and evaluated to provide long term projected wear patterns. From the data and analyses, product improvements would be made within the RIW contract prior to there being a field problem affecting aircraft reliability and to improve survivability of the pump while installed on the aircraft. The Abex test Plan TP-710 was developed. ASO provided approval for the use of RIW pumps for the purpose and tests were initiated in January 1977. To date, 495 pump test hours have been accumulated. This is insufficient test time to anticipate specific results. This test will be monitored and reviewed by ASO in 6-month intervals.

G. Configuration Status and Control:

674 pumps have been or will be delivered to the Navy for spares and to Grumman for aircraft installations and are included in the current population covered by the RIW contract. To date, the pumps delivered to Grumman Aircraft and the Navy were in the following configurations:

P/N 65070	15 units
P/N 65070-01	65 units
P/N 65070-02	45 units
P/N 65070-03	549 units

MOD P00013, when deliveries of aircraft are complete, will increase the total population to the 674 pumps.

With each return of a unit other than the latest configuration, the unit is updated to the latest configuration. Currently the population consists of 627 of the latest units and the remaining 47 a mixture of earlier configurations. Thus, the update of all delivered units is considered complete for all practical purposes. This change process has been very smooth within the RIW contract. No Navy capital investments were required for these changes. There were no updatings of data required for each change from one configuration to the next. 24 parts were changed (11 part number changes and 13 letter changes) in the course of the change process, yet there were no obsolescences created in Navy stocks of spare or installed pumps and supporting spare parts. Throughout the change process, which was continuous, there has been absolute control of configuration. Abex can produce records of configuration status for each pump by serial number and will continue to maintain these records throughout the RIW contract period. At the end of the contract, the Navy will receive this record for their continuing management of configurations. Figure 14 shows inventory configuration as a function of time.

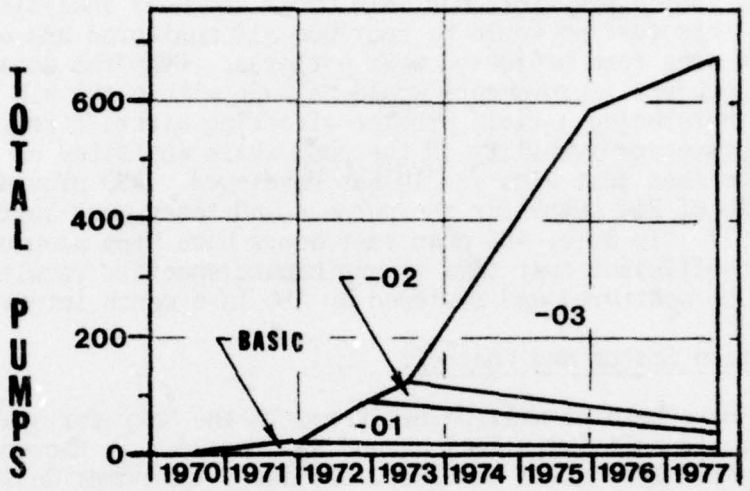


FIGURE 14: Configuration of Pumps in Navy Population

LOGISTICS

A. INVENTORY MANAGEMENT:

To date, the total procured inventory of pumps is 674 units. Of the currently delivered units, 468 units are installed in 234 F-14 aircraft. The remaining 136 units provide the logistics system with the resources to support the installed pumps. These 136 spare units at any given time are in supply depots, in transportation, in supply pools allowed for F-14 squadron operation sites both on aircraft carriers and land based, or in the Abex repair cycle and pool. It is usual, for example, that an aircraft carrier having F-14 squadrons deploys with an allowed quantity of 7 spare pumps. The economic study, enclosure XIII, analyzed the most likely spares requirement for the non-RIW alternative and showed that the current F-14 operations would have required 353 spares for a non-RIW alternative, 217 more than the RIW alternative. The changing picture of assets relative to total population is shown in Figure 15.

There are a number of measures used by inventory managers in the Aviation Supply Office to determine the effectiveness of supply support. They are as follows with corresponding explanations and relationships to the RIW contract:

1. Total Support Assets: This is a measure of all assets which were procured to ultimately provide logistics support to the operating fleet. It is usually measured as a percentage of spares as compared to installed (actively used) units. The normal range for an engine driven pump is 50% to 100% spares. The RIW population at the time of the report, includes only 25% spares, inadequate by any non-RIW standard.

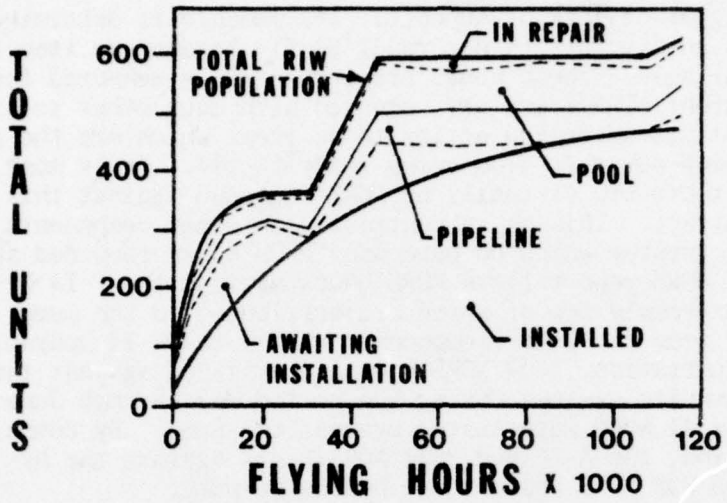


FIGURE 15: Breakdown of Assets Relative to Total Population

2. Total Available Ready for Issue (RFI) Assets: This measure is placed against standards of lead time and rate of use. For the pump, which is a repairable item, the lead time to be considered is the time it takes to convert a failed item on the supply shelf (unit turned into supply after removal) to a repaired ready for issue item on the supply shelf (Abex pool) available to meet a demand. The rate of demand is how many demands will have to be met for a given flying hour program. For the RIW contract the lead time consists of average time from removal to receipt at the Abex dock plus the average time for the unit to be repaired and placed in the Abex pool. These times have been measured within the RIW contract and are 67 days and 35 days respectively. The rate of return for the current flying hour program is 8 units per month. Thus, for the current conditions there should be at least 2.5 months demand available at any given time ready for issue. The actual ready for issue assets at this point in time are 40 units being held at Abex and used on a dynamic basis to ship a RFI unit in exchange for a unit received from that activity. This translates to a 5 months supply of ready for issue assets which is a healthy inventory management support posture for this measure of effectivness. There has been a consistent and healthy picture from this point of view since the start of the RIW contract.

Thus, notwithstanding the very low percentage of pump spares (low Navy investment), support of the F-14 fleet has been outstanding and much better than that obtained on other Navy aircraft hydraulic engine driven pumps. None of the other Navy aircraft have a RIW contract for their engine driven hydraulic pumps. Spare levels for support of other aircraft are shown below for comparison purposes:

Aircraft	% of Spares
S-3	49%
A-7	75%

3. Not Operationally Ready, Supply (NORS): This measure is the universal system trigger of lack of support. Its measure is determined by how many hours an aircraft is not ready to fly because an item from supply is not available. These hours are cumulatively measured for each item. Different NORS items are compared with each other to single out for management attention and action those items which are the worst offenders in keeping aircraft from being ready to fly. It is most significant that there are virtually no NORS recorded against this pump under the RIW contract. This is in contrast with other components of the F-14 hydraulic system which do have many NORS hours recorded against them. The latest NORS report lists NORS hours against the F-14 hydraulic system, extremely few of which are attributed to the pump. This experience is not true for other components within the F-14 hydraulic systems. For illustration, 1704 NORS hours were listed against the F-14 aircraft hydraulic systems during the period May through June 1977. Of this total only 41 NORS were listed against the pump. By comparison for this same period, the A-7E had 2024 NORS hours against the hydraulic system and 828 NORS against the hydraulic pump.

4. Spares: In addition to the pool quantities at Abex and allowance quantities at operation sites, there normally are the RFI (Ready for Issue) units stocked within the supply system. The total of these, plus RFI assets in transportation represent the total RFI supply support of spares available. The ASO inventory manager of these pumps has found that the supply of RFI assets can be most efficiently maintained by allowing the stocks not required for immediate needs to accumulate at Abex as part of the Abex pool. The current supply picture shows very few assets on the shelves within the supply system. When such assets do show up in the reporting system, the ASO inventory manager initiates transactions to ship those units to Abex for inclusion with the Abex pool, or induction for repair. 52 pumps are allocated to various F-14 operational activities for their defined allowances. Since there is a broadening of F-14 operations, 14 additional pumps are scheduled for new allowances in the near future. This new requirement for 14 pumps could be drawn from the Abex pool rather than obtained by new procurement, as usually occurs in a non-RIW situation.

5. Transportation: It is usual and normal in the management of high cost repairable assemblies that premium transportation would be utilized. Premium transportation with its associated higher costs is generally cost effective when only limited (generally insufficient) assets are available to the system. The current value of the Abex pump is approximately $4,000 and properly packaged in its assigned container weighs 46 pounds and has a volume of 2.3 cu. ft. Because of the reliability achievements within the RIW to date, there has been no adverse impact using normal, non-high premium modes of transportation. This is a savings to Navy operations which is real and a direct result of the RIW contract reliability achievements.

In order to avoid damage in handling and transportation, a special container P/N 61303 NSN 2RH-8145-00-111-2536PF has been designed by Abex, procured by ASO, and is being utilized to ship the pumps. 40% of all pumps returned to Abex from Navy activities have been packed in containers other than the above defined container. Of these improperly packaged units, at least half have shown damage in shipment

which increased costs to repair the pumps on the average of $50 per damaged pump. Continuous loss of special containers and subsequent added damage is considered inherent with usual supply system operations. However, for RIW this cost must be quantified carefully.

B. Turn Around Time:

The RIW contract provides the opportunity to observe, through data collection and analysis, the real time entire world average for turn around times. The four useful elements comprising a complete turn around cycle are listed below and described in terms of their impacts on logistics:

1. Installation to Removal: This part is the real end use portion of the cycle. The data of this portion can be used as an approximation of the reliability/survivability of the pump in service. Any improvement of the pump should be reflected as an increase in the average number of days the pump remains installed in the aircraft. This cannot remain an absolute measure because there are other hydraulic system aspects causing pump removals which can either improve or deteriorate over short or long periods of time biasing the trend of average number of days the pump remains installed. However, this measure is a good one to observe and compare to other data for specific intelligence as well as adding confidence to other logistics or performance measures. Figure 16 is a plot of the data currently available.

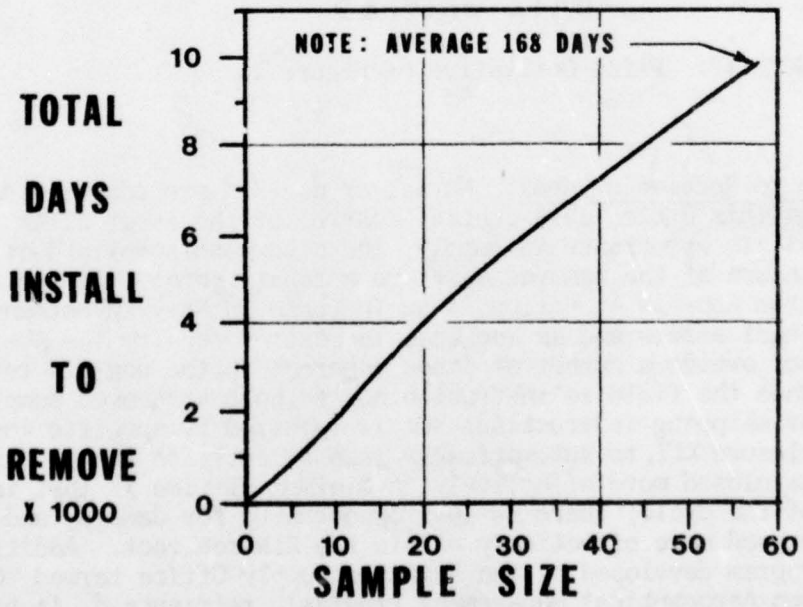


FIGURE 16: Measure of Turn Around Time Element: Install to Remove

The number of units shown in Figure 16 are not all the pumps that were installed and removed, since the field data is not perfect. Obvious bad data elements were removed and some pumps are not completely reported in the field data. However, the sample is reasonably large both in number and percentage of population providing a high confidence level that the data shown is truly representative of the total population. The analytic techniques used in plotting the data as a continuous integration easily provide resultant rates for any point in time as well as for any interval of time by observing the slope of the curve. The data of the curve of Figure 16 is reduced to average slope information and related to time in Figure 17.

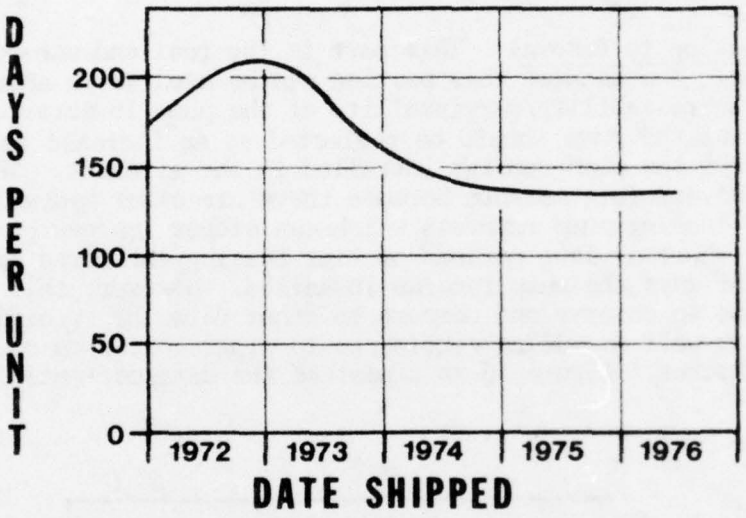


FIGURE 17: First Derivative of Figure 16

2. Remove to Receive at Abex: Normal or non-RIW procedures tend to lengthen this cycle, lose central control of the asset after removal until its appearance in supply, and allow undisciplined or careless return of the removed asset to a repair point. The net effect of the non-RIW situation is an increase in Navy investment for additional assets and an increase in cost of repair. The Abex pump RIW contract avoids a number of steps inherent in the non-RIW return process since the field is instructed not to hold a removed pump waiting for shipping instructions but is required by specific instructions, enclosure XIV, to automatically ship directly to Abex. Thus, the loop is closed more effectively; a minimum of time is lost in this leg of the cycle; there is less opportunity for damage, and the assets are used more effectively within the RIW contract. Additionally, another program developed by the Aviation Supply Office termed "CLAMP" (Closed Loop Aeronautical Management Program), reference d, is partially used in this RIW contract. Should a field user not have a pump immediately available to replace one removed, the user can ship and at the same time phone or telegraph Abex for a replacement. Abex is required to respond expeditiously by shipping within 24 hours, by

premium transportation, the replacement pump directly to that user. The average time of remove from aircraft to receive at Abex to total date average within the RIW contract has been 67 days. The most recent experience for the last 56 pumps received at Abex has changed considerably to 27 days

3. Receive (at Abex) to Ship (at Abex): This is basically the repair cycle within Abex. This cycle is relatively short since many of the repair actions phase directly into an ongoing production cycle. The close coordination between repair and production makes for very short lead times for parts replacement, plating, machining, coating, painting, and other operations. This also tends to decrease cost of repair since elements of the repair do not have to be batched for economic reasons, being able to fit into a corresponding, currently operating manufacturing step. This makes for extremely efficient operations, tends to keep manufacturing alert to processing efficiencies/quality, and keep the repair per se, up to manufacturing standards.

There are many synergistic benefits realized by keeping manufacturing and repair extremely close and common in specific areas of operation. Since returns can be considered a cost of manufacturing in spirit, if not in accounting, then the manufacturing operations are sensitized to decisions in favor of higher levels of quality, more critical review and rejections of gray areas and more attention/care to individual manufacturing processes. The government resident inspector has confirmed during the RIW program review that this is, in fact, the case at the Abex plant.

The average time to date between Abex receipt and shipment (to the bond room spare pool) has been 35 days. This is considered very good for the type of item involved and is generally much better than that normally obtained by similar repair cycles within Navy organic repair depots or equivalent commercial depots. It should be remembered that once shipped to the Abex bond room, the unit remains as part of the pool to be shipped at some later date upon receipt of another unit at the Abex dock. This average dead time must be considered in the turn around time of a complete population for reliability considerations but is not part of the turn around time elements included for logistics consideration.

4. Shipment to Install: This element of turn around time includes as well a dead time starting when the unit is received at the user's activity and finishing when the unit is actually installed in an aircraft. That dead time portion is an indeterminate and can only be estimated. The measured time (including the dead time) as recorded by the data system for this element of turn around time, is 165 days. For logistics considerations just the transportation time of this segment should be used. This is considered arbitrarily to be 30 days. There are potential increases of efficiency to be exploited in this area as a result of the sharp increase in pump reliability since the start of the RIW contract. Some of these improvements can be obtained by updating the logistics files with new factors reflecting the real life increase in reliability.

The above 4 elements of average turn around time, when added, do not provide the complete average turn around time of an average unit. To obtain this time, the average time a good unit remains in the Abex pool, other pools and supply shelves should be included as well. The average pool times as well as all the other turn around times, are not static since they change directly or indirectly as a function of reliability, system discipline, maintainability as well as management policy/attention. Thus, careful attention to changes in turn around can provide Navy and Abex management direct intelligence as well as inferences about total system performance. The Abex data system to date has not developed automatic sophisticated outputs in this area even though most of the elements of source data inputs are available in the data bank. The individual answers have required special analyses. Abex has been apprised of this and they plan to develop further ADP analytics for this area of turn around time indicators.

A special analysis of complete turn around time was made utilizing data of individual units (by serial number) that have completely turned around. The approach for this analysis is termed "Turnstile Analysis" since it picks a special point of reference, considers that point a turnstile through which every unit must pass and be recorded in that passage. The point of reference for this analysis was shipment to the user from Abex dock. The independent variable was cumulative days to delivery to the Abex bond room, of the same serial number unit. To avoid bias the only units included were those shipped from Abex to replace those received.

This analysis shows the total system average turn around time as the slope of the curve. Thus, the curve provides dynamic information in terms of any point in time as well as for any increment in time. Figure 18 is a curve utilizing this turnstile analysis. The curve shows complete turn around times for individual units as 543 days for the start of the RIW contract and 396 days currently experienced under the RIW contract.

This information is necessary in order to determine the anticipated average turn around of a complete population. Length of time to turn around a complete population is calculated using the current information (as average over the contract period) and the return rate as a function of flying hours (also related to time). This calculation results in a complete population turn around time of approximately 9 years at the 1976 flying rates and removal rates. Since this F-14 program will increase, then the dynamics of the situation indicate that there will be more than one turn around of the complete pump population within the Abex RIW contract. This is an essential ingredient toward success of a RIW Contract.

C. Bond Room and Abex Pool:

Government owned material, when in the custody of a contractor, must be secured during storage in accordance with government regulations. This secured space is referred to as a bond room. Abex maintains a pool of RFI (ready for issue) pumps in such a bond room in order to provide the exchange of an RFI pump within one working day for every pump received.

The pool is maintained by Abex under their control in this bond room. The contract original authorized pool of RFI units was 25 units. However, the growing reliability of the pump resulted in fewer units in transportation than anticipated, resulting in a larger accumulation of units in the pool. This accumulation, in just that one storage area, has made it possible to keep tighter control and higher visibility of available assets within the total logistics system.

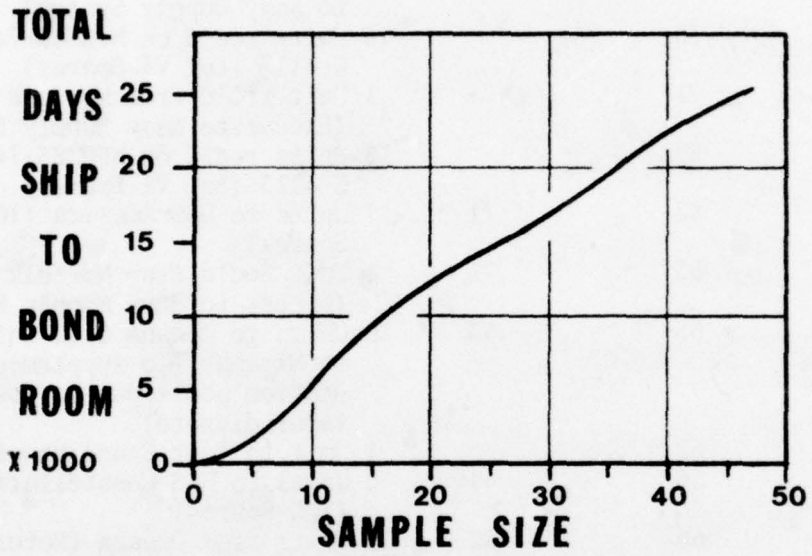


FIGURE 18: Turnstile Analysis

The Abex contract, at the time of execution, planned for support of all F-14 aircraft up to and including Lot IV. The pool of 25 pumps was calculated based on that level of support. By the time each new lot of aircraft (to Lot VIII) was defined for support under an amendment to the Abex contract, the pool had grown sufficiently above 25 to not require a specific procurement for additional support spares for that new lot of aircraft. This situation was attained successively for Lots V, VII and VIII. At the time of writing this report, Lot VIII was contracted for RIW coverage as modification P00013 to the Abex contract. And again, the pool has grown to 73 at the time of the last contract review and is 40 as of 15 August 1977. Thus, for Lot VIII aircraft, there appears to be no need for new spares procurement. It will be possible to live off of the existing assets without jeopardizing fleet support. However, 15 additional spares were procured for safety stock.

Table VI is a synopsis from contract start of the pool experience and inventory changes. The notes explain the inventory level changes, other than the one for one exchanges, which resulted in a pool above the contracted-for level of 25 pumps. Total assets represent that quantity of units in Abex representing total available to the pool at the indicated date.

TABLE VI: ABEX INVENTORY CHANGES

Date	Total Assets	Pool	Remarks
4/6/73	45	25	45 Units rec'd on N00383-72-C-4641
12/26/73	40		5 Units to NAS Miramar Pool
2/28/74	39		1 Unit to Test Stand Manuf.
10/30/74	40	29	1 Unit from Test Stand Manuf.
4/10/75	55		15 Units rec'd from Oceana - Norfolk - Bethpage (Excess to Navy Supply System)
4/17/75	70		15 Units rec'd on N00383-74-C-4113 (Lot VI Spares)
4/25/75	71		1 Unit rec'd from Norfolk (Excess to Navy Supply System)
6/19/75	89		18 Units rec'd on N00383-74-C-4113 (Lot VI Spares)
7/29/75	82	71	7 Units to USS America (IOL Spares)
8/26/75	83	71	1 Unit Rec'd from Norfolk (Excess to Navy Supply System)
11/13/75	63	53	10 Units to Oceana & 10 Units to Miramar (To supplement Station pools due to possible labor dispute)
11/25/75	62		1 Unit to Test Stand Manuf.
1/14/76	56	44	6 Units to USS Constellation (IOL Spares)
1/27/76	66	52	10 Units from Oceana (Return of Supplemental Pool Units)
1/29/76	70		4 Units rec'd from Norfolk (Excess to Navy Supply System)
2/16/76	80	55	10 Units rec'd from Miramar (Return of Supplemental Pool Units)
7/29/76	78	50	2 Units to Miramar (IOL Spares)
10/13/76	77	59	1 Unit to Miramar (ACEVAL/AIMVAL)
11/1/76	74	54	3 Units to North Island (ACEVAL/AIMVAL)
11/4/76	73	53	1 Unit to Test Stand Manuf.
1/14/77	72	59	1 Unit to Abex Eng. Test Lab
1/24/77	69	55	3 Units to USS Enterprise (IOL Spares)
2/18/77	68	58	1 Unit to Abex Eng. Test Lab
2/18/77	69		1 Unit rec'd from USS Kennedy (Excess to Navy Supply System)
2/21/77	70		1 Unit from Norfolk (Excess to Navy Supply System)
4/11/77	63	41	7 Units to USS Kitty Hawk (IOL Spares)
5/5/77	62	33	1 Unit to Naval Test Lab
5/5/77	61	32	1 Unit to USS Constellation (IOL Spares)

TABLE VI: (Continued)

Date	Total Assets	Pool	Remarks
5/13/77	61	40	Replenishment to bond room
6/10/77	56	25	Awaiting mounting flanges and
7/19/77	56	15	hangers for pumps in repair cycle
8/15/77	66	40	Repair parts received, replenishment to bond room

D. Bit and Piece (Spare Parts) Support:

The RIW contract calls for Abex to supply its own parts for repairs. This contract anticipated an average cost in parts per repair and included that cost in the contract price. Since the original contemplation of this RIW contract occurred during the time of the original F-14 provisioning, and at that time it was not known if an RIW contract would materialize, it was necessary to continue downstream preparing for a normal mode of organic support until the RIW could become firm. During this period, spare parts were procured by the Navy under ASO contract N00383-72-C-4641. During this period of time Abex could not invest its own money in spare parts for the RIW since it was not clear if such a contract would materialize. On the surface it would appear that the Navy could possibly duplicate, with their investment in spares, that investment for spares that Abex would have to make should the RIW materialize. This potentially costly duplication was avoided later when the RIW contract was negotiated and Abex agreed to a no cost cancellation of the ASO spares contract in order to allow Abex to continue the manufacture of those spares for the RIW contract. The net result of this change was to provide Abex the needed lead time in the production of spares for the start-up of the RIW contract.

The use of specific spare parts is recorded by Abex as part of their data inputs. The actual use rates of parts are reviewed and analyzed as part of Abex continuous reliability and maintainability improvement effort. Additionally, the composite use rates of the parts will provide a basis for determining the Navy requirements for spares at the end of contract when transitioning from RIW support mode to organic support.

Table VII is a partial listing of parts replaced and/or reworked to date. The listing is in the order of their usage to provide insights on which parts have greatest impact on the program and thus, which parts can be most lucratively changed, improved or better processed. This remains as a future Abex effort under the RIW contract, to decrease their costs to maintain and improve maintainability.

This RIW contract has provided a benefit over the organic support alternative not always recognized. This benefit is the ability to easily and most economically rework parts when there is an ongoing manufacturing production of the same part at the same time. Since Abex production of F-14 pumps will continue as long as Grumman produces the F-14 aircraft

and/or new spares replenishments are required, then it stands to reason that during the course of this Abex RIW contract (until 1983) that this advantage will be obtained. There are many of the Abex overhaul rework procedures which are phased into and become integral with the concurrent production of the same items. Thus, the cost for such rework is prorated on an allocated portion of the production cost which is much less than any rework accomplished as an independent shop effort. The records of parts used will ultimately be provided as real life provisioning inputs when phasing in organic support during the last year of the RIW contract. Abex has contractual responsibility to provide this information.

TABLE VII: PARTS REPLACED AND/OR REWORKED

PART NO.	REPLACED	QUANTITY
61569	Washer - Countersunk	1728
55953	Bolt - Machine 12 pt	1696
63498	Piston & Shoe S/A	569
55597	Insert - Helical Coil	320
61635	Ring - Retaining	156
50114	Plug - Protective	155
50071	Plug - Protective	155
50068	Plug - Protective	155
61305	Plate - Warranty	135
61496	Face - Seal Mating	125
8013303	Pkg Preformed	97
8001003	Pkg Preformed	94
8012403	Pkg Preformed	89
8090804	Pkg Preformed	86
8024103	Pkg Preformed	86
8091604	Pkg Preformed	85
8090404	Pkg Preformed	84
8016703	Pkg Preformed	82
8090603	Pkg Preformed	81
8091004	Pkg Preformed	81
8001203	Pkg Preformed	81
53566	Insert - Helical Coil	80
8001001	Pkg Preformed	78
63494	Barrel - Cyl	77
6676215	Insert & Keyring	77
	REWORKED	
63498	Piston & Shoe	799
69575	Hanger S/A	129
61080	Port Cap	121
69404	Port Plate	118
63494	Barrel	65
61340	Housing	50
61339	Flange	50
61496	Face - Seal	27
63496	Plate Wear	15

E. Procurement History:

1. Hardware:

The F-14 hydraulic pump was initially procured by Grumman from Abex after a competitive selection process. For each lot of F-14 production, Grumman procures directly from Abex the pumps required for installation (contractor furnished equipment). Thus, when the aircraft is accepted by the Navy, support of those pumps becomes a Navy responsibility. As is usual for the initial introduction of new aircraft into fleet operations, the aircraft manufacturer provides the early support of spares, generally referred to as augmented support. Grumman prepared for such augmented support by ordering 80 pumps from Abex. These pumps would have been made available to the Navy at a point in time when the F-14 would have become operational. The need for that number of spares would have existed for the non-RIW mode but were considered too high an investment by Navy for the RIW. Consequently, Grumman was requested by the Navy to reduce the procurement to 50 units. This represented a considerable savings to the Navy since the Grumman costs of augmented spares are passed on to the Navy with corresponding Grumman mark-ups above Abex sell prices.

2. Support Equipment:

Initial support of the F-14 called for Abex commercial overhaul of the hydraulic pump (Grumman contracts) until such time that the Navy system was prepared to provide organic overhaul of this pump. One critical key to Navy support was availability of a test stand. It was postulated at that time (1972) that it would have taken approximately 3 years until such organic depot support could become fully operative with support equipment, data, spares and training. Until that would have occurred, an ASO commercial overhaul contract with Abex would have been required. However, the early signing of the RIW contract with Abex made possible a very easy and smooth transition from the then existing commercial overhaul into the RIW contract which included as well those overhaul support functions. Overhaul support under the RIW contract has remained a smooth flow since with no negative impact upon fleet support.

There has been continuous development effort by NAVAIR to develop a test stand adequate for the purpose. 2 contracts have been issued to date for such a development. The first contract N00156-71-C-1053 of 25 January 1971 awarded to ACL-Filco, did not result in an acceptable test stand. The second contract N00140-75-C-0585 awarded to Dayton T. Brown, has resulted in a test stand to be delivered to the Navy in October 1978 for evaluation. Should this evaluation conclude that this test stand is satisfactory for its intended intermediate maintenance and depot support purposes, then procurements for the additional units would have to be initiated. It could be anticipated that a lead time of at least 2 years is required for procurement and delivery after requirements are crystallized and money is made available. Thus, it could be postulated that adequate equipment for Navy organic support will not be available until 1980.

F. Training:

Abex has made many visits to the field to investigate reasons for removals. With each visit they have provided both fleet operations and intermediate level maintenance people specific indoctrinations on the pump and the RIW contract. This consistent Abex action, accomplished through their own initiative and expense, has resulted in much more disciplined and cooperative fleet operations and maintenance responses and is materially responsible for some of the continuing lowering of removal rates. Additionally, Abex has invited newly formed F-14 squadrons to send their personnel associated with the aircraft hydraulics for indoctrination at the Abex plant. To insure covering all newly formed squadrons, Abex has provided the same indoctrination at the military bases as well.

This training process is a continual one since there is considerable turnover of Navy personnel. Prior to aircraft carrier deployment Abex generally insures that the applicable personnel have had the indoctrination. If not, Abex takes the necessary steps to provide indoctrinations. Thus, at this point in time, virtually every person directly involved in dealing with the hydraulic pump in field operations has been made knowledgeable of the pump, its application capabilities, cautions for servicing and the RIW contract support capabilities.

The RIW contract includes an Abex requirement to train Navy personnel who will be responsible for overhaul of the pump as part of the transition to Navy depot support during the final year of the contract.

G. Communications and Data:

There are 2 major sources of data fed into the RIW program. The first source is records generated from fleet level activities, generally removals/installations of the pump and F-14 aircraft activity. The data, as recorded in field operations, is transmitted directly to a Navy data repository in Mechanicsburg, PA. The system within the Navy requiring the generation, transmission, storing, and retrieval of this type of data is called the Navy's Material Maintenance Management System, generally referred to as 3M. The applicable 3M data as originally recorded source data from the 3M data bank is tabulated and rerecorded on tape monthly and sent directly to Abex for their use. Enclosure III is the letter which initiated that 3M input directly to Abex.

The second major source of data is that generated in Abex during control of the pump through receipt to shipment as well as the data generated during the overhaul and test cycle. The main elements of data generated become inputs to the automated data processing (ADP) system developed by Abex for the RIW contract. There are other manual sources to data inputs peripheral to RIW but fed to Abex to add to other data.

All the 3M inputs are supplemented by the Abex form included with each pump shipped and distributed during the Abex indoctrinations and completed by the field on a courtesy basis. This form is included with this report as Enclosure VI. This form has been an excellent vehicle for communication with each returning pump. The field has shown outstanding

cooperation in taking the time and effort to fill in the form in addition to their requirement to provide forms for 3M inputs. It is easy to speculate that this unusual additional field effort and cooperation might be due to two reasons:

1. The field has been able to identify this effort with potential improvements which ease their problems in maintenance.

2. The field via Abex indoctrinations has learned that the form they fill out is really used and is very useful, overcoming the field's usual frustrating feeling that no one in "headquarters" listens to what they have to say.

The net result has been that this communication has been extremely valuable in determining Abex reaction to field occurrences. Many design changes were in fact conceived as a result of these direct field communications. This field form is physically received at Abex with the applicable pump. Thus, the information is most timely without ADP gaps in the process plus retrieval problems when related to a specific pump. The pump and form are usually received at Abex within 67 days of the removal of that pump from an aircraft. 3M data, due to its intermediate processing steps from sources to its receipt at Abex, is generally at least 90 days behind in currency.

Although the data inputs at the start of RIW could not justify the economics of an ADP system, Abex desired to develop such a system in advance of the actual need to allow considerably longer lead times in its development. At this point the ADP system development suffices for Abex and Navy current needs even though there remains considerable manual analytic efforts which can be automated in the future. Some of these analytics which were performed manually are illustrated throughout this report. Flight hour summaries are developed within the ADP system as well as many other ADP outputs. Material Management summaries are also developed for ADP output reports. These are combined in the ADP output to provide removal (return) rates relative to flight or pump hours. The emphasis in the future is to develop the ADP outputs which are required to support those future analytic efforts as well as to replace remaining manual efforts with appropriate ADP programming and outputs. Enclosure XV provides samples of the Abex ADP outputs.

ECONOMICS

A. RIW Costs:

The Abex RIW contract with all its amendments to date, contractually obligated the Navy for approximately $1.6 million. Payments are arranged to be made on an "as you go" basis; each increment paid is an advance payment of 1 year's pro rata portion of its RIW operations. The pro rata is based on per installed pump in an F-14 aircraft. Thus, each time the Navy

accepts an aircraft from Grumman, pro rata billings are initiated for the 2 pumps installed in that aircraft. Each billing is for 1 year of warranty operations. Another billing is made on the 1st anniversary of that first billing and so on each year until payment of that pro rata portion of the RIW contract is complete.

The annual schedule of payments has been designed to reflect start up costs and other fixed costs by being heavier in the beginning. The basic schedule called out in the RIW contract is as follows:

Initial Delivery	20%
1st anniversary	20%
2nd anniversary	20%
3rd anniversary	20%
4th anniversary	10%
5th anniversary (or contract completion)	10%

The actual payments to date and future schedule of payments are shown in Figure 19 below:

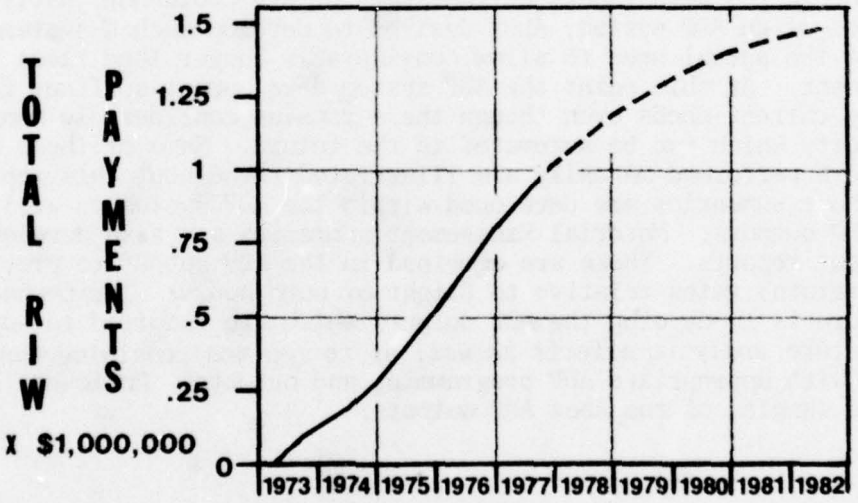


FIGURE 19: RIW Payments and Schedule

B. Alternatives to RIW:

The RIW contract, although only half way through its course, has provided many significant opportunities for cost reductions. The cost reductions are considered as those system or element costs which have been proven to be less within the RIW contract when compared to the most likely non-RIW alternative. For the purposes of comparison in this case, the most likely non-RIW alternative would have been a plan to maintain which included a Navy organic depot or Abex as a commercial depot to provide overhaul of the pump.

A total system cost comparison was originally made for management review in its decision to go the RIW route. This study was published, reference e. This original cost comparison for Lots I to IV provided considerable evidence from 1972 projected information that RIW was the most cost effective alternative available to the Navy. This study concluded that the non-RIW alternative would cost approximately $100,000 more when compared to the RIW proposed costs. In addition, at the end of the RIW contract the Navy would have at least $150,000 of assets available for transfer and use in Navy organic support.

Since this cost comparison was based on the then Abex proposal for 5 years of RIW reliability growth, and this proposed growth was not only achieved but exceeded by the contract midpoint, the cost effectiveness of the RIW has been well demonstrated. Specific cost reductions over non-RIW alternatives have been documented, i.e., no Navy investment required to update pumps to the 03 configuration ($151,000 saved) and the reduction of spares required for adequate fleet support mentioned previously in this report.

Another study has been made (1977) to determine as realistically as possible what the real life alternative would have been, should RIW not have been available to the Navy. The study considered the most likely reliability which would have been achieved in an environment of organic and/or commercial overhaul without any RIW reliability growth incentives. The base developed and end points developed to the present time showed that the non-RIW alternative would have required organizational, intermediate and depot levels to support 228 additional returns to date above that obtained for the RIW alternative. Projections of returns for the alternative were made to the end of the RIW contract period to support an updated economic analysis. This economic study is included as Enclosure XIII of this report.

This economic study made for this RIW mid-contract review intended to surface actual differences of costs and resource requirements between the RIW and non-RIW alternatives. Costs are considered as "out of pocket" type of expenses which when not required can become cash or resources available for other support requirements. For the purposes of this economic study. resources not considered elements of the study were those which, when quantified, would not or could not become available as cash to be applied elsewhere.

Any resource which could not be quantified with confidence was not considered. The study is in effect a Life Cycle Costing analysis for the two alternatives considered. This study is included as part of this report as Enclosure XIII and is backed up by another study of escalation, Enclosure XVI.

The study showed that the non-RIW alternative would have cost more and would have required additional resources for support. The difference when quantified totaled $749,844 to date in favor of RIW. For the life cycle cost the differences of costs in favor of RIW are $1,940,498. When it is considered that the RIW contract up to and including Lot VIII aircraft costs $1,595,344, this result becomes very significant in proving the wisdom and cost effectiveness of the RIW alternative for the F-14 engine driven hydraulic pump. This economic study will be updated at the end of the RIW contract to completely document this RIW experience.

CONCLUSIONS

A. The growth of reliability from 500 to above 1250 hours between returns is very significant. The continuous field reliability growth for this generic type of item has not been achieved before with any other program or procurement approach. At the half-way point in the contract, the reliability is continuing its growth.

B. The inventory support posture has been excellent since the start of the RIW contract, and has every indication of remaining that way for the contract duration. This support posture has been accomplished with much less Navy investment for spares support than that considered normal for a non-RIW mode of support.

C. This RIW contract has been the most cost effective support alternative available to the Navy.

D. Operations within the RIW contract have been extremely effective in catching system deficiencies and expeditiously reacting to avoid fleet operational degradations due to those deficiencies.

E. All design changes and updates to a latest configuration, through 3 configurations, have been effectively made with no capital investment required of the Navy, no cost to update data and no obsolescence of spare parts.

F. The RIW contract facilitated and phased into a concurrent qualification process in a positive manner providing synergistic benefits for both.

G. Within the RIW contract there will be a complete turn around of the pump population permitting all units to be updated to the latest 03 configuration before contract completion.

H. The ADP system requires further development to provide analytic and dynamic system indicators of performance and control.

I. This RIW program has provided a cost effective and practical TAF (Test, Analyze, and Fix) operation utilizing real life field experience for the "Test" bed, "Analysis" by the engineers most knowledgeable about the pump's design and manufacture, and "Fix" , concurrent with production, with no Navy investment or lost time.

RECOMMENDATIONS

A. The Lot VIII pumps will complete the RIW coverage simultaneously with the other existing pump population under RIW contract for one total common point of population contract completion. Future Lot IX, etc. production aircraft should obtain RIW coverage at no additional cost by keeping the aircraft flying hour cutoff at 393,024 hours and contract calendar cut-off at 15 March 1983.

B. ASO should review and update provisioning factors and allowance lists to exploit the current higher levels of reliability obtained under the RIW contract. A desk reprovisioning action could initiate the required logistics data, records, and publication changes.

C. Abex should place more emphasis on the analysis of parts used for further improvements of reliability, maintainability, and to further decrease costs to maintain.

D. Heavier Navy emphasis should be placed on correcting known system deficiencies, i.e., the quick disconnects, thermal relief valve, etc.

E. Abex, with ASO support, should develop further dynamic indices of turn around time, engine to flying hour ratio, turnstile analysis techniques for analysis of reliability, growth of time between install and remove, and system indicators of contract performance and system control.

F. Abex should continuously monitor critical indicators of field returns such as, leaky front seals, test good units, sheared shafts, etc.

G. Page 1 of Enclosure 3 to FASOINST 4440.86C (Enclosure XIV to this report) should be revised to include more detail of recommended container and shipping instructions.

H. This report should be updated at the conclusion of the Abex RIW contract.

REFERENCES

a. Aviation Supply Office contract with Abex Corporation number N00383-73-C-3318, dated 2 April 1973

b. Proceedings of Aviation Supply Office Failure Free Warranty Seminar, December 12, 13, 1973. AD #779068

c. Technical Paper; Markowitz, Oscar "Aviation Supply Office FFW/ RIW Case History #2, Abex Pump" published in Proceedings 1976 Annual Reliability and Maintainability Symposium

d. ASO Field Instruction FASOINST 4440.92B "CLAMP (Closed Loop Aeronautical Management Program)," dated 17 June 1974

e. Aviation Supply Office Report No. LCC-72-4, "Determination of Life Cycle Costs of the Alternative Choice Between FFW as Proposed by Abex Corporation and Standard Maintenance/Overhaul Procedures Utilizing NARF Organic Capability," dated 2 June 1972

COPY

PGB8-2:WMc:cfr
N00383-73-C-3318
29 May 1973

From: Commanding Officer, Aviation Supply Office, Philadelphia
To: Commander, Defense Contract Administration Services District (DCRL-DVCD/B6), 18321 Ventura Boulevard, Tarzana, CA 93156

Subj: Contract N00383-73-C-3318 with Abex Corporation, Oxnard, CA

1. Subject contract was executed on 2 April 1973 and provides for a long-term service warranty covering 258 Government-owned engine driven hydraulic pumps. Abex Corporation part numbers 65070-01 and 65070-02, used in the F-14 aircraft. The concept is termed Failure Free Warranty (FFW) and the purpose of this communication is to clarify the DCAS function with regard to quality assurance (QA) and other matters within this FFW concept.

2. The purpose of FFW is twofold, i.e., to reduce the total cost of ownership by the application of life cycle costing techniques, and to continuously increase product reliability by directing the thrust of the profit incentive toward such end. It is the latter aspect of FFW which bears most directly on the Government's QA function. Under normal circumstances the contractor is motivated to achieve only that quality level which meets the minimum requirements stipulated in the contract. Beyond that, the incentive is negative in that lower product reliability results in additional sales in equipment, spare parts, and repairs. Under FFW, however, the contractor is totally responsible for failures in the operational environment and the consequent maintenance of the equipment and is thus motivated to achieve the highest possible performance level in order to decrease failures and subsequent maintenance costs. This is a dramatic shift in risk from the Government to the contractor and must be accompanied by a similar shift in QA responsibility. The contractor must be permitted a wide degree of latitude in making decisions which affect quality, reliability, and final acceptance of the product.

3. In view of the foregoing, the DCAS QA role under the subject contract is as follows:

a. The QAR has no responsibility with regard to the receipt of units for warranty servicing since the Government need not demonstrate that the warranty has been breached.

b. With respect to units undergoing repair, the QAR function is limited to a surveillance of the contractor's quality assurance system to ensure that such is being maintained. The QAR shall not be a member of the Material Review Board (MRB) since the total risk in MRB decisions remains with the

contractor after final acceptance of the repaired unit.

c. The final test and acceptance of repaired units must be a contractor responsibility. The QAR will monitor only to the extent necessary to ensure that the final test and acceptance procedures are not inconsistent with those approved by Grumman Aircraft Corporation. Any such inconsistencies should be reported to the PCO with sufficient technical detail to permit evaluation. The contractor will certify, by the use of the "Certificate of Conformance" mentioned in clause I-930 entitled "Inspection and Acceptance" that the repaired unit has been successfully tested in accordance with the established procedures. Government acceptance of repaired units should be based on the certificate and block 21 of the applicable DD Form 250 should be so noted.

4. Turning to a related matter, it should be noted that the contractor is required to ship units from the Government bond room on an expedited basis. In this connection it is requested that Abex be given full access to bond room assets consistent with the provisions of ASPR, Appendix "B".

5. When travel funds permit, the PCO will arrange a postaward conference at the contractor's plant for the purpose of exploring all areas. Until such time it is hoped that this letter will serve as a guide for contract administration. Any questions in this regard should be directed to this office, Mr. W. McCleary (Code PGB8-2, A.C. 215-697-3160, autovon 442-3160).

W. J. JEKOT
By direction

Abex

An IC Industries Company

Abex Corporation
Aerospace Division
3151 West 5th Street
Oxnard, Ca. 93030
(805) 486-1666

22 June 1977

Aviation Supply Office
700 Robbins Avenue
Philadelphia, Pennsylvania 19111

Attention: Mr. Oscar Markowitz Code TEE-A

Subject: AP27V Hydraulic Pump FFW/RIW Contract;
Key Abex Personnel

Dear Oscar,

Per your request during our visit to ASO on 16 June 1977 the following is provided:

Fred J. Anderson - Director of Military Sales

Duties and responsibilities include contract negotiations and overall responsibility for the entire program at Abex.

Charles H. Miller, Jr. - Manager F-14 FFW/RIW Program

Duties include overall administration and management of the program. Specifically; maintenance of data accumulation, field visits to AP27V users, providing feed back to interested personnel, monitoring progress of units within repair cycle, insuring timely shipment of replacement units. Directly responsible to Fred Anderson for the overall operation of the program.

Russ Stanton - Reliability and Maintenance Engineer (RAME)

Duties include inspection, evaluation, testing of all FFW units received. He reports all findings to the review team and analyses all pump returns to determine if design change is required. He prepares all engineering changes and technical reports as required by contract and publishes minutes of design review meetings. Makes field visits if a specific problem concerning design of either the pump or the system requires his presence.

Abex

Jack Kirkpatrick - Hydraulic Technician

Duties are to complete teardown of unit, make all repairs and rebuild for testing. Also keeps up with parts usage on each unit.

Several other personnel are of course involved in the handling of the FFW units as a part of their normal duties such as shipping, receiving , quality control, testing, etc. If other information or more details are required please let me know.

Very truly yours,

ABEX CORPORATION
AEROSPACE DIVISION

Charles H. Miller
F14 RIW Program Manager

CHM:gws

COPY

TEE-1:PAA:en
4855
19 Jun 1973

From: Commanding Officer, Aviation Supply Office, Philadelphia
To: Commanding Officer, Maintenance Support Office, Mechanicsburg, PA (Code 313)

Subj: FFW (Failure Free Warranty) type contract, N00383-73-C-3318, with Abex Corporation for the long term warranty of the hydraulic pumps used on the F-14 aircraft

Ref: (a) ASO (P. Ahern TEE-1) visit to MSO (C. Miller, W. Bard, E. Derstler) on 5 June 1973
(b) Fonecon (P. Ahern, ASO and W. Bard, MSO) on 15 June 1973

1. The ASO has entered into a FFW type contract, N00383-73-C-3318, with Abex Corporation for the long term warranty of the hydraulic pumps used on the F-14 aircraft. The contract includes a commitment to supply Abex with U.S. Navy maintenance source data relative to this equipment.

2. It is requested that the MSO supply the data for Work Unit Codes beginning with the digits 45 from the Repairable Item Data Bank (Card types 16, 17, 26, 27, 31, 34 and 35) for the F-14 aircraft in ADP tape format on a monthly basis. It is also requested that Aircraft Statistical Data (73 and 76 cards) be supplied on a separate tape also on a monthly basis. Arrangements to rotate the tapes for reuse can be made directly with Abex.

3. As discussed during the 5 June 1973 visit between Mr. Ahern of this activity and your activity, the tapes generated would be directly analogous to those received for the AJB3 gyro FFW contract, N00383-67-C-3101, with the exceptions being Type Equipment (F-14) and System Work Unit Code (45). The first tapes delivered would be from the initial F-14 records received at MSO up to some convenient cutoff date (e.g. July 31). Subsequently, the data on the tapes would represent those records received at MSO in calendar months. Another exception is the requirement for 800 character density on 9 track tape as discussed during a telcon on 15 June between Mr. Bard of your activity and Mr. Ahern of ASO.

4. It is requested that the tapes be shipped directly to the Abex Corporation, Aerospace Division, Oxnard, CA, and a copy of the forwarding document be sent to the ASO (Code TEE-1). A specific contact point at the Abex Corporation will be established at a later date.

5. Your cooperation is greatly appreciated.

O. MARKOWITZ
By direction

Copy to:
CNM (Code 04142)
Blind copy to:
TE-A SD-A SDB21-5 SCI-A PGB-A

Aerospace Division
OXNARD, CALIFORNIA

16 September 1974

858998

AP27 FFW - DESIGN REVIEW MEETING

AGENDA: Review of pump rejections and design related areas of concern.

DESIGN REVIEW TEAM MEMBERS ATTENDING:

W. Benson
R. Burrow
R. DeBaun
M. Leisten
J. Mileti
D. Moreland
G. Sorenson

This review covers the evaluation of units received through 26 August 1974.

The pump parts evaluated and the recommendations and action to be taken are as follows:

1. Piston Shoe Wear - It was recommended that design and testing of a piston shoe having loose shoe pads and made of a more wear resistant steel be accomplished.

   ACTION TO BE TAKEN: G. Sorenson will proceed with the shoe design and coordinate the necessary test requirements with W. Benson.

2. External Drive Shaft Shearing - It was determined that the shear section of the shaft was correct and to increase it might cause more serious pump failures. The shaft failures seem to relate to incorrect fastening of the hydraulic lines. More data will be gathered and presented at the next meeting.

3. External Drive Shaft Engine Spline Engagement - The engagement of the external drive shaft into the engine drive spline was reviewed and a decision was made to increase the length of the spline.

   ACTION TO BE TAKEN: G. Sorenson will initiate an engineering change order to improve spline engagement.

4. Mounting Flange Leaks - Leaks in the area of the trunnion bearing pocket were discussed and it was recommended that a review of the drawings be made and a report on the mounting flanges recently returned for leaks be prepared.

   ACTION TO BE TAKEN: G. Sorenson will review the dimensioning on the mounting flange casting and machining drawings. W. Benson will prepare a report on the leaking mounting flanges.

5. Port Cap to Front Housing Interface Leak - The leaks at the stroking piston supply passage were reviewed and it was recommended that the port cap drawing be checked for a possible improvement in the drilling of the oil passages to the stroking piston. Data will be collected to determine the effect of the rework to the retainer ring presently being used at the o-ring seal.

   ACTION TO BE TAKEN: W. Benson will collect data on returned units. G. Sorenson will review port cap drawings.

6. Piston & Shoe End Play - It was decided to replace the shoes on piston and shoe subassemblies having .005 or greater end play. Piston and shoe subassemblies having less than .005 end play should be rerolled to meet drawing requirements for end play.

7. Cylinder Barrel Piston Bore Wear - A recommendation to collect actual bore wear figures, until the next design review meeting, was made.

   ACTION TO BE TAKEN: W. Benson will collect data.

8. Cylinder Barrel Bearing - It was recommended that surfaces contacting the cylinder barrel O.D. be checked for possible improvement of the surface finish callouts.

   ACTION TO BE TAKEN: Surface finish callouts will be checked by G. Sorenson.

9. Silver Plating - It was decided to continue silver plating after lapping where previously required.

10. An engineering change order to incorporate Micro-Seal of the port threads in the port cap will be written by W. Benson.

Abex

An IC Industries Company

Memorandum

Date:
6/9/77
Subject:
Minutes for FFW Design Review Meeting
From:
R. Stanton
To:

Members Attending

J. Mileti
R. Burrow
F. Parrone
C. Miller
F. Anderson

This review covers the evaluation of units for the period November 1, 1976 to April 30, 1977.

The life cycle and wear analysis test on a sample AP27V-5 FFW pump was initiated and 495 hours of testing were accumulated prior to shutdown due to high case leakage. Evaluation of parts at teardown revealed a wiped cylinder barrel face and an excessive amount of cavitation erosion on cyclinder barrel, shoes and wear plate. Evaluation of the test stand is now being made to determine the cause of the caviation. Continuation of testing is scheduled for the week of June 20th.

There were 34 removals during this reporting period, 20 of which were confirmed. From the quantity confirmed, 15 were pump design related. The two major causes confirmed were leaking due to porous mounting flange casting and leaking around the control passage O-ring between the port cap and front housing. Both causes have been corrected in the past and all units returned for service have the corrections incorporated.

Oscar Markowitz prepared a mid-contract report and submitted it to Abex for review. In the section about pump removal causes, he cited shaft seal leaking as the cause for 53 removals since the beginning of the contract. After reviewing all of the evaluations, I found only 20 removals due to shaft seal leaks. From this number, 13 were confirmed. I will prepare a detailed review of all units returned for leaking and pass it on to Fred Anderson.

Two units were returned with broken compensator spools. Metallurgical analysis revealed that the break was a result of stress risers developed from grind burn. After reviewing the design, it was decided that the spool land should be lengthened to provide more support from the sleeve. I will write the change order to accomplish this.

The spring guide in the compensator is fretting where the end of the spring rests. The present material is 303 stainless in the annealed condition. It was decided that the material should be changed to 17-4 PH, heat treated to Rockwell C34-38. I will write the change order to accomplish this

Russ.

R. Stanton
RAME

AEROSPACE DIVISION

Oxnard, California

September 9, 1974

MEMO TO: Bill Benson

FROM: Dick Moreland

SUBJECT: External Drive Shaft engagement AP27V-5-03
P/N 65070-03 F-14

REFERENCE: Our recent discussion

ENCLOSURE: Annotated copy of Installation Drawing

The enclosed drawing and layout of the accessory pad drive of the TF30 P420A engine confirms out suspicion that the external drive shaft is only engaging about 0.750".

It is requested that engineering verify the GAC Specification for the pump and accessory drive pad specification since only one pad was checked at NAS Miramar's engine shop. If an error in dimension is evident, a change order for the shaft and pump should be prepared and submitted to GAC. If possible, we should also investigate increasing the shear section of the shaft.

SHEARED SHAFT PROBLEMS

During last visit to NAS Miramar, also checked on recent removals for sheared shaft. In April on A/C 158634, there were two (2) pumps removed for sheared shaft consecutively. The mechanic that was on the line said that both of these failures were due to the QD releasing and popping the hose completely off the pump during start up. The P/N of the QD on the pressure side is A51H9182-1, UR's have been submitted on the QD's. The suction QD P/N is A51H9181-1.

September 9, 1974

In discussing the QD problem with GAC at Miramar, it was stated that it is a policy to break the QD at the pump on the Combined Side and plug in a ground cart to power the system. On the Flight Side, there is a fitting installed in the system to accommodate the ground cart. GAC has proposed to the Navy to re-incorporate this change to the Combined System side, as it was installed in the original design and later on removed.

The practice to supply power to the Flight System Fitting and using the transfer package to power the Combined system is not used, as they claim it takes too long and the flow requirement is not sufficient to perform a good component checkout.

Dick

DICK W. MORELAND

DWM:jt

enc.

cc: M. Leisten
G. Sorenson
F. Girolamo
R. DeBaun

Abex Corporation
Aerospace Division
3151 W 5TH ST. OXNARD CAL 93030

RMO # _____

FAILURE DATA F-14

CONTRACT N00383-73-C-3318

HYDRAULIC PUMP MODEL AP27V-5-_____

LCC/FFW

NOTE: THIS FORM SHALL BE COMPLETED AND RETURNED TO ABEX CORPORATION

INSTRUCTIONS: 1) Use protective caps from replacement pump and install in all openings of the removed pump.

2) Complete this form and attach to Hard Card M.A.F. (OPNAV Form 4790/41. Place this form and the removed pump in the same container in which the replacement was received. Return to Abex Corporation.

Ship/Station _____ Removed Pump S/N _____

Squadron _____ Total Pump Hours _____

Aircraft BU No. _____ Installed Pump S/N _____

Engine No. _____ Date Installed _____

Aircraft Hours _____ Job Control No. from M.A.F. _____

WHEN DISCOVERED CODE: (see back) _____ System: ( ) Flight ( ) Combined

REASON FOR REMOVAL CODE: (check one)

( )	523 High Pressure	( ) 068	Inoperative
( )	524 Low Pressure	( ) 258	Overheats/Heat Warning Light
( )	525 No Pressure	( ) 668	Run Dry
( )	037 Fluctuates, Unstable or Erratic	( ) 381	Leaking, Internal or External
( )	433 Performance Unusual	( ) 799	No Defect (Precaution/Directed Removal

( ) 790 Other - Explain _____

CONDITION OF HYDRAULIC SYSTEM (check as applicable)

System fluid loss	( ) yes	( ) no	
Other system component failed	( ) yes	( ) no	Location _____
Other system component leaking	( ) yes	( ) no	Location _____
Fitting/line broken	( ) yes	( ) no	Location _____
System fluid contaminated	( ) yes	( ) no	
System fluid sample taken	( ) yes	( ) no	
Fluid sample enclosed	( ) yes	( ) no	

CONDITION OF FILTERS (check as applicable)

	Case Drain	Return Line	Pressure
Clean	( )	( )	( )
Contaminated	( )	( )	( )
Metal Particles	( )	( )	( )
Other Foreign Material	( )	( )	( )
Collapsed	( )	( )	( )

Was hydraulic system purged and new filter elements installed before installing the replacement pump? ( ) yes ( ) no

NAVAIR _____ _____ _____

Signature Rank/Rate

Date: _____

FAILURE DATA F-14

CONTRACT N00383-73-C-3318

HYDRAULIC PUMP MODEL AP27V-5-

NAVAIR 01-85AD-8
WHEN DISCOVERED CODES

CODE **DESCRIPTION**

A. **BEFORE FLIGHT - ABORT - AIR CREW.** This code is used when a need for maintenance is discovered by an air crew before flight and it is necessary to abort the mission.

B. BEFORE FLIGHT - NO ABORT - AIR CREW. This code is used when a need for maintenance is discovered by an air crew before flight and it is not necessary to abort the mission.

C. IN-FLIGHT - ABORT. This code is used when a need for maintenance is discovered in flight and it becomes necessary to abort the mission.

D. IN-FLIGHT - NO ABORT. This code is used when a need for maintenance is discovered in flight and it is not necessary to abort the mission.

E. AFTER FLIGHT/BETWEEN FLIGHTS - AIR CREW. This code is used when a need for maintenance is discovered after completion of a flight or between two flights. Examples are:

1. A pilot, alighting from an aircraft after completing a photo mission, notices that an access panel is missing from the tail section. Code E would be used.
2. During a passenger stop, a pilot notices a sudden drop in fuel pressure. Code E would be used.

F. PILOT'S WEEKLY INSPECTION. This code is used when a need for maintenance is discovered during a pilot's weekly aircraft inspection.

G. ACCEPTANCE/TRANSFER INSPECTION. This code is used when a need for maintenance is discovered during an acceptance/transfer inspection, regardless of the depth of the inspection.

H. BETWEEN FLIGHTS - GROUND CREW. This code is used when a need for maintenance is discovered between flights by personnel other than the air crew. Example: A taxi director notices an oil leak from an engine while directing a pilot into the chocks. Code H would be used.

J. DAILY, DAILY/POSTFLIGHT OR DAILY/SPECIAL INSPECTION. This code is used when a need for maintenance is discovered during a daily, daily/postflight or daily/special inspection.

K. PREFLIGHT OR TURNAROUND INSPECTION. This code is used when a need for maintenance is discovered during a preflight or turnaround inspection.

M. CALENDAR ODD INSPECTION. This code is used when a need for maintenance is discovered during a calendar inspection - odd for aircraft and during a major inspection on engines.

N. CALENDAR EVEN INSPECTION. This code is used when a need for maintenance is discovered during a calendar inspection - even.

P. FUNCTIONAL TEST FLIGHT. This code is used for all needs for maintenance discovered during a flight which was conducted for the purpose of testing installed aircraft and engine accessories and/or equipment.

Q. CONDITIONAL INSPECTION. This code is used when a need for maintenance is discovered during an inspection which does not have a prescribed interval and depends upon occurrence of certain circumstances or conditions, i.e., oil analysis, X-Ray, Magnaflux, etc.

R. QUALITY ASSURANCE INSPECTION. This code is used when a need for maintenance is discovered during an inspection conducted by personnel designated as quality assurance inspectors or collateral duty inspectors.

U. MODIFICATION/PAR/OVERHAUL/AIRLINE MAINTENANCE. This code is used when a need for maintenance is discovered during depot level maintenance.

W. IN-SHOP REPAIR AND/OR DISASSEMBLY FOR MAINTENANCE. This code is used when a need for maintenance is discovered during in-shop repair and/or disassembly for maintenance.

X. TEST BENCH/ENGINE TEST STAND OPERATION. This code is used when a need for maintenance is discovered on aeronautical components installed in test benches, ready rooms, line shacks, etc., or when a need for maintenance is discovered during engine test stand operation.

Y. UPON RECEIPT OR WITHDRAWAL FROM SUPPLY. This code is used when a need for maintenance is discovered on parts/components/assemblies, etc., after their receipt or withdrawal from supply.

The use of When Discovered Codes is for the most part self-explanatory. In case of doubt, however, use the code which most logically identifies when the need for maintenance was discovered, i.e., P would take precedence over C, and K would take precedence over M.

In instances where the maintenance action was never discovered as a requirement on the end item involved, i.e., cannibalization actions, removals due to TDC's, high time items, removals and replacements to facilitate other maintenance, etc., enter 0 in the When Discovered block.

ABEX
Corporation

C O P Y

AEROSPACE DIVISION
OXNARD, CA

27 February 1976

MEMO TO: Fred J. Anderson

FROM: Dick W. Moreland

SUBJECT: Trip Report NAS, Oceana, VA 2-17, 2-18-76
FFW-LCC Presentation and Review:

ENCLOSURE: Information and Organization Breakdown
with lists of contracts.

This visit was very timely due to the establishment of three (3) more squadrons of F-14 Airplanes. Numerous personnel changes had been made since our last visit and only a few of the original squadrons maintenance personnel were still aboard.

The NAVAIR Rep. and Chief Stephens from Fighter Wing One were very helpful and cooperative in arranging for personnel from all squadrons to attend the meeting. The majority were familiar with the contract concept and favorable comments as to how "good support" had been realized.

Adequate supply of our "removal forms" were distributed and we should start receiving more information from the squadrons. Also we will start receiving the original copy of the MAF card.

There is still some confusion on the procedure for generating an E.I. or U.R. Per NAVAIR Instruction it is still required but some Q.A.'s are using removal cause's, common sense and do not implement an E.I. or U.R., others still go by the book. It was explained to and thoroughly understood by all attendees that each pump returned was subject to an Engineering Evaluation. It was also explained that copies of these evaluations are available upon request, perhaps this may cut down on future E.I. or U.R. requests.

There are about four (4) airplanes that are approaching the 600 hour time, BU no's will be checked to see if the original pumps have remained on the plane, but with all the engine modifications it is doubtful.

A few symetric quick-disconnect problems still occur especially on the combined system pump. Pre lubing the Q-D's was discussed at length to prevent seizure in the port cap. The T.O. has not been updated to call this out, but a copy of the GAC procedure for cleaning and lubing the threads was provided.

27 February 1976

Base supply had three (3) pumps as rotable stock, but were requesting eight additional pumps from ASO, since they are anticipating additional aircraft and increased flight hours.

On the next visit to Headquarters NAVAIR Systems Command we should concentrate our efforts to request them assign an official NAVAIR Form Number to the Abex Form. Also they should implement an appropriate Notice or Instruction covering preparation and distribution. Of course this would only be applicable to squadrons or stations that have the F-14A.

Dick W. Moreland

DWM:gws
Enc:
cc: NAVAIRSYSCOMREPLANT
O. Markowitz, ASO-TEE
Fit Wing One - AMSC R. P. Stephens
F. X. Parrone
R. Stanton
W. Benson
V. Driskill

Abex

An IC Industries Company

Memorandum

Date: 21 June 1977

Subject: Trip Report NAS Oceana and NAVAIR Rework Facility Norfolk, Virginia 9 thru 11 June 1977

From: Charlie Miller

To: Fred Anderson

After initial contact with Mac Carpenter (NASCREPLANT), he and I called on the following units and personnel.

NAS Oceana Supply Shipping Area - Spoke with Mr. T. D. Clancy, civilian incharge of shipping units to our plant. Problem areas discussed were his lack of reuseable containers for returning units. He was under the impression he wasn't authorized to ship a unit without the ATA container. He had been holding units awaiting proper containers. This area was ironed out. Additional contact was made later with AKCM Potter USN, same subject. He was very helpful and courteous.

FITWINGONE Maintenance Office -Met with AMSC Stephens and Assistant Maintenance Officer, LCDR Paust.

VF143 - LT Neel discussed Q.D. project on BUNO 159438. Aircraft was in SDLM at NARF NORVA. Attempted to get more information on Q.D's. He thought the experimental Q.D's were still installed but I wasn't able to verify that at NARF.

VF-142 - Spoke with QA Assistant from squadron which was deployed aboard USS America. I gave him our Failure Data form and asked him to pass the information along, but I don't believe the visit was very effective.

VF41- AMHC Smith Airframes CPO and CPO Reagan, Maintenance Material Branch.

CPO Smith said he had been throwing away our Failure Data Forms. I convinced him we needed the information and he will fill them out in the future. This is a new squadron. They filled out a UR on pump S/N 133325A and sent it to supply. The pump was later sent to NAVPRO Bethpage. Mary Fitzpatrick from ASO is trying to run down the unit for us.

VF101- Replacement Training Squadron

This unit is rather stable and most of their personnel are aware of our procedures. No problems noted.

Abex

VF84 - (New Squadron)- CPO Rose was formerly attached to VF101 and is entirely familiar with the correct procedures.

All personnel with whom I spoke had a positive attitude and were appreciative of the fact that we cared about their problems. I gave a copy of the AP27V enclosure from FASOINST 4440.86C to each unit and a complete copy to Mac Carpenter.

On Friday 10 June, I visited the NAVAIR Rework Facilty at Norfolk, Virginia. After considerable searching I was able to find the personnel most closely associated with the FFW program. Mr. Rodney Spencer, Production Control Supervisor for F-14 engine accessories and I discussed removals, ATA container utilization, Q.D. fittings, etc. The Handbook of Maintenance Instructions (HMI) states that the external drive spline should be greased prior to installation on the engine. This is a Grumman procedure and not recommended by Abex. I don't know the answer to this one. I can't verify that the grease has actually created any reliability problems for us. I stressed the importance of maintaining accountability of the ATA containers and was assured of Mr Spencer's cooperation.

The problem which arose late Friday afternoon concerning the shipment of the three pumps from USS America (S/N's 133133, 133241 and 133329) improperly packed was investigated by phone and I was not able to run it down. Everyone with which I spoke denied ever packing anything in sawdust. This method is not used by Naval Supply Center, Norfolk nor at NARF.

I believe the trip was very productive.

Charlie Miller

CM:gws

cc: O. Markowitz Code TEE-A
FITWINGONE AMSC R.P. Stephens
R. Stanton
F. Parrone

Abex Corporation

Aerospace Division

3151 W. 5TH ST., OXNARD, CAL. 93030
TEL: 805—486 1666
CABLE: AERO OXNARD, CAL.

15 November 1976

U.S. Naval Air Station
Miramar
San Diego, California 92145

Attention: CDR West, Maintenance Officer VF-124

Subject: Abex Hydraulic Pump - Engine Driven F-14A Aircraft

Reference: (a) Failure Free Warranty Contract N00383-73-C-3318

Gentlemen:

During recent visits to your facility for purposes of monitoring and offering technical assistance in regards to the referenced contract your personnel have been extremely courteous and helpful.

Early in the program VF-124 sent a few people to our facility in Oxnard for a one day familiarization visit which was very beneficial to the Navy and Abex.

Again we would like to invite a few of your personnel to visit our facility, on my last visit I mentioned this to Chief Walker - QA, ADJ1 Fredrickson and AMH1 Dairymple who were very much interested. Of course there is no charge for this visit, but please give us a weeks notice and advise names of personnel who will attend.

Very truly yours,

ABEX CORPORATION
AEROSPACE DIVISION

Dick W. Moreland
Manager Sales Operations

DWM:gws
cc: Oscar Markowitz

Enclosure IX-64

An IO Industries Company

Abex Corporation
Aerospace Division
3151 West 5th Street
Oxnard, Ca 93030
(805) 486-1666

23 August 1977

Headquarters
Naval Air Systems Command
Washington, D.C. 20361

Attention: AIR 4101, Mr. Bill Anthony

Subject: F-14 Main Engine Hydraulic Pump Quick Disconnect

Gentlemen:

The Abex Corporation manufactures the main engine hydraulic pump for the Grumman F-14. It is our sincere desire to increase the reliability of these pumps. To help accomplish this goal we entered into a Failure Free Warranty contract (N00383-73-C-3318) with the U.S. Navy in March of 1973.

During the last four years the MTBUR for this pump has increased from a first year figure of 663 hours to 1701 hours as of March 1977. This improvement has been due to several engineering changes made by the contractor and the co-operation of the Navy personnel involved in the maintenance of these aircraft.

This letter requests your assistance with a problem which is beyond the capabilities of this contractor to resolve and which at the present time is causing the majority of the F-14 pump removals. (12 out of last 31 removals) The pressure line quick disconnect to the pump has no positive lock indicator and can appear to be installed correctly when it is actually not. When the engine is started the connector blows apart, disrupts the flow of fluid to the pump causing internal damage, a sheared shaft and a pump change.

Abex has coordinated a change to the connectors with the manufacturer and there have been test units flying on both the east and west coasts for a year. Nothing further has been heard concerning a change to the positive locking quick disconnects.

We request your help in getting an ECP approved to change all present connectors to the new configuration which we believe will improve a poor maintenance situation.

Very truly yours,

ABEX CORPORATION
AEROSPACE DIVISION

C.H. Miller, Jr.

CHM:gws
cc: Oscar Markowitz

Enclosure X-65

Abex Corporation

Aerospace Division

3151 W. 5TH ST., OXNARD, CAL. 93030
TEL: 805—486-1666
CABLE: AERO OXNARD, CAL.

16 July 1976

USS America
Fleet Post Office
New York, New York

Attention: Supply Officer

Subject: Contract N00383-73-C-3318 - Failure Free Warranty

Reference: (a) Hydraulic Pump P/N 65070-01, 02 or 03 NSN 4320-00-383-7949PF
(b) Listed Documents

Gentlemen:

Briefly the subject contract requires that we provide a RFI pump on a one for one basis within twenty four (24) hours after receipt. This is a long term contract and to date expires in 1982. No funds are required for individual transactions, as installment payments are billed annually to ASO Philadelphia.

In case of emergency, or if no pumps are available for issue to the squadrons we can effect shipment of a replacement pump providing that you send a message indicating the document number and pump serial number of the unit you are returning to us.

We do however request that when a pump is returned to us that a legible copy of the MAF card, a copy of the Abex form (copies enclosed) which is in the RFI pump container be returned with the failed pump. This data is required to promulgate the reliability reports as required by contract.

Another item of extreme importance is that each failed pump or suspected failed pump should be returned in the re-useable shipping container provided for each RFI unit. Thus far only one (1) unit has been received from the USS America in the proper shipping container. The FSN or NSN of the container is RHS145-111-2536PF or 8145-00-111-2536PF.

Abex

The following listed documents show the number of units we have received from your activity within the past six (6) months.

UNIT RECEIVED			REPLACEMENT UNIT SHIPPED		
Document Number	Pump S/N	Rec'd. Date	Pump S/N	Shipped Date	How
V03336 6161 G122	133075	6/18/76	133176A	6/18/76	Parcel Pos
V03336 6147 G063	133398	6/21/76	133201A	6/21/76	Parcel Pos
V03336 6178 G04[illegible]	133082	7/12/76	133498A	7/13/76	Parcel Pos

We realize that there has been some problems within the Naval Supply System in locating the seven (7) pumps shipped to you as I.O.L. on 22 July 1975 per ASO MSG 231950Z JUL 75. It was not known that these units were lost until we received a message from ASO R281356Z May 1976 requesting a tracer. Tracer was initiated and verified that the pumps were received at Norfolk Naval Shipyard 8/8/75 signed by J. Griggs. We immediately sent a message to ASO on 15 June 1976 with a copy to you and COMNAVAIRLANT.

It is requested that we be advised if you were able to locate or received the seven (7) pumps. If you have not received them by now you should request additional replacement pumps from ASO Code: WL-W2-23. When and if the original seven (7) pumps do show up they could be returned back to the Government Bond Room at Abex.

Should you have any questions concerning this contract or require any additional information please do not hesitate to let us know.

Very truly yours,

ABEX CORPORATION
AEROSPACE DIVISION

Dick W. Moreland
Manager Sales Operations

DWM:gws
cc: ASO O. Markowitz TEE-A
M. Fitzpatrick WLW2-23
CO VF-14
CO VF-32
COMNAVAIRLANT
CO NORNAV Shipyard

C O P Y

03070 259 184313 01460209 259A

RTTEZYUW RUFRSCG9768 2590806-EEEE--RUEOALA RUEOALL.
ZNY EEEEE SEP 21 1976
R 150806Z SEP 76
FM USS AMERICA
TO RUEOALL/COMNAVAIRLANT NORFOLK VA
RUEBAGB/ASO PHILADELPHIA PA
INFO RUEOALA/NAS NORFOLK VA
BT
UNCLAS E F T O //N04400//
F-14 HYDRAULIC ENGINE PUMP 2RH-4320-00-389-7949
A. COMNAVAIRLANT NORFOLK VA 091247Z AUG 76
B. USS AMERICA 261348Z JUL 76
1. IRT PARA 2 REF A, CANCEL REQ FOR SURVEY ACTION. SEVEN EACH PUMPS DISCOVERED UNDER INTERCHANGEABLE S/N 2RH-4320-00-690-2059. AFTER RECEIPT OF INITIAL REPLACEMENTS FOR UNITS REQN REF B, UNUSUAL WHITE PROTECTIVE CASE OF UNITS RECD CAUSED SEARCH TO BE CONDUCTED FOR SIMILAR CASES IN REPARIABLES STOREROOMS. SEVEN EACH CASES DISCOVERED WHICH PROVED TO BE MISSING PUMPS. NO ENTRY OF INTER-CHANGEABLE S/N HAD BEEN MADE IN MSSL AND NO LOCATE WITH SEVEN DUE SHOWED ON MSSL UNDER SUBJ NSN.
2. REQ CANCEL PUSH REQNS TO AMERICA FOR SUBJ PUMP. CURRENTLY FIVE EACH ON HAND. REQUEST FILL AMERICA PULL REQNS FOR STOCK REPLENISHMENT.

PAGE 02 RUFRSGC9768 UNCLAS E F T O
ALL RETROGRADE PUMPS HAVE BEEN RETURNED TO DOP.
BT
#9768

NNNN

AVIATION SUPPLY OFFICE
Philadelphia, PA

NON-RIW ALTERNATIVE
SUPPORT COSTS ANALYSIS
IN LIEU OF
ABEX RIW CONTRACT
N00383-73-C-3318

Prepared by: J. Giordano John Volpe
J. Giordano John Volpe

12 October 1977

DISCUSSION SUMMARY

This analysis was prepared to examine the most probable costs which would have been encountered if the Abex RIW contract had not materialized for the F-14 engine driven pump. The approach was to consider a most likely set of conditions for such a non-RIW alternative which included:

A. Commercial overhaul of the pump by Abex. This condition was considered most likely because the 400 HP drive stand was not fully developed by the Navy and thus not available for Navy depot use.

B. Each area of RIW improvement would not have been attained. This assumption, borne out during the history of many other aircraft engine driven pumps, is most likely because the Abex beginning mean time between returns would have been considered reasonable.

C. Every major failure mode was considered separately in the non-RIW alternative as continuing at the same rate as established by early field returns prior to RIW improvements becoming effective.

D. All remaining failures not included in C. above were grouped together and analyzed similarly but as one group and added to the modes of C. above to provide a total rate of return for the non-RIW alternative.

E. An average cost of all returns to depot was developed based on actual present costs, then de-escalated to the starting year and escalated for future years. The "test good" returns were included as part of the average cost per return.

The analysis developed the number of returns which would be anticipated in a non-RIW mode of support. Costs were developed to maintain and support this non-RIW mode and then compared to the costs identified to the RIW contract. The difference of these two, non-RIW less RIW, are summarized below for the time period April 1973 through 31 March 83:

Non-RIW returns less RIW returns = 829
Cost of overhaul for 829 returns = $938,807
Cost of 829 removals = $16,061
Non-RIW spares required less RIW spares = 370
Cost to procure 370 spares = $953,518
Actual escalation costs to end of 1976 beyond that allowed for RIW = $32,112

All cost differences are in favor of the RIW over the non-RIW alternative by a total of $1,940,498 providing considerable confidence that the Abex RIW contract provided cost effective support for the F-14 engine driven pump.

F. The analysis does not segregate fiscal year (FY) 7T (1 Jul 77-30 Sep 77) returns and cost differences, however, FY 7T projection data (flight hours, returns, cost differences) is inherent in the analysis since continuous calendar year data was used prior to converting to a different base year. Not segregating the 3 month increment data within a 10 year projection did not affect the precision of the analysis.

DETAILED DISCUSSION

A. RIW Engineering Improvements (EI):

1. The following 5 engineering improvements are considered:

a. Sheared Shaft (Graph A)
b. Pump Leaks (other than shaft leak) (Graph B)
c. Test Good (Graph C)
d. Leaking Front Seal (shaft) (Graph D)
e. Combined EI, other than above (Graph E)

(1) Torsion Spring Pocket Wear
(2) Quick Disconnect (QD) Seized in Port Cap
(3) Oscillations/Fluctuations
(4) Hanger Arm/Mounting Flange Interference

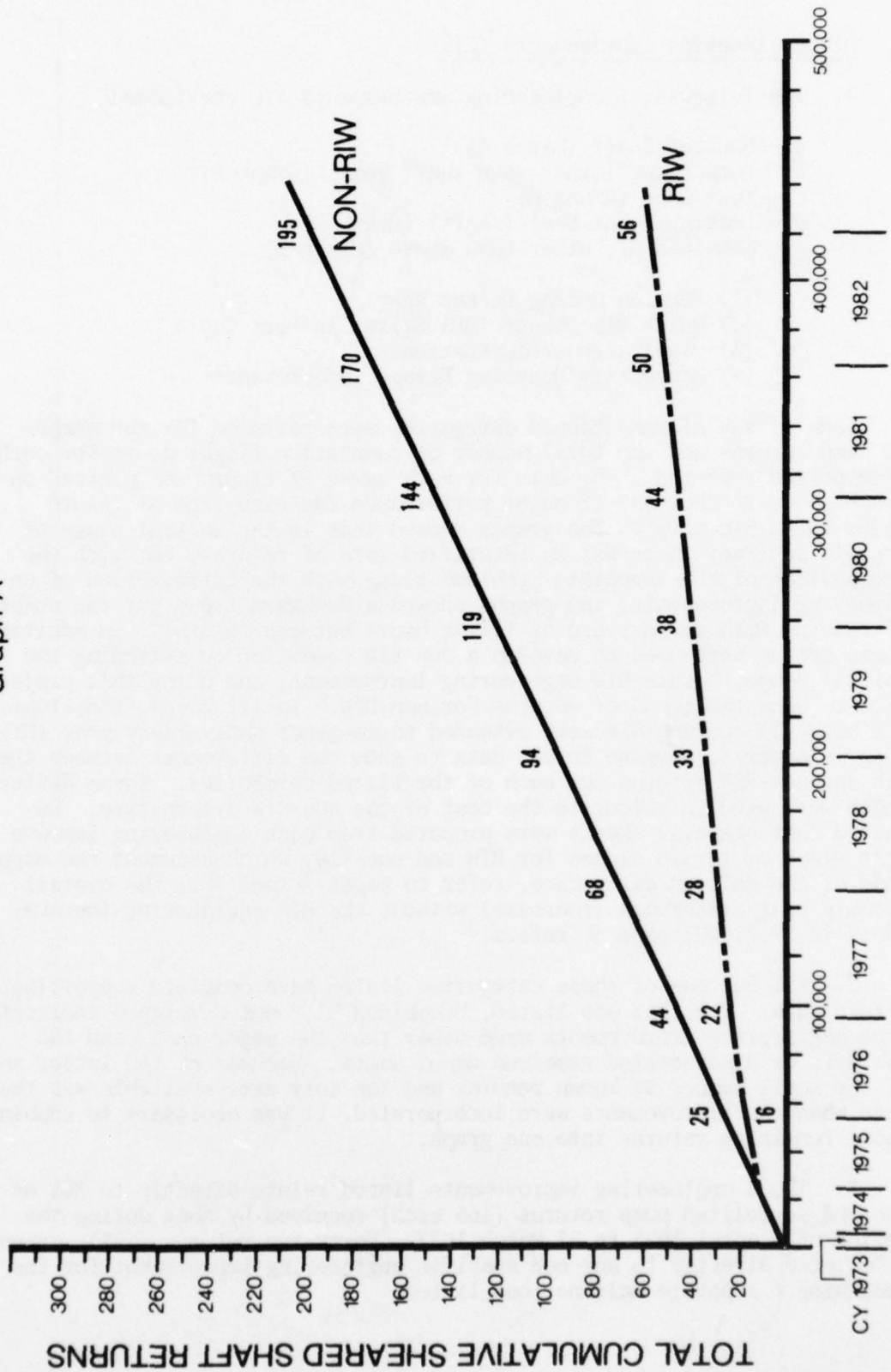
Each of the aforementioned categories were reviewed for the number of pump returns and the total number of cumulative flight hours for each time period reported. The data for each cause of return was plotted on graph paper to show the trend of performance for each type of return under the RIW concept. The graphs showed that in the initial phase of the RIW contract there was an identified rate of returns, but with the recognition of the immediate problems along with the introduction of engineering improvements, the graphs showed a downward trend for the number of returns with an increase of flight hours between returns. In addition, these graphs were used to develop a non-RIW condition by extending the initial slope, before RIW engineering improvement, and using this projection to show the trend of returns for non-RIW. In all cases, the slopes for both RIW and non-RIW were extended to contract anniversary year (CY) 1982 in order to develop future data to show the differences between the RIW and non-RIW returns for each of the listed categories. These differences were used to calculate the cost of the non-RIW alternative. Detailed cost planning sheets were prepared from each engineering improvement graph of return slopes for RIW and non-RIW, which document the magnitude of the dollars difference, refer to pages 8 and 9 . The overall summary cost difference (increase) without the RIW engineering improvements is $939,000, page 9 refers.

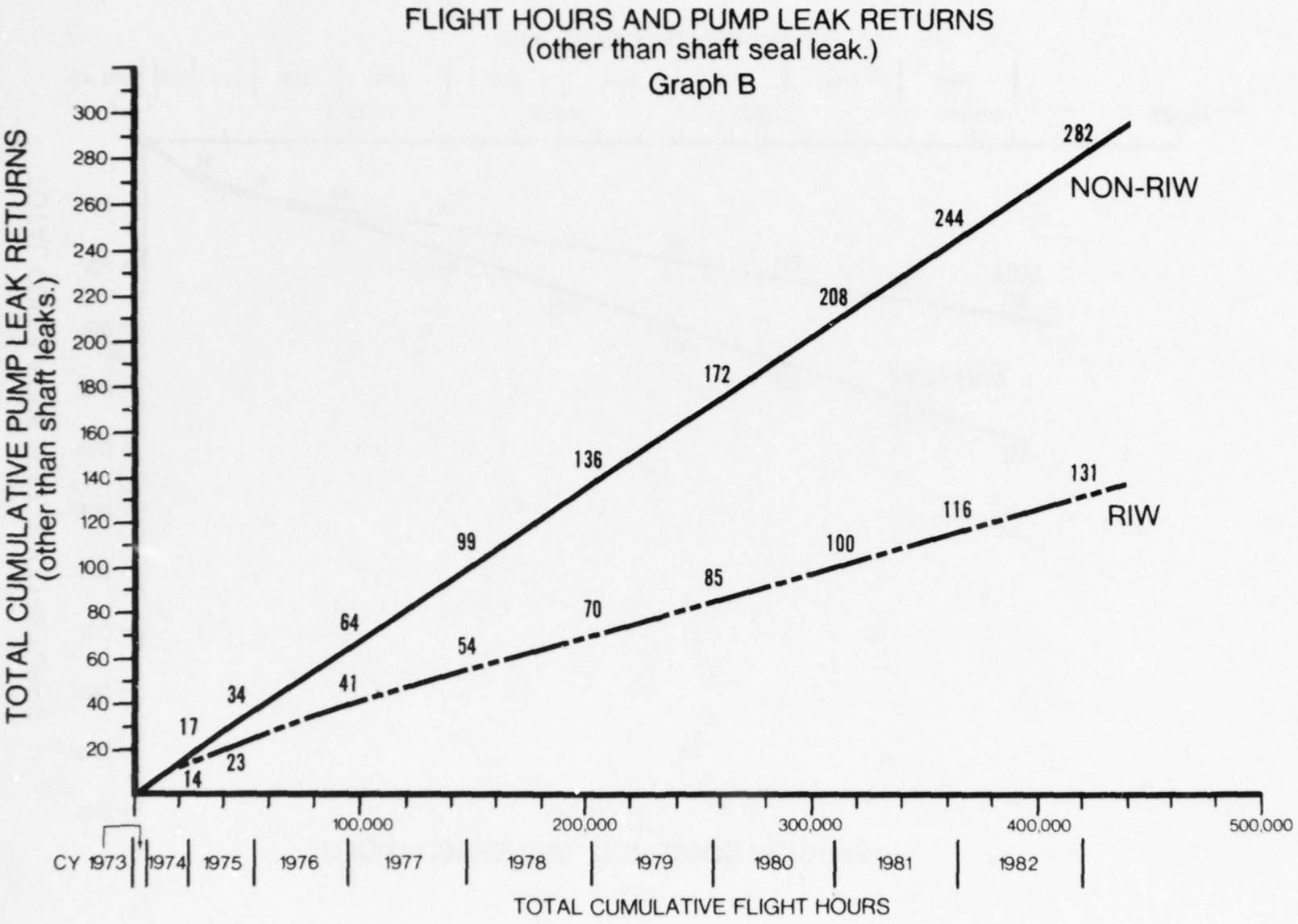
2. All but one of these categories listed have complete supporting return data. The last one listed, "Combined EI," was developed indirectly from engineering improvements made other than the major ones, and the analysis of disassembled repaired depot units. Because of the latter and of the small number of known returns and the only date available was the date when the improvements were incorporated, it was necessary to combine those remaining returns into one graph.

3. The 5 engineering improvements listed relate directly to 80% of the 208 serialized pump returns (166 each) received by Abex during the period of 3 April 1973 to 31 March 1977. Forty-two returns (20%), cannot be related directly to any one specific engineering improvement for the remaining 6 separate malfunctions listed.

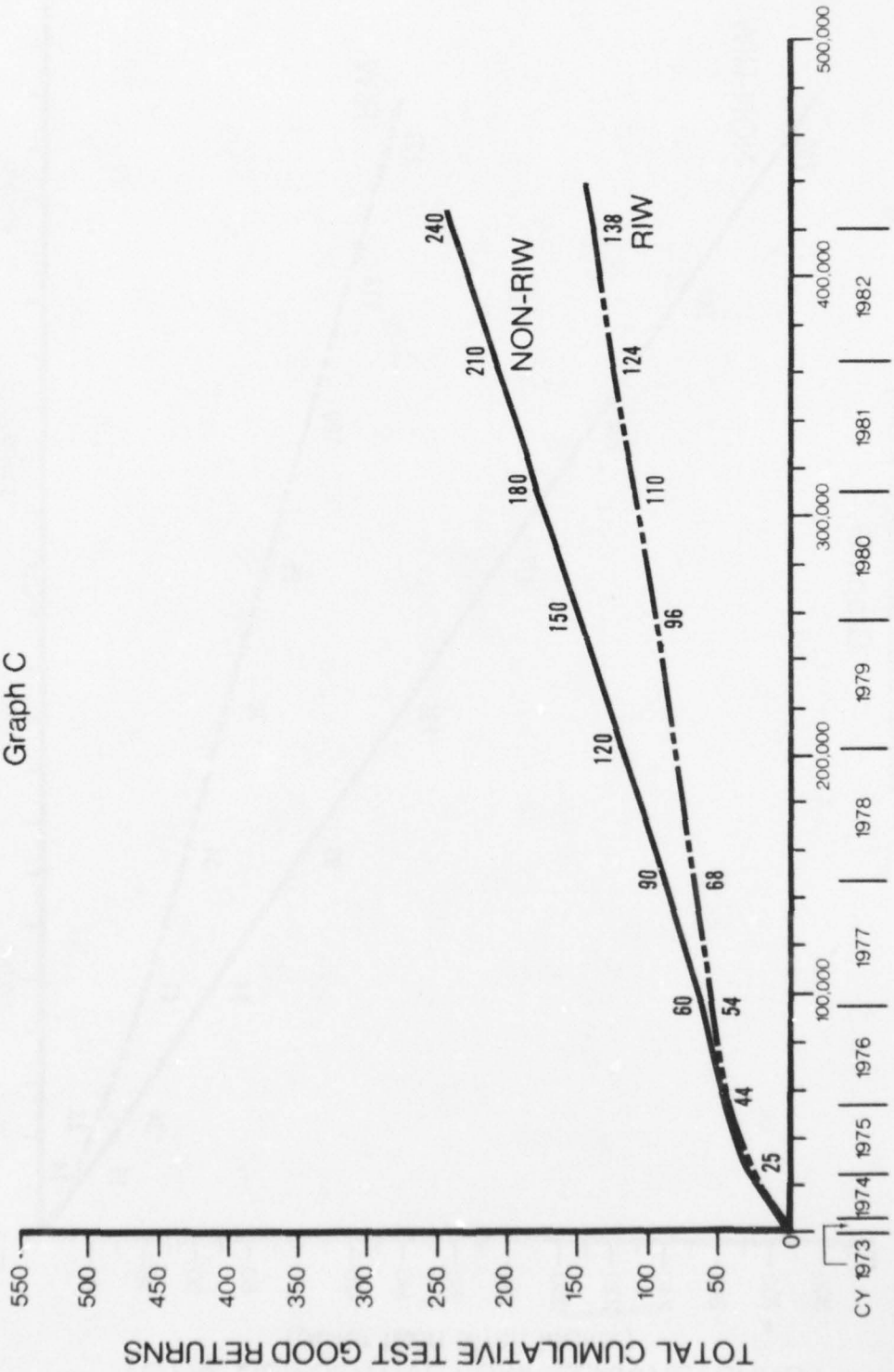
FLIGHT HOURS AND SHEARED SHAFT RETURNS

Graph A

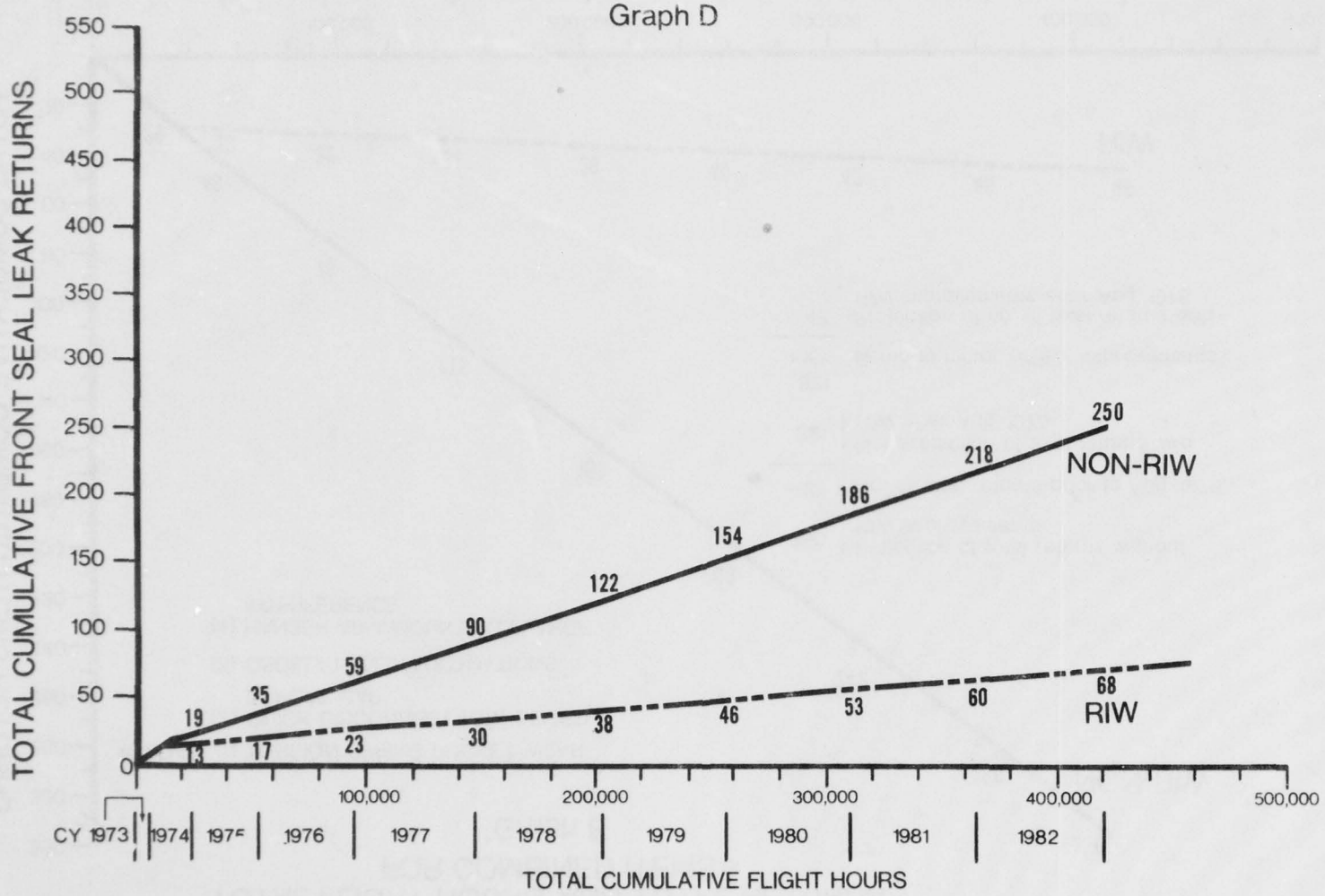



FLIGHT HOURS AND PUMP LEAK RETURNS
(other than shaft seal leak.)
Graph B
TOTAL CUMULATIVE PUMP LEAK RETURNS
(other than shaft leaks.)
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
282
NON-RIW
244
208
172
136
99
64
34
17
131
RIW
116
100
85
70
54
41
23
14
100,000
200,000
300,000
400,000
500,000
CY 1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
TOTAL CUMULATIVE FLIGHT HOURS

FLIGHT HOURS AND TEST GOOD RETURNS
Graph C

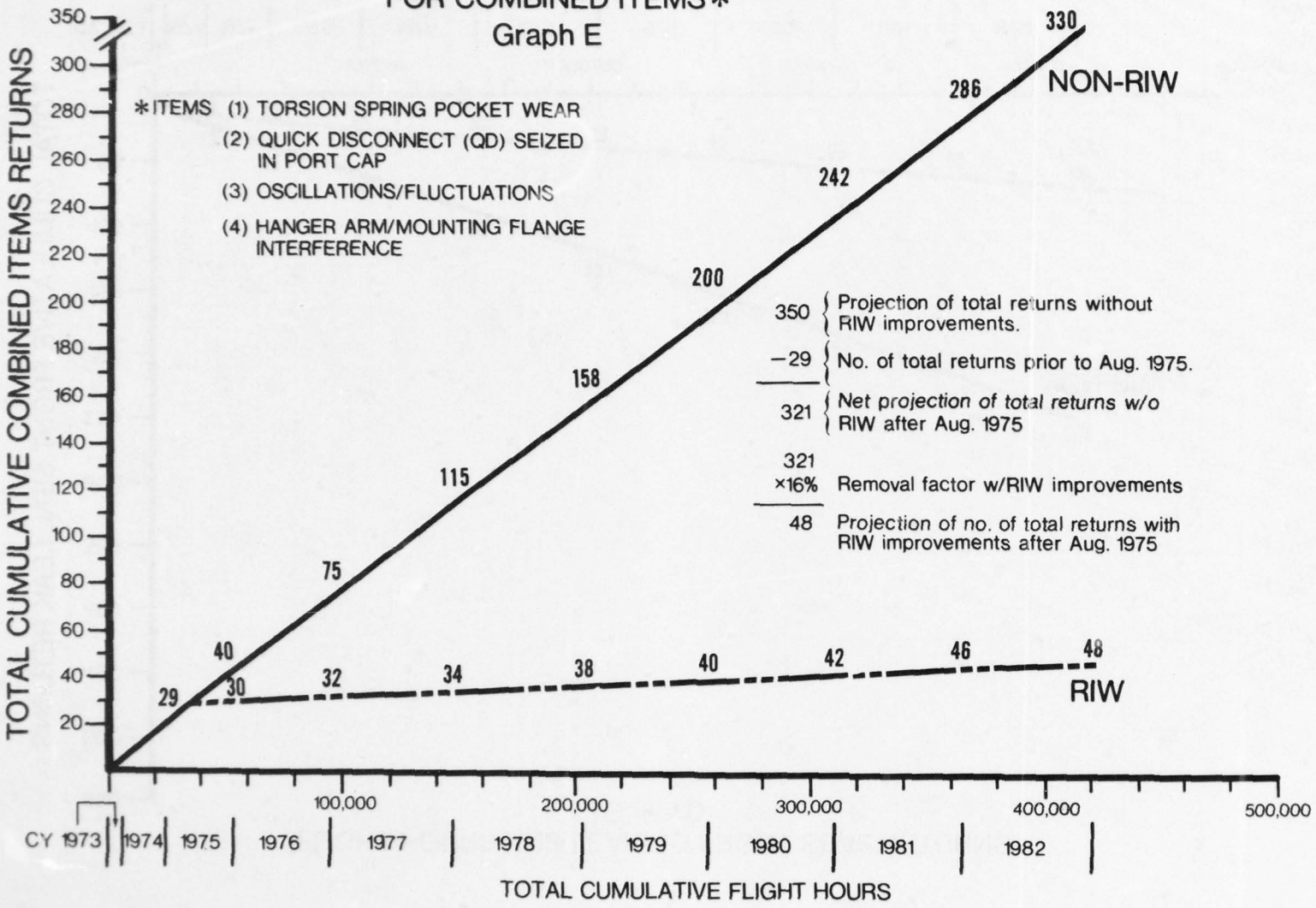


FLIGHT HOURS AND LEAKING FRONT SEAL RETURNS
Graph D



TOTAL FLIGHT HOURS AND TOTAL RETURNS FOR COMBINED ITEMS*

Graph E



RIW ENGINEERING IMPROVEMENTS VS. NON-RIW ALTERNATIVE - RETURNS

PLANNING WORK SHEET
4ND-GEN-5200/1 (REV. 9-66)
S/N 0195-LF-202-1101

	CONTRACT ANNIVERSARY YEAR (CY)	SHEARED SHAFTS	PUMP LEAKS	TEST GOODS	FRONT SEAL LEAKS	COMBINED ITEMS	20% RESIDUAL (RANDOM)	UNIT REPAIR COST NON-RIW ALTERNATIVE	TOTAL RETURNS DIFFERENCE
		*1	*2	*3	*4	*5	*6	*7	
		← RETURNS DIFFERENCE →							
1 APR 73-31 MAR 74	CY 73	0	0	0	0	0	0	$714	0
1 APR 74-31 MAR 75	CY 74	0	0	0	0	0	0	764	0
1 APR 75-31 MAR 76	CY 75	6	8	6	2	0	0	817	22
1 APR 76-31 MAR 77	CY 76	12	8	12	17	30	0	899	79
1 APR 77-31 MAR 78	CY 77	16	21	26	21	36	0	979	120
1 APR 78-31 MAR 79	CY 78	18	18	29	22	37	0	1048	124
1 APR 79-31 MAR 80	CY 79	18	19	23	21	35	0	1121	116
1 APR 80-31 MAR 81	CY 80	18	18	29	22	40	0	1200	127
1 APR 81-31 MAR 82	CY 81	19	17	26	23	36	0	1284	121
1 APR 82-31 MAR 83	CY 82	19	20	19	23	39	0	$1374	120
TOTAL - RETURNS DIFFERENCE	-	126	129	170	151	253	0	-	829
		→ RIW ENGR. IMPROVEMENT CATEGORIES ←							

*1: REFER TO GRAPH A
*2: REFER TO GRAPH B. THIS CATEGORY CONTAINS RETURNS OTHER THAN SHAFT SEAL LEAKS
*3: REFER TO GRAPH C
*4: REFER TO GRAPH D
*5: REFER TO GRAPH E
*6: REFER TO GRAPHS F & G
*7: REFER TO PAGE 17

Enclosure XIII-77

☆ U.S. GOVERNMENT PRINTING OFFICE: 1976—603-813/5220 2-1

RIW ENGINEERING IMPROVEMENTS VS. NON-RIW ALTERNATIVE - COST DIFFERENCE

PLANNING WORK SHEET
4ND-GEN-5200/1 (REV. 9-66)
S/N 0195-LF-202-1101

	CONTRACT ANNIVERSARY YEAR (CY)	SHEARED SHAFTS	PUMP LEAKS	TEST GOODS LEAKING FRONT SEALS	COMBINED RETURNS	20% RESIDUAL	TOTAL
		RIW/NON-RIW RETURNS COST DIFFERENCE*					
1 APR 73-31 MAR 74	CY 73	0	0	0	0	0	0
1 APR 74-31 MAR 75	CY 74	0	0	0	0	0	0
1 APR 75-31 MAR 76	CY 75	$4902	$6512	$4902	$1634	0	0	$17,950
1 APR 76-31 MAR 77	CY 76	10,788	7136	10,788	15,283	26,970	0	70,965
1 APR 77-31 MAR 78	CY 77	15,664	20,559	25,454	20,559	35,244	0	117,480
1 APR 78-31 MAR 79	CY 78	18,864	18,864	30,392	22,836	38,776	0	129,732
1 APR 79-31 MAR 80	CY 79	20,178	21,299	25,783	23,541	39,235	0	130,036
1 APR 80-31 MAR 81	CY 80	21,600	21,600	34,800	26,400	48,000	0	152,400
1 APR 81-31 MAR 82	CY 81	24,396	21,828	33,384	29,532	46,224	0	155,364
1 APR 82-31 MAR 83	CY 82	26,106	27,480	26,106	31,602	53,586	0	164,880
TOTAL		$142,498	145,278	191,609	171,387	288,035	0	$938,807

SEE PAGE 8 FOR RETURNS DIFFERENCE QUANTITY AND NON-RIW UNIT REPAIR COST

*Non-RIW minus RIW returns difference quantity (for RIW improvement category) times the unit repair cost for the non-RIW alternative equals the RIW/Non-RIW returns cost difference.

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These 20% residual returns (42 identified and listed on page 11) were plotted cumulative returns versus cumulative flight hours (FH), Graph F (page 12) refers. The straight line correlation coefficient (CC) of Graph F was determined as 0.98 . Texas Instrument Trend Line Analysis program #BA1-10 as listed in their 1975 Program Manual BA1 Basic Library was used to calculate the CC. Hence, a 98% confidence exists for the linear relationship of cumulative FH and cumulative returns. This linear relationship (slope of Graph F) implies a constant failure rate which is a charactersitic of random type failures on an exponential probability distribution. Hence, these 42 random returns were not influenced by the contractor's RIW efforts and would, in fact, remain intact in a non-RIW alternative. This group when projected at the same slope of Graph F, would remain the same both for RIW and the non-RIW alternative, Graph G page 13 refers. Therefore, no cost differences between RIW and non-RIW exists for this residual random category of returns.

B. Non-RIW Alternative Cost to Repair Pump Returns (Commercial Overhaul):

1. The next phase to be considered for cost differences is the non-RIW alternative cost to repair pump returns. The first thing considered was the availability of Hydraulic Test Stands to test the Abex Model AP27V-5 hydraulic pump. Investigation has shown that a test stand Model HCT-12 (ACL-Filco) was delivered on Contract N00156-71-C-1053 to Miramar. The latter contract was amended to construct and deliver 2 each Model HCT-12A. One each Model HCT-12A was delivered March 1977 to Oceana. It is understood that neither of the 2 delivered test stands are considered satisfactory for testing the Abex pump. Presently, there is a development contract with Dayton T. Brown, Bohemia, L.I., NY, to develop a hydraulic test stand. From all indications, there won't be any production hydraulic test stands accepted before 1982. Based on these findings, the cost of repair will be predicated on the use of commercial overhaul.

2. To assist in the development of the cost of repair, Graph H, page 14, RIW Program Model AP27V-5 Pump Reliability, was prepared to determine the number of non-RIW pump returns. The slope for RIW was plotted with known mean pump hours between unscheduled removal (MPHBUR) hours and pump hours for the period of 31 Mar 74 to 31 Mar 77. This curve was projected to cover the period of 3 Apr 73 through 31 Mar 83. The non-RIW slope was developed by taking a 5% increase of the real life 488 MPHBUR value for 3 Apr 73 and plotting the new value of 512 for 31 Mar 74. The resultant curve was then projected to 31 Mar 83. This is truly a conservative approach used in developing the non-RIW curve. In other cases, the non-RIW slope is most likely to be either constant or with some degradation. Page 15 shows the computation and quantity of pumps that would have been returned for repair within a non-RIW alternative.

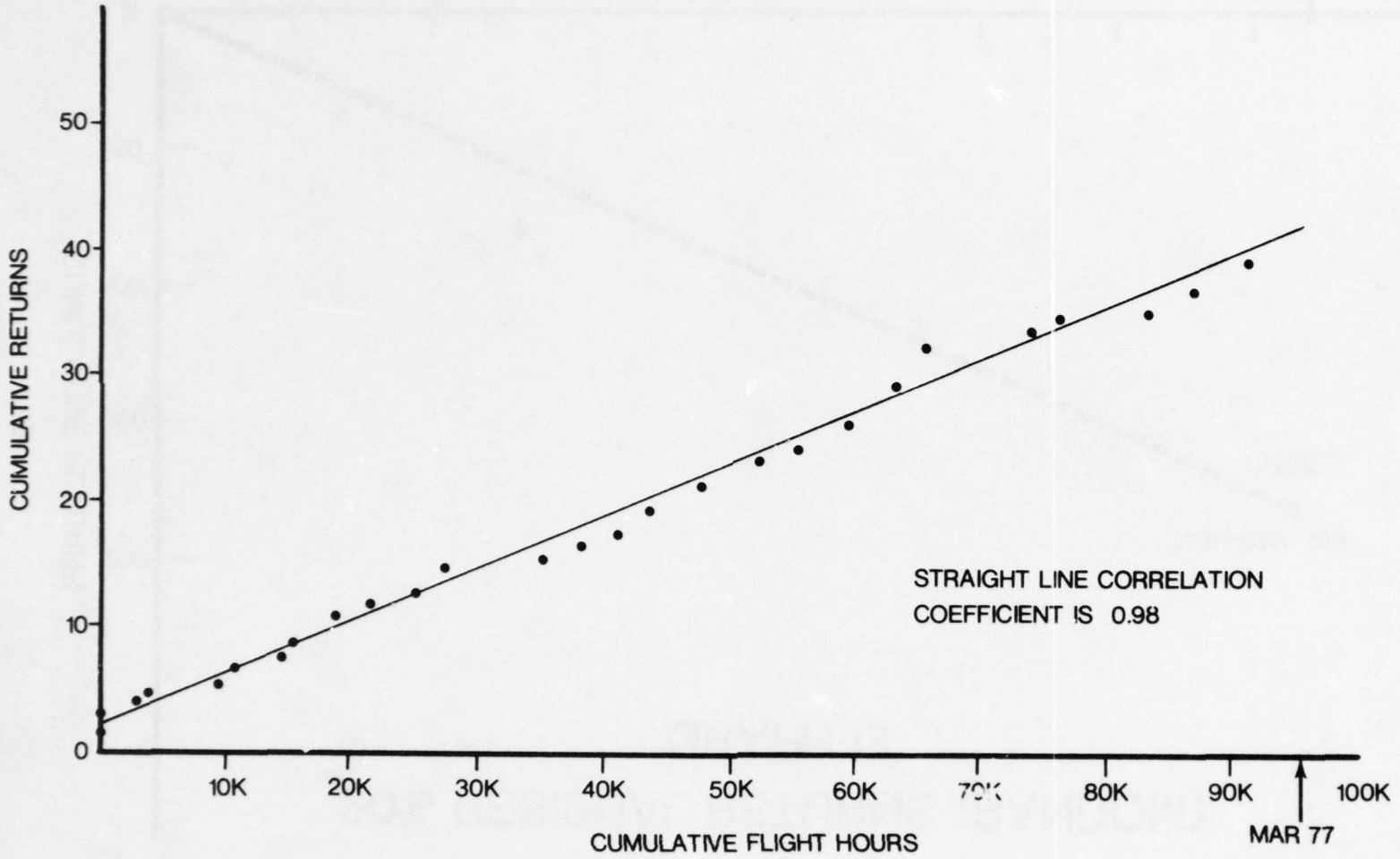
3. The next point to be considered is the repair cost that would be used in determining the cost of overhaul. Graph I, Escalation Schedule, page 16, was prepared and used along with Planning Memo page 17,to develop unit pump repair cost.

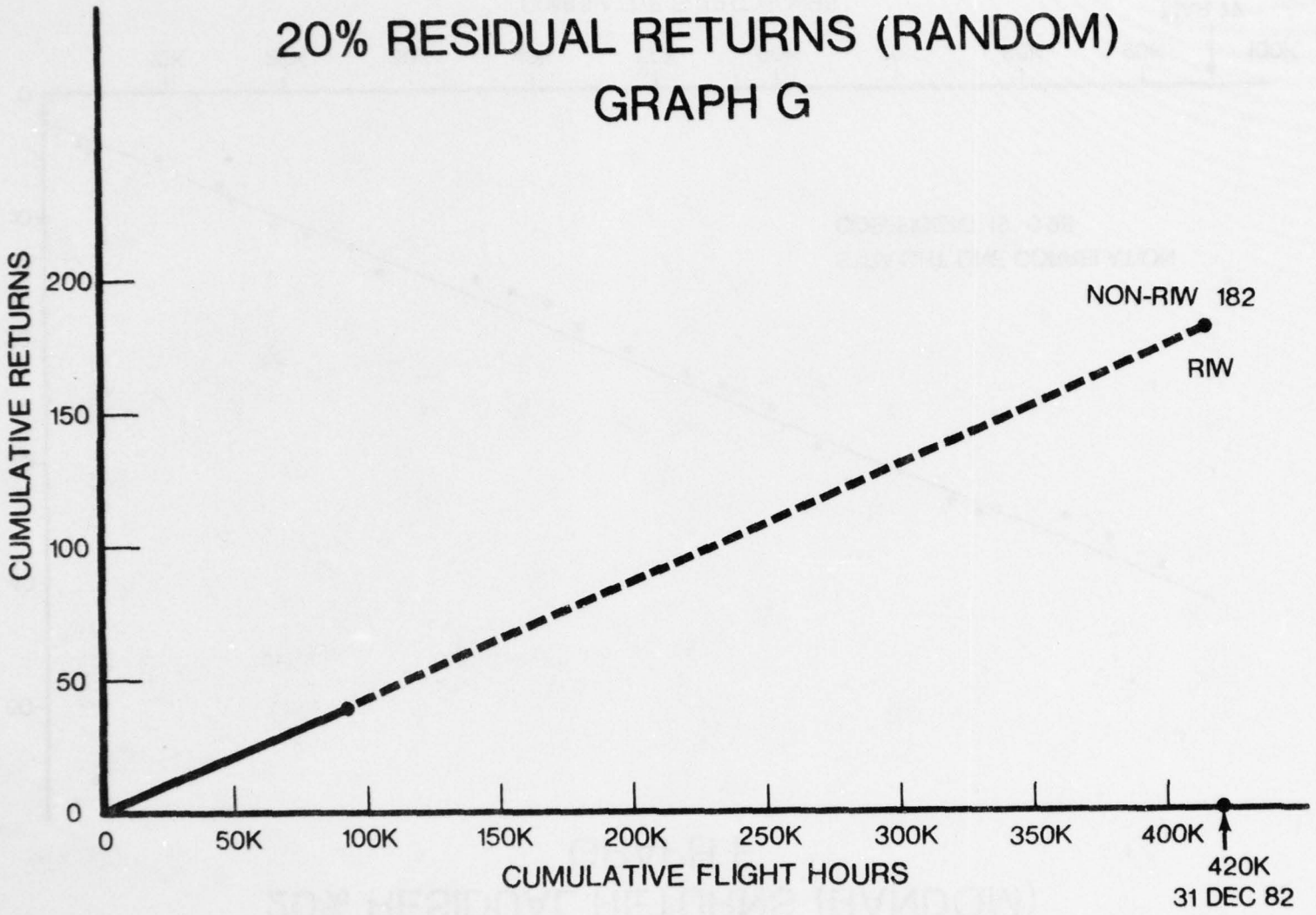
20% RESIDUAL RIW RETURNS

1973	Serial No.	Cum. Flt. Hrs.	Qty. (Cum.)
Jan	009	0	1
Apr	070	0	2
Nov	020	3249	3
Dec	028	3819	4
1974			
May	171	9434	5
Jun	283	10,793	6
Aug	263	14,038	7
Sep	121	15,428	8
Nov	268)	18,743	10
Nov	035)		
1975			
Jan	301	21,858	11
Mar	114	25,081	12
Apr	206)	27,215	14
Apr	092)		
Aug	111	35,033	15
Sep	498A	38,383	16
Oct	450A	41,269	17
Nov	033)	43,720	19
Nov	190)		
1976			
Jan	199)	47,812	21
Jan	098)		
Mar	508A)	52,920	23
Mar	390)		
Apr	290	55,771	24
May	307)	59,879	26
May	330)		
Jun	102)		
Jun	398)	63,186	29
Jun	444A)		
Jul	082)		
Jul	131)	65,614	32
Jul	186)		
Sep	316	74,432	33
Oct	242	76,374	34
Dec	463A	83,147	35
1977			
Jan	521A)	86,861	37
Jan	210)		
Feb	479A)	91,167	39
Feb	366)		
Mar	256)		
Mar	386)	95,248	42
Mar	576A)		

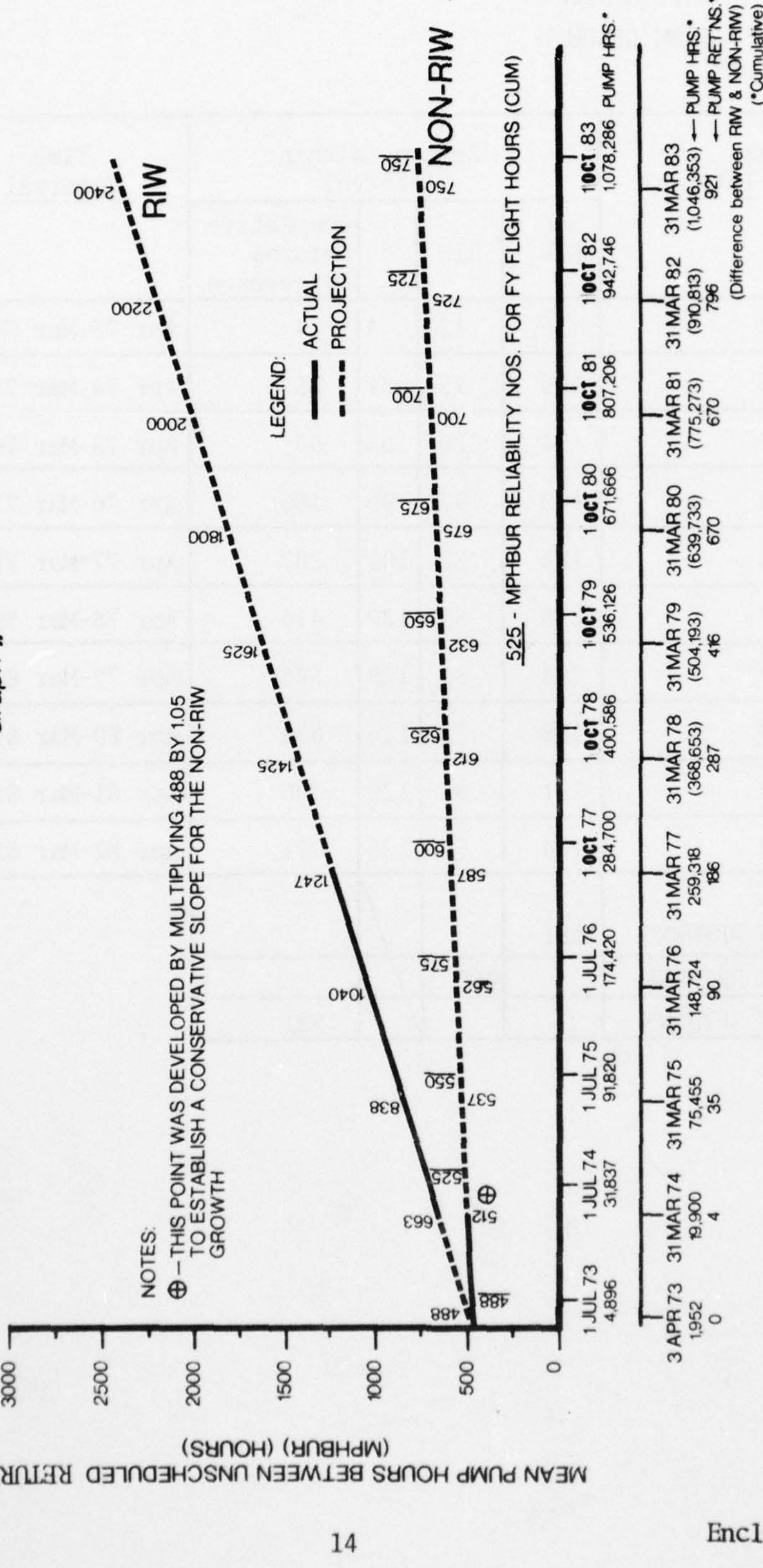
SEE GRAPHS F & G

20% RESIDUAL RETURNS (RANDOM)
GRAPH F




20% RESIDUAL RETURNS (RANDOM)
GRAPH G
CUMULATIVE RETURNS
200
150
100
50
0
NON-RIW 182
RIW
0
50K
100K
150K
200K
250K
300K
350K
400K
420K
31 DEC 82
CUMULATIVE FLIGHT HOURS

RIW PROGRAM MODEL AP27V-5 PUMP RELIABILITY
Graph II



see narrative page 1, paragraph F.

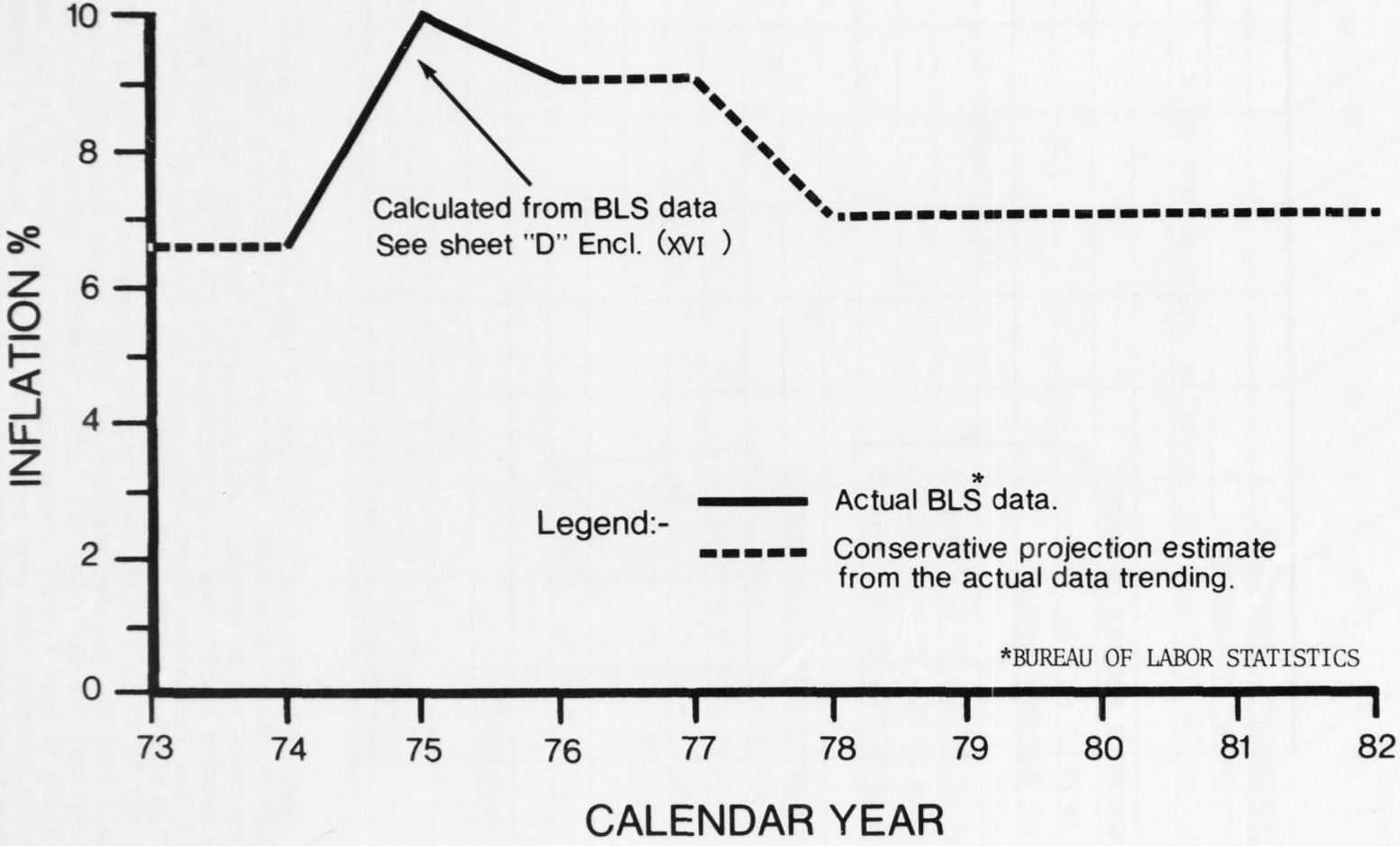
SYSTEM RETURNS

FROM GRAPH H

Avg. Interval MPHBUR		Pump Hrs. Within Interval	Returns Within Interval				Time Interval	
RIW	NON-RIW		Non RIW	RIW	*	Cumulative Returns Difference		
575.5	500	17,948	36	32	4	4	Apr 73-Mar 74	CY 73
750.5	524.5	55,555	106	75	31	35	Apr 74-Mar 75	CY 74
939	549.5	73,269	134	79	55	90	Apr 75-Mar 76	CY 75
1143.5	574.5	110,594	193	97	96	186	Apr 76-Mar 77	CY 76
1136	599.5	109,335	183	82	101	287	Apr 77-Mar 78	CY 77
1525	622	135,540	218	89	129	416	Apr 78-Mar 79	CY 78
1712.5	653.5	135,540	208	80	128	544	Apr 79-Mar 80	CY 79
1900	687.5	135,540	198	72	126	670	Apr 80-Mar 81	CY 80
2100	712.5	135,540	191	65	126	796	Apr 81-Mar 82	CY 81
2300	737.5	135,540	184	59	125	921	Apr 82-Mar 83	CY 82
		NON-RIW RETURNS	1651					
		RIW RETURNS		750				
		NON-RIW MINUS RIW RETURNS				921		

*Interval Difference

ESCALATION SCHEDULE
Graph I



NON-RIW ALTERNATIVE - COMMERCIAL OVERHAUL PUMP REPAIR COSTS

PLANNING WORK SHEET
4ND-GEN-5200/1 (REV. 9-66)
S/N 0195-LF-202-1101

CY	73	74	75	76	77	78	79	80	81	82

UNIT PUMP REPAIR COSTS DEVELOPMENT:

THE TOTAL COMMERCIAL OVERHAUL UNIT PUMP REPAIR COST FOR FY 77 (LOT VII) IS $987.00 REFER TO NOTE BELOW.

BASED ON ESCALATION SCHEDULE OF GRAPH I

91% OF FY 77 = CY 76
91% OF $987.00 = $898.57

ALSO: DE-ESCALATED

90.9% of CY 76 = CY 75 = $816.80
93.5% of CY 75 = CY 74 = $763.71
93.5% of CY 74 = CY 73 = $714.08

BASED ON ESCALATION SCHEDULE OF GRAPH I

9% of CY 76 = CY 77 = $979.44
7% of CY 77 = CY 78 = $1048.00
7% of CY 78 = CY 79 = $1121.36
7% of CY 79 = CY 80 = $1199.85
7% of CY 80 = CY 81 = $1283.84
7% of CY 81 = CY 82 = #1373.71

ESCALATED

UNIT PUMP REPAIR COSTS:

	$714	$764	$817	$899	$979	$1048	$1121	$1200	$1284	$1374
	← DE-ESCALATED →			BASE	← ESCALATED →					

NOTE:

Abex indicates that 1 1/4 hours of engineering time is contained in the 16 hour pump repair time (7.8% engineering time) which could not be included in a commercial overhaul cost. The engineering hourly rate is approximated at 35% of the total labor rate (per Escalation Report Memoranda, see enclosure XVI , sheet "A" to ASO Report TEE-2-77). The total overhaul labor cost for Lot VII FY 77 is $377.00, per contract information, and 35% of $377.00 equals $132.00, the engineering unit labor repair cost. The total repair cost for FY 77 Lot VII (labor, material, overhead, and profit) is $1119.44 less $132.00 engineering cost yields $987.00 as the commercial overhaul unit pump repair cost. For past as well as future contract anniversary year commercial overhaul costs, the escalation schedule of Graph I was used to modify FY 77 costs for the years under consideration (1973 to 1982).

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4. Planning Memo page 19, brings together all the data collected and gives the detailed repair cost data for each year. The grand total summary shows a cost difference of $1,020,072.

C. "O" Level Cost Differences:

1. Cost difference is the result of having fewer returns under RIW (and its associated cost of not removing and replacing these additional returns) as compared to the greater returns for non-RIW. Explanation of this axiom can be found on Graph H, and Planning Memo page 15. The graph shows 2 slopes, one for RIW and the other for non-RIW. The average interval Mean Pump Hours Between Unscheduled Removals (MPHBUR) was found for each time interval of 3 Apr 73 through 31 Mar 83 for both slopes, and is shown on Planning Memo, page 15. As can be seen on page 15, the average interval MPHBUR's for RIW are greater than non-RIW. This means that the expected pump returns for non-RIW will be greater which will necessitate the handling and processing of additional pumps by the "O" level maintenance personnel. This will result in additional costs which may be considered as "O" level cost differences.

2. The savings was calculated by taking the number of pump returns (see page 8) times the number of "O" level direct maintenance man-hours to handle each pump, refer to Planning Memo page 20, times the labor rate for an aviation mechanic hydraulic, refer to Planning Memo page 21, and Planning Memo page 20, equals the "O" level return cost. Planning memo page 21, shows the detailed cost differences for each contract anniversary year along with the grand total cost difference of sixteen thousand dollars for 829 returns.

D. Inventory Spares:

1. Currently, the spares program required to support the Abex pump under the RIW contract is most favorable. The number of procured spares has declined from 90 for Lot I-IV to 15 each for Lot VIII, with zero requirements for Lots V and VII. The total number of RIW procured spares to date is 138.

2. To determine the dollars not spent for RIW spares growth, it was necessary to develop the quantity of spares required to support the F-14 aircraft under the non-RIW support alternative. This was done by generating the number of flight hours and the average reliability value (MPHBUR) for each fiscal year from 1 Jul 73 to 1 Oct 83 from Graph H, page 14. This data is shown on Planning Memo page 22. The F-14 Item Manager WLW2-23 supplied the price of RIW spares purchased for Lots I-IV, VI and VIII, refer to Planning Memo page 23.

3. The prices for the non-RIW spares was reconstructed from the prices paid for the RIW spares. Planning page 23 shows the analyzed non-RIW spares prices for FY 73 through FY 82. Explanation of the development of these prices is as follows:

a. A cursory review of the prices for RIW spares showed that the prices varied with the quantity purchased and with the inflationary cost of each successive year.

NON-RIW ALTERNATIVE - COMMERCIAL OVERHAUL
PUMP REPAIR COSTS DIFFERENCES

TEE-7:Sep 77

PLANNING WORK SHEET
4ND-GEN-5200/1 (REV. 9-66)
0195-202-1101

CY	73	74	75	76	77	78	79	80	81	82
(1) NON-RIW PUMP RETURNS	4	31	55	96	101	129	128	126	126	125
		REFER TO PAGE 15								
(2) OVERHAUL REPAIR PRICE	$714	$764	$817	$899	$979	$1048	$1121	$1200	$1284	$1374
	← DE-ESCALATED →			BASE	← ESCALATED →					
		REFER TO PAGE 17								
(3) SAVINGS	$2856	23,684	44,935	86,304	98,879	135,192	143,488	151,200	161,784	171,7

EXAMPLE: (3) = (1) x (2)

GRAND TOTAL: $1,020,072 (921 RETURNS)

Enclosure XIII-88

AD-A048 244 ABEX CORP OXNARD CA F/G 15/5
RELIABILITY IMPROVEMENT WARRANTY (RIW) MID CONTRACT EVALUATION.(U)
OCT 77 O MARKOWITZ N00383-73-C-3318
UNCLASSIFIED ASO-TEE-2-77 NL

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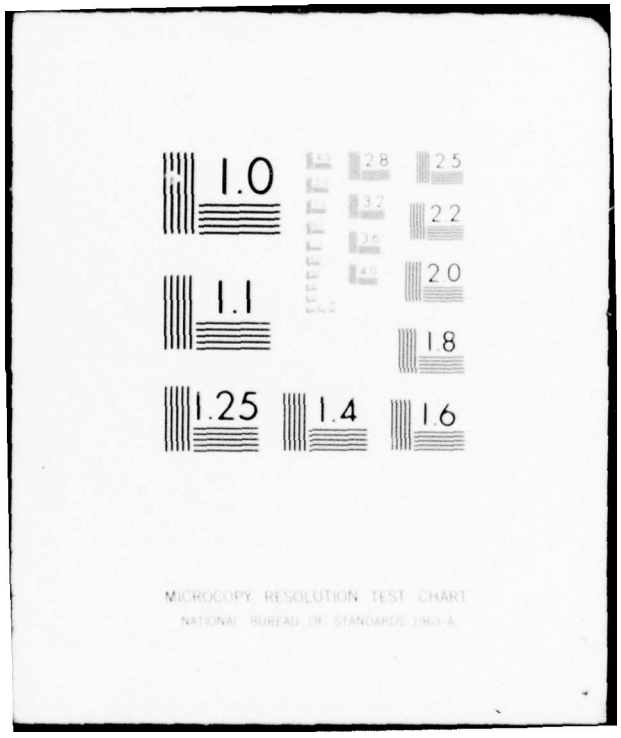
1.0
1.1
1.25
1.4
1.6
2.8
2.5
3.2
2.2
3.6
2.0
4.0
1.8
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

NOTES:

A. The following information on Organization Level maintenance man-hours was found:

1. 3M data report MSO 4790.A2245-03 for the periods of July 74 through Dec 74, Jan 76 through Jun 76, and Oct 76 through Mar 77 for Abex Pump P/N 65070-03 shows the following AVG ML1 DMMH (Direct Maintenance Man-Hours), respectively:

a. 3.2
b. 13.3
c. 24.8

2. Per telecon 8/21/77 w/CPO M. C. Pearson, VF-32 squadron, Oceana (autovon 274-2992), the squadron experience shows 1 1/2 hours DMMH for removal, installation, check out and administrative time. CPO Pearson indicated that their time is the exception, the usual time for other activities is about 1 3/4 hours.

3. Per telecon 9/7/77 with Mr. C. Miller of Abex, the time for removal, installation and checkout is 1 1/2 hours for each pump. There are two pumps on the F-14 a/c and one of the pumps is not readily accessable and the removal and installation of this pump would take longer, perhaps 2 hours.

B. After reviewing the available data found, it was determined that a conservative number of 3 hours would be reasonable for the removal, installation, checkout, and administrative time for each pump.

C. Determination of Skill Rating & Labor Rate for ML1 and ML2 Mechanic

1. Inquiries were made with the VF-32 squadron and the Intermediate Maintenance Activity (IMA), respectively, at NAS Oceana and it was found that the skill rating for an "O" level mechanic on hydraulic pumps for the F-14A aircraft is AMH-3 and the skill rating for an IMA mechanic is AMH-2.

2. In referring to Bureau of Naval Personnel Memo: Pers-2122B1/cr on Manpower Cost Element Data of 17 January 1977, it was found that the annual pay for an AMH-2 and AMH-3 is $9900 and $10,652, respectively. Telecon was made to Mr. P. Hogan, Pers-2122B1 to establish the hourly pay rate for both skill ratings. Mr. Hogan explained that a factor of 1.1 could be applied against the hourly rate calculated from the annual salaries. The hourly rates for $9900 and $10,652 come out to be $4.76 and $5.12, respectively. When the factor of 1.1 was applied to both annual hourly rates, the applicable hourly rate comes out to be $5.24 for $4.76 and $5.63 for $5.12 for Fiscal Year 1977.

PLANNING WORK SHEET
NAVMAT-GEN-5200/1 (REV. 9-66)
S/N 0195-LF-202-1101

CY	73	74	75	76	77	78	79	80	81	82	
Hourly rate for AMH-3 for FY 77 is $5.63. Refer to Page 20											
Based on Escalation Schedule of Graph I											
91% of FY 77 = CY 76											
91% of $5.63 = $5.12											
90.9% of CY 76 = CY 75 = $4.66						DE-ESCALATED					
93.5% of CY 75 = CY 74 = $4.35											
93.5% of CY 74 = CY 73 = $4.07											
Based on Escalation Schedule of Graph I											
9% of CY 76 = CY 77 = $5.58											
7% of CY 77 = CY 78 = $5.98											
7% of CY 78 = CY 79 = $6.39						ESCALATED					
7% of CY 79 = CY 80 = $6.84											
7% of CY 80 = CY 81 = $7.32											
7% of CY 81 = CY 82 = $7.83											
Hourly rate for AMH-3:											
	$4.07	$4.35	$4.66	$5.12	$5.58	$5.98	$6.39	$6.84	$7.32	$7.83	
	← DE-ESCALATED →			BASE	←		ESCALATED →				
			"O" LEVEL COST SAVINGS								
QTY PUMP RETURNS	0	0	22	79	120	124	116	127	121	120	(1)
		REFER TO PAGE 8									
ML1 DIRECT MAINTENANCE MAN-HOURS	3 HRS. (Removal, installation, checkout & administration time) REFER TO PAGE 20										(2)
ML1 LABOR RATE, SKILL RATING AMH-3	$4.07	$4.35	$4.66	$5.12	$5.58	$5.98	$6.39	$6.84	$7.32	$7.83	(3)
	← DE-ESCALATED →			BASE	←		ESCALATED →				
	REFER TO PAGE 20										
SAVINGS	0	0	$308	$1213	$2009	$2225	$2224	$2606	$2657	$2819	(4)
(4) = (1) x (2) x (3)											
GRAND TOTAL	$16,061 (829 returns)										

PLANNING WORK SHEET
NAVMAT-GEN-5200/1 (REV. 9-66)
S/N 0195-LF-202-1101

FY	73	74	75	76	77	78	79	80	81	82
⊕										
CUM. PUMP HRS.										
CUM. MPHBUR										
FY 73/4896										
/488										
FY 74/31,837	10,776									
/ 525	507									
FY 75/91,820		23,993								
/ 550		538								
FY 76/174,420			33,040							
/ 575			563							
FY 77/284,700				44,112						
/ 600				588						
FY 78/400,586					46,354					
/ 625					613					
FY 79/536,126						54,216				
650						638				
FY 80/671,666							54,216			
/ 675							663			
FY 81/807,206								54,216		
/ 700								688		
FY 82/942,746									54,216	
/ 725									713	
FY 83/1,078,286										54,216
/ 750										738

EXAMPLE:

1. Flt. Hrs(Non-Cum) = $\frac{[\text{Pump Hrs(Cum)}]_1 - [\text{Pump Hrs(Cum)}]_2}{2.5^*} = \frac{31,837-4896}{2.5} = 10,776$

*TOTAL PUMP HRS. OF OPERATION FOR EACH AIRCRAFT FLIGHT HR.

2. Avg. MPHBUR = $\frac{\text{MPHBUR}_1 + \text{MPHBUR}_2}{2} = \frac{488 + 525}{2} = 507$

◆REFER TO GRAPH H

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RECONSTRUCTED NON-RIW SPARES PRICE TEE-7:Aug 77

PLANNING WORK SHEET
NAVSEC-5200/1 (REV. 9-66)
S/N 0195-LF-202-1101

FY	73	74	75	76	77	78	79	80	81	82
RIW SPARES PRICE		*								
FY 73/74/$2145	(a)	94% (2145)	=	$2016 (Lot I - IV)						
FY 75/$2358	(b)	93.5% (2358)	=	$2205 (Lot V)						
FY 76/$2571	(c)	90% (2571)	=	$2314 (Lot VI)						
FY 77/$2980	(d)	91% (2980)	=	$2712 (Lot VII)						
FY 78/$3388	(e)	93% (3388)	=	$3151 (Lot VIII)						
FY 79/$3388		3.5% (3388)	=	$3506						
FY 80/$3388		0% (3388)		$3506						
FY 81		3% (3625)		$3611						
FY 82		3% (3879)		$3719						

*DEVELOPED FROM GRAPH I, ALSO SEE NARRATIVE PAGE 18, PARA. D.3

NON-RIW SPARES PRICE	$2016	$2205	$2314	$2712	$3151	$3506	$3506	$3611	$ 3719

NOTES:

(a) UNIT PRICE PAID ON CONTRACT N00193-69-C-0422 FOR 45 SPARES & CONTRACT N00383-72-C-4641 FOR 45 SPARES

(b) THE MEAN VALUE BETWEEN UNIT PRICE OF LOTS I-IV & VI

(c) UNIT PRICE PAID ON CONTRACT N00383-74-C-4113 FOR 33 SPARES

(d) THE MEAN VALUE BETWEEN UNIT PRICE OF LOTS VI & VIII

(e) UNIT PRICE PAID ON CONTRACT N00383-76-C-2619 FOR 15 SPARES

* U.S. GOVERNMENT PRINTING OFFICE: 1976—603-813/5220 2-1

b. As shown on Planning page 25, the quantities developed for the non-RIW spares were in most cases twice the quantities purchased for RIW. Therefore, the cost for non-RIW spares should be less based on the larger ordering quantities; however, this is offset by the inflationary costs incurred during the spares procurement year in question. For the record, Abex concurs that a larger number of spares purchased would contribute towards a lower unit price. Hence, a reasonable assumption was made that the reduction of unit price on larger non-RIW spares quantities equals the yearly inflationary percentage increase for the procurement year in question. In this way, the unit cost reduction accompanying a large quantity spares order should offset the economic inflation of the outyears spares buy. Thus, it is anticipated that each oppositely directed cost driver (spares quantity and inflation) would tend to cancel each other toward an equilibrium price.

c. To implement the above assumption, the RIW price was de-escalated using Graph I, page 16, Escalation Schedule, for those non-RIW spare quantities that were two or more times greater than the RIW spares quantities. This is applicable to the non-RIW spares price for FY 73 through FY 78. Hence, Graph I was used to remove the percentage inflation for the year when the spares procurement occurred. This removal of inflationary costs or a portion thereof is assumed to be the price discount associated with larger quantity spares procurements for non-RIW vice RIW. When non-RIW spares are double or more, than RIW spares quantity, the full "inflationary discount" is taken. When the non-RIW to RIW spares quantity ratio is less than double, an appropriate proportion of the inflationary discount is used.

d. For the cost of the FY 79 non-RIW spares, an escalation factor was used since there wasn't any RIW cost data available beyond FY 78 to de-escalate. An escalation factor of only 3.5% was used for FY 79 in lieu of 7%, because the quantity of non-RIW spares was only 1 1/2 times greater than the RIW spares. If the FY 79 non-RIW spares were twice (or more than) the RIW quantity, a zero percent escalation factor would have been used, thus allowing for a full inflationary discount per Graph I.

e. For the costs of non-RIW spares for FY 80 the full inflationary discount (estimated at 7% from Graph I) was allowed as the non-RIW spare quantities were estimated at five times the RIW spares quantity estimate. This factor of five is applicable to FY 81 and FY 82 non-RIW to RIW spares ratio (with its corresponding justification for the full inflationary discount allowed); however, it is realized that a slight increase in price would occur for FY 81 and FY 82. This slight increase is estimated at 3% each for FY 81 and FY 82 non-RIW spares costs as RIW spares costs are not available, and one would not expect for identical buy quantities, FY 81 and FY 82 spares costs as being the same.

4. Planning page 25 summarizes all of the data required to calculate the spares difference costs. The spares difference costs are shown for each fiscal year along with the total cost difference of $1,007,443 Graph J refers, page 26.

5. Page 27 summarizes all cost differences totaling $1,940,498 in favor of RIW over the non-RIW alternative.

SPARES SAVINGS COSTS TEE-7:Sep 77

PLANNING WORK SHEET
WND-GEN-5200/1 (REV. 9-66)
S/N 0195-LF-202-1101

FY	73	74	75	76	77	78	79	80	81	82
NON-RIW										
⊙ FLIGHT HOURS	10,776	23,993	33,040	44,112	46,354	54,216 →				
⊙ AVG MPHBUR	507	538	563	588	613	638	663	688	713	738
* A/C SUPPORTING	85	48	50	50	36 →					
⊕ QTY OF SPARES	118	48	64	68	60	52	36 →			
	166 EQUIVALENT TIME PERIOD TO LOT I-IV OF RIW						⊙ REFER TO PAGE 22			
							⊕ ESTIMATED SPARE QUANTITIES SUPPLIED BY F-14 ITEM MANAGER WLW2-23			
	← ACTUAL →						PROJECTED →			
RIW - LOT	I - IV		V	VI	VII	VIII				
SPARES	90		0	33	0	15	25	7 →		
							PROJECTIONS SUPPLIED BY F-14 ITEM MANAGER WLW2-23			
DIFFERENCE (NON-RIW MINUS RIW)	76		64	35	60	37	11	29	29	29
**PRICE OF NON-RIW SPARES	$2016		$2205	$2314	$2712	$3151	$3506	$3506	$3611	$3719
***SAVINGS	$153,216		141,120	80,990	162,720	116,587	38,566	101,674	104,719	107,851

GRAND TOTAL $1,007,443 (370 SPARES)

* ATTRITION NOT INCLUDED

**REFER TO PAGE 23

***SPARES DIFFERENCE TIMES COSTS OF NON-RIW SPARES

FOR GRAPHICAL REPRESENTATION OF RIW VS NON-RIW SPARES SEE GRAPH J

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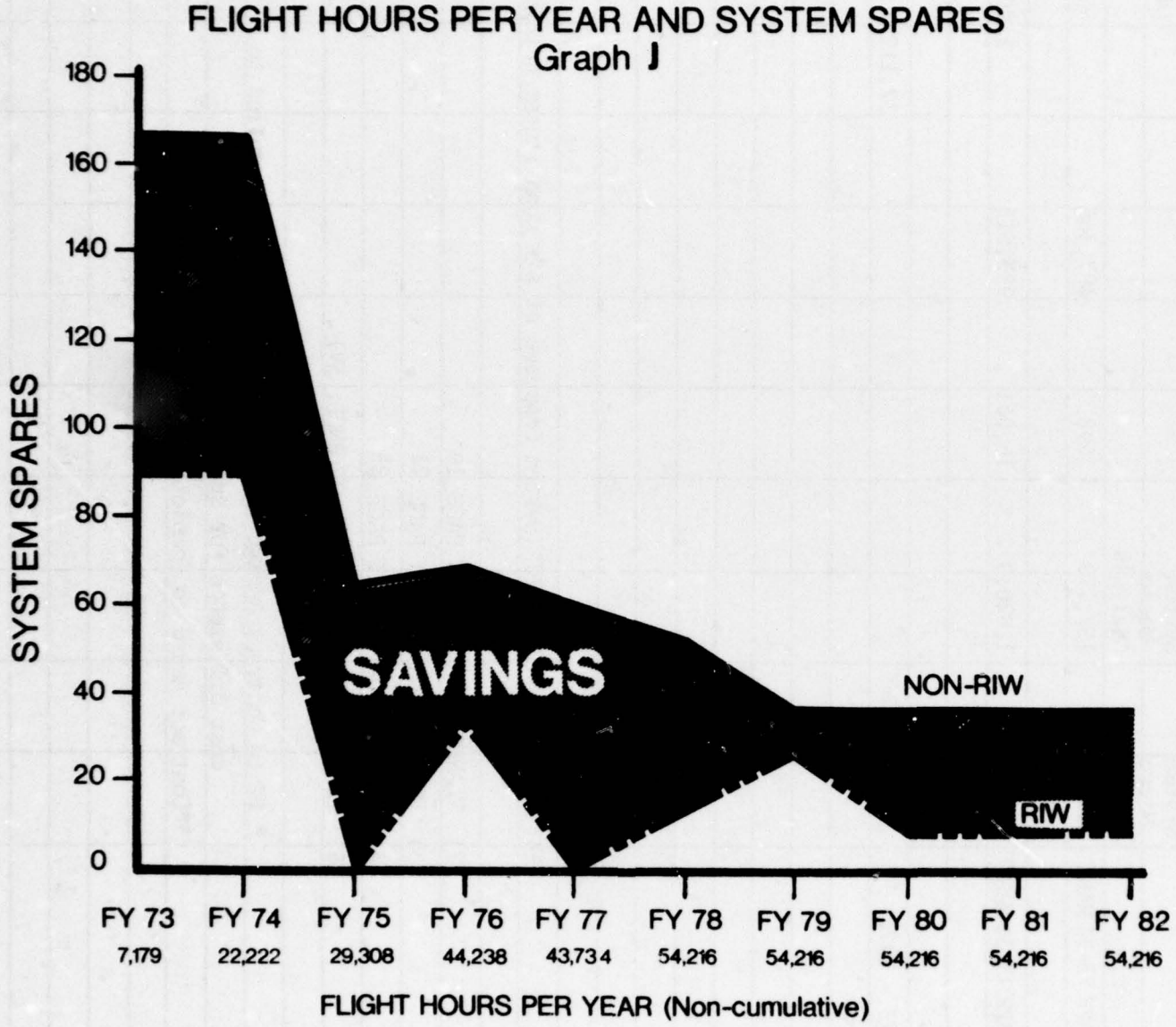
FLIGHT HOURS PER YEAR AND SYSTEM SPARES
Graph J
SYSTEM SPARES
180
160
140
120
100
80
60
40
20
0
SAVINGS
NON-RIW
RIW
FY 73
7,179
FY 74
22,222
FY 75
29,308
FY 76
44,238
FY 77
43,734
FY 78
54,216
FY 79
54,216
FY 80
54,216
FY 81
54,216
FY 82
54,216
FLIGHT HOURS PER YEAR (Non-cumulative)

COST DIFFERENCE SUMMARY TEE-7:Sep 77

PLANNING WORK SHEET
4ND-GEN-5200/1 (REV. 9-66)
S/N 0195-LF-202-1101

	RIW ENGINEERING IMPROVEMENTS	NON-RIW ALTERNATIVE COMMERCIAL O/H PUMP REPAIR COST SAVINGS	"O" LEVEL COST SAVINGS	INVENTORY SPARES COST DIFFERENCE	ESCALATION	TOTAL
	(1) System Micro Analysis	(2) System Macro Analysis	(3)	(4)*	(5)	(1)+(3)+(4)=TOTAL
3 APR 73-31 MAR 77	$88,915	157,779	2698	497,366		588,979
3 APR 73-31 MAR 77	938,807	1,020,072	16,061	953,518		1,908,386
1973 - 1976 **					32,112	

REFERENCES

(1) PLANNING DATA SHEET (System Composed of six constituent categories) PAGE 9

(2) PLANNING DATA SHEET PAGE 19

(3) PLANNING DATA SHEET PAGE 21

(4) PLANNING DATA SHEET PAGE 25

(5) PLANNING DATA SHEET (E) OF ENCL. XVI

* FY to Contract Anniversary Year (CY) Conversion applied to cost difference for spares

**Contract Award to Completion Lots I - VII

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DEPARTMENT OF THE NAVY
AVIATION SUPPLY OFFICE
700 ROBBINS AVENUE
PHILADELPHIA, PA. 19111

FASOINST 4440.86C
TEE
1 Feb 1977

ASO FIELD INSTRUCTION 4440.86C

From: Commanding Officer, Aviation Supply Office, Philadelphia
To: Distribution List

SUBJ: FFW (FAILURE FREE WARRANTY)/RIW (RELIABILITY IMPROVEMENT WARRANTY); PROGRAM FOR

REF: (a) NAVSUP Publication 4107, Master Repairable Item List
(b) OPNAVINST 4790.2 Series, Subj: The Naval Aviation Maintenance Program
(c) FASOINST 4000.9 Series, Subj: Reusable Protective Shipping and Storing Devices; procedures concerning
(d) NAVSUP Publication 437, MILSTRIP/MILSTRAP

ENCL: (1) List of Equipments covered by this instruction (summarized)
(2) AN/CN494A/AJB3 and AN/CN1359/AJB3 Gyroscope Assemblies
(3) AP27V-5-01 and AP27V-5-02 Engine Driven Hydraulic Pumps
(4) RT-763E/APN-154(V) Receiver-Transmitter
(5) PV3-044-029 Engine Driven Hydraulic Pump
(6) AN/AVQ-24 Head-up Display Set
(7) RT 601B/APN-141(V) Receiver-Transmitter
(8) AN/APN-194(V) Radar Altimeter

1. PURPOSE. This instruction provides special procedures for the shipment, receipt, and reporting of equipment under FFW (Failure Free Warranty)/RIW (Reliability Improvement Warranty) contracts.

2. DIRECTIVE CANCELED. FASOINST 4440.86B

3. SCOPE. Applies to:

a. All activities and aviation units in the Naval Aviation Supply Distribution System including COMNAVAIRLANT/PAC, AMO (Aviation Material Office) Norfolk and FLEAVNMATOPAC (Fleet Aviation Material Office Pacific) San Diego, and maintenance activities supporting the Fleet.

b. Only those items covered by FFW/RIW contracts which are listed in enclosures (1) through (8) to this instruction.

4. STATEMENT OF CHANGES. This revision:

a. Expands the scope of the instruction to include all items currently under an FFW/RIW contract.

b. Updates FSNs to NSNs.

5. INFORMATION

a. Equipments within the scope of this instruction are covered with a prepaid warranty contract. The contractor warrants reliability growth and support of the units within the service life and calendar limitations specified in the contract. (See enclosures (1) through (8) for specific terms and conditions of individual contracts.)

b. The contractor has affixed to each item an FFW/RIW nameplate or decal bearing an individual serial number for tracking purposes. By monitoring the reporting of these items, the contractor and ASO can perform technical reviews toward improving the reliability, life cycle costs and fleet readiness relative to the equipment. Items not listed in the enclosures to this instruction are excluded from the provisions of this instruction. Those excluded FJ units will be shipped in accordance with reference (a).

6. ACTION

a. Maintenance Activities

(1) Upon removal of a unit from its installation:

(a) Test the unit in accordance with procedures specified in the applicable manuals (note any special instructions in the enclosure of this instruction). If the unit passes the tests, return it to service; if it fails, immediately prepare it for shipment as described below.

1. No unit bearing an FFW/RIW plate or decal is to be opened or repaired by any party other than the contractor, unless specifically permitted by the applicable enclosure of this FASO Instruction. Unauthorized repairs by other than the contractor can abrogate warranty obligations of the contractor.

(b) If the unit fails the test, furnish failure circumstances, data, and test readings where applicable on OPNAV Form 4790/47 (Unsatisfactory Material/Condition Report) in accordance with reference (b), or on SF368 (Quality Deficiency Report), whichever is applicable. Forward a copy to the contractor indicated in enclosure (1).

(2) Upon removing an RFI (Ready for Issue) unit from the container for installation when a project code tag is provided:

(a) Remove the project code tag from the envelope attached to the container.

(b) Enter the station and date on the tag in the "From" section.

(c) Mail the tag (the tag is preaddressed to the contractor and the postage is prepaid).

(d) Remove the plastic envelope from the container and retain the container for return of a FJ unit. The container is subject to procedures listed in reference (c).

b. Supply Department

(1) Issuance. In order to obtain maximum benefits of the warranty, FFW/RIW units are to be issued "off the shelf", ahead of non-FFW/RIW units.

(2) Shipment of FFW/RIW Units

(a) Assure that the unit has the original manufacturer or modification repair/overhaul plate or decal securely attached.

(b) Package the unit together with a completed and legible copy of OPNAV Form 4790/47 or SF 368 in the shipping container, one per container. In order to protect the warranty, only the container specified in the applicable enclosure will be used for all shipments or transportation of the units whether new or in need of repair. In an emergency, when the specified containers are not available, insure that equivalent protection is used for shipment of the items.

(c) Ship the packaged unit to the contractor by the most expeditious mode of transportation available. The contractor's name and address appear on the FFW/RIW nameplate and in enclosure (1). Immediate rapid shipment of failed units directly to the designated contractor facility is required to obtain maximum benefits of the warranty.

(3) Reports

(a) Whenever a supply action is taken for a FFW/RIW unit, prepare a transaction report in accordance with reference (d).

(b) When a shipment is made to the contractor, forward a list of the unit(s) in the shipment to the contractor via the Administrative Contracting Officer. The list shall reference the FFW/RIW contract number as authorization by ASO for such shipment.

(c) Use Fund Code "15" in columns 52 and 53 on DD Form 1348-1. (Paragraph 05180, Schedule No. 6 of reference (d) defines this category of issue as follows: "To contractor for repair or replacement under warranty clause of contract and subject to redistribution.")

(d) Indicate "ZW5" in columns 57 through 59 on DD Form 1348-1. (Reference (d) defines the special project code "ZW5" as; "ASO Failure Free Warranty Contract Material.")

(e) Indicate the serial number in the Item Nomenclature block on DD Form 1348-1.

7. ASO CONTACT POINT. For any other information required on warranted units contact Harry Furlong, Autovon 442-2861/2 at ASO.

8. FORMS CITED

a. OPNAV Form 4790/47 - Unsatisfactory Material/Condition Report.

b. Standard Form 368 - Quality Deficiency Report (Category II).

c. DD Form 1348-1 - DOD Single Line Item Release/Receipt Document.

Asterisks are not used to indicate changes since this is a general revision.

/s/ G. R. HENRY
CAPTAIN, SC, USN
Executive Officer

AUTHENTICATED

V. O. KIBLACK
Director
Administrative Division

DISTRIBUTION LIST NO. 7

INTERNAL DISTRIBUTION

LIST OF EQUIPMENTS COVERED BY THIS INSTRUCTION

1. AN/CN494A/AJB3 and AN/CN1359/AJB3 Gyroscope Assemblies (Enclosure (2)).

   a. Warrantor:

      Lear-Siegler Inc., Instrument Division
      4141 Eastern Ave., S.E., Grand Rapids, MI 49508

   b. Equipment Under Warranty:

NSN	PART NUMBER	FSCM
2RG1280-00-869-9245FZ	134383-01-23	35351
2RG1280-00-869-9246FZ	134383-01-22	35351
2RG1280-00-912-2164FZ	134282-01-26	35351
2RG6615-00-150-6777FZ	149900-01-02	35351
2RG6615-00-150-6778FZ	149900-01-01	35351
2RG6615-00-138-7978FZ	149900-01-04	35351
2RG6615-00-138-7986FZ	149900-01-05	35351

2. AP27V-5-01 and AP27V-5-02 Engine Driven Hydraulic Pumps (Enclosure (3)).

   a. Warrantor:

      Ahex Corporation, Aerospace Division
      3151 W. 5th St., Oxnard, CA 93030

   b. Equipment Under Warranty:

NSN	PART NUMBER	FSCM
2RH4320-00-690-2059PF	65070-02	75250
2RH4320-00-389-7949PF	65070-03	75250

3. RT-763E/APN-154(V) Receiver-Transmitter (Enclosure (4)).

   a. Warrantor:

      United Telecontrol Electronics, Inc.
      3500 Sunset Ave., Asbury Park, NJ 07712

   b. Equipment Under Warranty:

NSN	PART NUMBER	FSCM
2RH5895-00-110-8174FX	B18C015	07450

4. PV3-044-029 Engine Driven Hydraulic Pump (Enclosure (5)).

a. Warrantor:

Sperry-Vickers, AOM Division
5353 Highland Drive, Jackson, MS 39206

b. Equipment Under Warranty:

NSN	PART NUMBER	FSCM
To Be Assigned	40720A	62983

5. AN/AVQ-24 Head-Up Display Set (Enclosure (6))

a. Warrantor:

E-A Industrial Corp.
4500 N. Shallowford Rd., Chamblee, GA 30341

b. Equipment Under Warranty:

NSN	PART NUMBER	FSCM
2RH6605-00-346-2557DA	009-102-01	33827
2RH6605-00-346-2530DA	009-103-01	33827
2RH6605-00-346-2551DA	009-104-01	33827
2RH6605-00-346-2531DA	009-105-01	33827
2RH6605-00-346-2553DA	009-106-01	33827
2RH6605-00-346-2533DA	009-107-01	33827
2RH6605-00-346-2555DA	009-108-01	33827
2RH6605-00-346-2534DA	009-109-01	33827
2RH6605-00-346-2556DA	009-110-01	33827
2RH6605-00-518-4933DA	009-111-01	33827
2RH6605-00-518-4929DA	009-112-01	33827
2RH6605-00-518-4949DA	009-113-01	33827

6. RT-601B/APN-141(V) Receiver-Transmitter (Enclosure (7)).

a. Warrantor:

Naval Air Rework Facility
Naval Air Station, North Island
San Diego, CA 92135
ATTN: Project RAMPART

b. Equipment Under Warranty:

NSN	PART NUMBER	FSCM
2RH5841-01-017-5528NZ	74766	91145

7. AN/APN-194(V) Radar Altimeter (Enclosure (8)).

a. Warrantor:

Honeywell, Inc. Government & Aeronautical Products Div.
2600 Ridgway Parkway, Minneapolis, MN 55413.

b. Equipment Under Warranty:

NSN	PART NUMBER	FSCM
2RH5841-00-110-4130WZ	ID-1811/APN-194(V)	94580
2RM5841-00-110-4882WZ	MX-9132A/APN-194(V)	94580
2RH5841-00-110-4883WZ	ID-1760A/APN-194(V)	94580
2RH5841-00-110-4912WZ	ID-1768A/APN-194(V)	94580
2RH5841-00-110-6262WZ	RT-1042/APN-194(V)	94580
2RH5841-00-110-8125WZ	RT-1015/APN-194(V)	94580
1RM5841-00-181-0330WZ	AS2595/APN-194(V)	94580

AN/CN494A/AJB3 AND AN/CN1359/AJB3 GYROSCOPE ASSEMBLIES

1. EQUIPMENT AFFECTED

a. The provisions of this instruction apply to the following items only if an FFW plate bearing serial numbers commencing with "FFW0001" is attached:

NSN	PART NUMBER	FSCM
2RG1280-00-869-9245FZ	134383-01-23	35351
2RG1280-00-869-9246FZ	134383-01-22	35351
2RG1280-00-912-2164FZ	134282-01-26	35351
2RG6615-00-150-6777FZ	149900-01-02	35351
2RG6615-00-150-6778FZ	149900-01-01	35351
2RG6615-00-138-7978FZ	149900-01-04	35351
2RG6615-00-138-7986FZ	149900-01-05	35351

2. WARRANTY DETAILS

a. Contract Number N00383-67-C-3101 with LSI (Lear Siegler, Inc.) warranted repairs of above gyroscopes having up to 1,500 hours of use, or for a period of five years from the date of delivery of the article initially overhauled by LSI, whichever occurred first. The contract was completed in June 73 and a separate contract renewing the warranty was signed. Thus units with nameplates indicating contract N00383-67-C-3101 will remain under warranty until 1979. Contract Number N00383-73-C-3537 is the renewal of contract N00383-67-C-3101. This renewal extends the LSI warrantv on the above equipment for an additional 1500 hours or six (6) years, whichever occurs first.

b. Contract Number N00383-71-C-0078 provides a warranty of six (6) years or 1500 hours for an additional quantity of new production gyroscopes purchased from LSI, which were not covered by the original FFW contract.

3. TEST PROCEDURES

a. Upon failure of an installed unit, test the unit on the applicable LT3275 test stand per AN/AJB-3 Intermediate Service Instructions Manual, NAVAIR 11-70-FF-6 or NAVAIR 11-70-FF-8. If the unit passes the test, return it to service; if it fails, take action to ship the unit per paragraph 6b(2) and 6b(3) of this instruction.

4. SHIPPING CONTAINERS

a. Only the following containers are authorized for all shipment of material under this contract:

2RM6615-00-906-6787FZ (Inner), Part Number 999204-01
2RH1280-00-921-5014FZ (Exterior), Part Number 999205-01 or
1RD8145-01-016-3449UX, Part Number (80132) 15024-4, which consists of:
1RM8145-01-016-3456UX (Inner), Part Number (80132) 15024-201 and
1RD8145-01-016-3452UX (Exterior), Part Number (80132) 15024-200.

b. The contractor's name and address appear on the FFW nameplates and in enclosure (1). FFW nameplates showing an address other than the following should be ignored, and the unit shipped to:

DCASMA GRAND RAPIDS
c/o LEAR SIEGLER INC.
Instrument Division
4141 Eastern Avenue S.E.
Grand Rapids, MI 49508

AP27V-5-01 AND AP27V-5-02 ENGINE DRIVEN HYDRAULIC PUMPS

1. EQUIPMENT AFFECTED

a. The provisions of this instruction apply to engine driven hydraulic pumps manufactured by the Abex Corporation, NSN 2RH4320-00-690-2059PF and 2RH4320-00-389-7949PF, only if an FFW plate bearing one of the following Abex serial numbers is attached:

133003, 133009, 133013 through 133024, 133026, 133027, 133029, 133030 through 133125, and 133127 through 133271

b. Subsequent serial numbers for future production F-14A aircraft will be covered by amendment to the basic FFW/RIW contract and are applicable to this instruction.

2. WARRANTY DETAILS

a. ASO contract number N00383-73-C-3318 with the Abex Corporation warranted repairs of the complete population of the hydraulic pumps for a total of 387,000 operating hours or a period of six (6) years after delivery of the last of the production units, whichever occurs first. Abex is required under the contract to ship a pump within twenty-four (24) hours of the receipt of a pump. In a NORS condition, Abex will respond to a telecon by shipment of a replacement pump within twenty-four (24) hours of the shipment of a pump to Abex. This is accomplished with a pool of RFI pumps at Abex. This contract has been amended to extend the warranty for the entire population of 587 Abex pumps, part number 65070-03 and 65070-02, to July 1982.

3. TEST PROCEDURES

a. Not applicable. All testing of these units is to be performed by the contractor under the provisions of the FFW contract. Upon removal and/or failure of an installed unit, return it to the contractor with the required documentation as specified in paragraphs 6b(2) and 6b(3) of this instruction, and Abex form number A-710 when available.

4. SHIPPING CONTAINERS

a. Reusable containers shall conform to ATA (Air Transport Association) Specification 300, Category I, or MIL-C-4150.

RT-763E/APN-154 (V) RECEIVER-TRANSMITTER

1. EQUIPMENT AFFECTED

a. The provisions of this instruction are applicable to the AN/APN154 Receiver Transmitter assembly, RT-763E/APN154(V), manufactured by United Telecontrol Electronics, Inc. (FSCM 07450) only if an FFW label is attached. Manufacturer's part number for subject assembly is B18C015, NSN 2RH5895-00-110-8174FX.

2. WARRANTY DETAILS

a. ASO contract number N00383-72-C-2458 with United Telecontrol Electronics, Inc. warranted repairs of above receiver-transmitter assemblies having up to 1,000 operating hours or for a period of 26 months after delivery of the units, whichever occurred first. The warranty applied to all parts and components of the receiver-transmitter except the magnetron, UTE part number B18B022, which was warranted for 500 operating hours or 24 months, whichever occurred first. UTE was required under this contract to return the repaired unit within thirty days of its receipt. This contract has been completed.

b. Contracts N00383-73-C-3384 and N00383-75-C-0045 are follow-ons to the above contract, which provide additional quantities of new production receiver-transmitter units from UTE, with the same warranty provisions as the above contract.

3. TEST PROCEDURES

a. Upon removal and/or failure of an installed unit, the unit is to be sted in accordance with the checkout procedures listed in paragraph 4-11 of APN 154 Intermediate Maintenance Manual, NAVAIR 16-30 APN154-2. If the unit passes the test, return it to service; if it fails, return it to the contractor with the required documentation per paragraphs 6b(2) and 6b(3) of this instruction.

4. SHIPPING CONTAINERS

a. Reusable shipping container, NSN 2RH8145-00-288-1396TA will be used exclusively for all shipments of receiver-transmitter units under this RIW program.

PV3-044-029 ENGINE DRIVEN HYDRAULIC PUMP

1. EQUIPMENT AFFECTED

a. The provisions of this instruction are applicable to the AV-8A engine driven hydraulic pump, model PV3-044-029, manufactured by Vickers AOM Division of Sperry Rand Corporation (Vickers part number 407204, NSN to be assigned).

2. WARRANTY DETAILS

a. ASO contract number N00383-76-C-0491 with Vickers warranted repairs of 240 above engine driven hydraulic pumps for a total of 125,000 operating hours (equivalent to 50,000 aircraft flying hours) or a period of 30 months from the date of acceptance and delivery of the last production unit, whichever occurs first. Vickers is required under this contract to ship either the repaired unit or a replacement unit within 30 days of the receipt of a failed unit. When this unit is delivered from Vickers production starting 29 October 1977, it will become the replacement for Vickers pumps part number 715404 (NSN 2RH4320-00-356-1055KA) and 776422 (NSN 2RH4320-00-452-1988KA). The production schedule provides for delivery of 40 pumps per month for six months starting on the above date.

3. TEST PROCEDURES

a. Not applicable. All testing of these units is to be performed by the contractor under the provisions of the RIW contract. Upon failure and/or removal of an installed unit, return it to the contractor with the required documentation as specified in paragraphs 6b(2) and 6b(3) of this instruction.

4. SHIPPING CONTAINERS

a. Reusable shipping containers conforming to MIL-D-6054 shall be furnished by the government.

AN/AVQ-24 HEAD-UP DISPLAY SET

1. EQUIPMENT AFFECTED

a. The provisions of this instruction apply to the following components of AN/AVQ-24 Head-Up Display set manufactured by E-A Industrial Corp. (P/N 009-101-01) under contract numbers F34601-74-A-0081, order GB31 and F34601-73-A-2883, order GB14:

NSN	NOMENCLATURE	PART NUMBER
2RH6605-00-346-2557 DA	Indicator, Digital Display	009-102-01
2RH6605-00-346-2530 DA	Amplifier, Video	009-103-01
1RD6605-00-346-2551 DA	Mounting Base, Electrical Equip.	009-104-01
2RH6605-00-346-2531 DA	Power Supply	009-105-01
1RM6605-00-346-2553 DA	Mounting Base, Electrical Equip.	009-106-01
2RH6605-00-346-2533 DA	Control, Computer	009-107-01
1RM6605-00-346-2555 DA	Mounting Base, Electrical Equip.	009-108-01
2RH6605-00-346-2534 DA	Computer, Digital Data	009-109-01
1RM6605-00-346-2556 DA	Mounting Base, Electrical Equip.	009-110-01
2RH6605-00-518-4933 DA	Control, Range	009-111-01
2RH6605-00-518-4929 DA	Gyroscope, Accelerometer	009-112-01
1RM6605-00-518-4949 DA	Mounting Base, Electrical Equip.	009-113-01

(One each of the above listed components constitutes a complete AN/AVQ-24 Head-Up Display Set.)

2. WARRANTY DETAILS

a. Under contract number F34601-73-A-2883, order GB14, ASO procured 84 AN/AVQ-24 Head-Up Display systems from E-A Industrial Corp. This order was amended to include provisions for reliability shakedown and reliability verification testing.

(1) Reliability shakedown, consisting of five cycles, each of five hours HUD system operation, is conducted on each system to identify and correct infant mortality failures.

(2) After completion of reliability shakedown the contractor performs a reliability verification test on each system to demonstrate that the MTBF (Mean Time Between Failures) meets the requirements of MIL-D-81879 (350 hours MTBF). The reliability verification test consists of a minimum of 50 hours of operation for each system. The MTBF is determined by dividing total operating hours by the number of relevant failures.

(a) If the reliability verification indicates a reject condition, the contractor is responsible for making the necessary changes at his cost in all production sets (including the update of equipment already produced under this contract) to remove potential additional failures of the nature which produced the reject condition.

(3) In addition, the contractor warrants the failure free operation of each system for 50 operating hours, or a period of one year from the date of delivery to the Navy.

b. Contract number F34601-74-A-0081, order GB31 is a follow-on to the above contract, providing for an additional 42 HUD systems to the quantity procured above. The reliability provisions of this contract are essentially the same as those detailed above for contract F34601-73-A-2883.

c. Equipment which fails in service after the expiration of the warranty period is repaired by E-A Industrial Corp. under a commercial overhaul contract. (Current contract is N00383-76-A-6330.)

3. TEST PROCEDURES

a. All reliability testing described above is to be conducted by the contractor.

4. SHIPPING CONTAINERS

a. The following reusable shipping containers are to be used for all shipment of the items listed below under this contract:

NSN	NOMENCLATURE	SHIPPING CONTAINER
2RH6605-00-346-2557	Indicator, Digital Display	1RM8145-00-485-8256PF
2RH6605-00-346-2530	Amplifier, Video	2RH8145-00-522-6907DA
2RH6605-00-346-2534	Computer, Digital Data	2RH8145-00-540-1762EE
2RH6605-00-518-4929	Gyroscope, Accelerometer	1RM8145-01-016-3448RA

RT 601B/APN-141(V) RECEIVER-TRANSMITTER

1. EQUIPMENT AFFECTED

a. The provisions of this instruction apply to those RT-601B/APN-141(V) receiver-transmitter assemblies reworked by the NARF NORIS (Naval Air Rework Facility North Island) under an organic RIW program. The units which have been modified to the RIW configuration are identified by NSN 2RH5841-01-017-5528NZ.

2. WARRANTY DETAILS

a. The first organic RIW program was initiated by NAVAIRSYSCOM letter AIR-414C:PB of 24 September 1975. This program (designated Project RAMPART) requires NARF, NORIS to update 200 subject units to an RIW configuration by incorporating changes designed to increase the reliability of this equipment. NARF NORIS in turn warrants that any of these 200 units which fail in less than 200 hours from the previous failure will be repaired without reimbursement throughout the three year period specified for this program. NARF NORIS is required to ship a replacement unit within 24 hours of receipt of a failed unit. In addition, the turnaround time for repair of a particular unit shall not exceed 14 days. The funding for this program was based on a minimum of 100% increase in receiver-transmitter reliability, as reflected by the MTBF (Mean Time Between Failures). These units as required by the program approval will be used only in support of the F-4J and TA-4J aircraft.

3. TEST PROCEDURES

a. Upon failure of an installed unit, the unit is to be subjected to the Minimum Performance Standard tests contained in the field maintenance manual, NAVAIR 16-30 APN 141-1, Tables 6-12 and 6-13. If the unit passes these tests, return it to service; if it fails, take action to return the unit with the required documentation per paragraphs 6b(2) and 6b(3) of this instruction.

4. SHIPPING CONTAINERS

a. Reusable shipping container, NSN 9G8110-00-254-5713 will be used exclusively for all shipments of receiver-transmitter units under this RIW program. The unit will be shipped to NARF NORIS, Attn: Project RAMPART.

AN/APN-194(V) RADAR ALTIMETER

1. EQUIPMENT AFFECTED

a. The provisions of this instruction apply to the following components of the AN/APN-194 (V) Radar Altimeter System manufactured by the Government & Aeronautical Products Division of Honeywell., Inc. only if an unexpired warranty decal is attached:

NSN	NOMENCLATURE	PART NUMBER
2RH5841-00-110-4130WZ	Height Indicator	JG1082AA01
2RM5841-00-110-4882WZ	Interference Blanker	LG1056AB01
2RH5841-00-110-4883WZ	Height Indicator	JG1061AB01
2RH5841-00-110-4912QZ	Height Indicator	JG1073AB01
2RH5841-00-110-6262WZ	Receiver-Transmitter	HG719A4
1RM5841-00-181-0330WZ	Antenna	LG81J1
2RH5841-00-110-8125WZ	Receiver-Transmitter	HG7194A3

2. WARRANTY DETAILS

a. The APN 194 system was originally purchased from Honeywell by NAVAIR under contracts N00019-70-C-0352, N00019-73-C-0086 and N00019-74-C-0090. Under these contracts, receiver-transmitters were warranted for 1500 operating hours or two years after acceptance, whichever occurred first; the remaining components, which do not have elapsed time indicators, were warranted for two years after acceptance. Honeywell was required under these contracts to return the repaired unit (or a replacement unit) within 45 days of its receipt.

b. ASO purchased additional quantities of above APN-194 (V) components under contract number N00383-76-C-1535. This contract is a follow-on to the above NAVAIR contracts, with the same warranty provisions.

(1) The warranty includes the following provision for above Receiver-Transmitters only:

"This equipment shall not be opened during the warranty period except for the purpose of installing a Digital Computer Assembly to allow for use on those aircraft which require a Digital Range Output."

3. TEST PROCEDURES

a. Upon failure of an installed unit, the unit is to be tested in accordance with the applicable checkout procedures listed in the field maintenance manual, NAVAIR 16-30APN194-1. If the unit passes these tests, return it to service; if it fails, take action to return the unit with the required documentation per paragraphs 6b(2) and 6b(3) of this instruction.

4. SHIPPING CONTAINERS

a. The following reusable shipping containers are to be used for all shipment of the items listed below under this contract:

NSN	NOMENCLATURE	SHIPPING CONTAINER
2RH5841-00-110-4130	Height Indicator	00-192-1604
2RH5841-00-110-4883	Height Indicator	00-192-1604
2RH5841-00-110-6262	Receiver-Transmitter	LLS1ZE018
2RH5841-00-110-8125	Receiver-Transmitter	LLS1ZE018

ABEX ADP OUTPUT

PARTS USAGE BY PART NUMBER*

P/N	DESCRIPTION	TOTAL QTY.
50068	PLUG-PROTECTIVE	155
50071	PLUG-PROTECTIVE	155
50114	PLUG-PROTECTIVE	155
50699	KIT-PACKING	1
52649	WASHER-FLAT	24
52963	PLATE-RETAINING SHOE	37
52997	PIN-STR HDLS	29
53566	INSERT-HELICAL COIL	80
53570	PLUG-PROTECTIVE	38
53575	PIN-STR HDLS	2
53588	SCREW-CAP SOC HD	26
55591	NUT-CHECK	2
55597	INSERT-HELICAL COIL	320
55953	BOLT-MACHINE 12 PT	1696
56438	BEARING-NEEDLE	21

*Extracted from Abex Part Number Master File Printout of 5/77

Enclosure XV-114

ABEX ADP OUTPUT

SYSTEM STATUS SUMMARY FROM 04/76 THRU 03/77 *

			MTBR	MTBF	OPERATING HRS.
UNITS AT NAVY	501				
IN POOL	67	FROM 04/76 THRU 03/77	1595.1	2931.6	108471.7
AT REPAIR	19	NO OF INCIDENTS	68	37	
STRICKEN	2	SINCE 04/02/73	1203.8	2266.7	251609.5
TOTAL UNITS	589	NO OF INCIDENTS	209	111	

TOTAL CONTRACT HOURS	880,500.0
HRS. ACCRUED SINCE 1971	258,992.5
BALANCE REMAINING	621,507.5

*Extracted from Abex Report QC344-B of 3/77

REPAIR ACTIVITY REPORT FROM 04/76 THRU 03/77**

		TOTAL RCD/SHP	04/76 RCD/SHP	05/76 RCD/SHP	06/76 RCD/SHP	. . . .	01/77 RCD/SHP	02/77 RCD/SHP	03/77 RCD/SHP
CYCLE	1	51/45	4/3	3/5	10/9	. . . .	4/3	3/2	6/6
CYCLE	2	11/6	0/	1/	0/1	. . . .	0/	1/1	0/
TOTAL		62/51	4/3	4/5	10/10	. . . .	4/3	4/3	6/6

**Extracted from Abex Report QC344-A of 3/77

ABEX ADP OUTPUT

UNIT STATUS SUMMARY THRU 3/77*

S/N	CYCLE	SHIPPED		INSTALLED		REMOVED		RECEIVED
		DATE	LOC	DATE	BU NO.	DATE	MAL	DATE
133027	2	4273	OCEANA	5279	159456			
133028	1	2019	GAC		158612	3341	977	3351
	2	4266	BETHPA	5297	159825			
133030	1	2020	GAC					
133031	1	2035	GAC	2230	158619	3252	374	3263
	2	4191	MIRAMA	4198	158984			
133032	1	2035	GAC		157984	2314	523	3242
	2	4246	MIRAMA	4339	159006			
133033	1	2047	GAC	3252	158619	3322	799	5328
	2	7005	ENTERP					

*Extracted from Abex Report QC340-A of 3/77

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ASO

MEMORANDUM REPORT

F-14 HYDRAULIC PUMP RIW

STUDY OF ESCALATION

LOTS I - VI

N00383-73-C-3318

Joseph C. Giordano TEE-3

Reported by

20 Sept 1977

Date

Enclosure XVI-117

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	F. ESCALATION MODEL PERCENTAGE CHANGES AND PROGRAM FLIGHT HOUR ADJUSTMENTS	SHEET "F"

ESCALATION

In the Abex contract, N00383-73-C-3318, inflation magnitudes were approved by Defense Contract Audit Agency (DCAA) Van Nuys, CA auditors from contractor submitted inflation rates. The auditors criteria for establishing the percentage escalation allowed were various Bureau of Labor Statistics Data among which were the Gross National Product, Wholesale Price Indices, Implicit Price Deflator Indices, etc. per telcon with Mr. Miska, DCAA Van Nuys, CA, 213-997-3101 and ASO (TEE-3). This memorandum report compares the auditor's approved escalation rates with those determined by an ASO Escalation Model which was presented at the 11th International Logistics Symposium, August 1976, Valley Forge, Pa, sponsored by the Society of Logistics Engineers. The ASO Escalation Model quantifies the outyears economic uncertainty for more equitable risk sharing between buyer and seller on long term fixed price contracts.

The ASO Escalation Model is applied to the F-14 RIW pump under contract and the model is block diagrammed on sheet "A". Various national Wholesale Price Indices (WPI) and Standard Industrial Classification (SIC) labor rates were selected from Bureau of Labor Statistics (BLS) data tailored to the pump under contract. Using the Escalation Model equation on sheet "B" for the BLS data recorded on sheet "C", the indices for labor and material were calculated and recorded on sheet "D". Compatible Overhead Indices were used from "Overhead Index for Aircraft Manufacturing" prepared by American Power Jet Co., Ridgefield, NJ, for NAVAIR 5063 under N68335-75-C-1088, APJ report #761-217. Overhead indices used are recorded on sheet "C" with their corresponding model indices calculated in accordance with the model and listed on sheet "D". Indices were not generated for 1977, as the calendar year 1976 is the last full year of BLS data.

The results of the comparison between DCAA Van Nuys and the ASO Model for Escalation is listed on sheet "E". After allowing for plus or minus one percent equal risk sharing between buyer and seller (for data precision and administrative economy), dollar adjustments were calculated for Lots I - IV, V, and VI for each category of labor, material, and overhead. In each case a small adjustment in favor of the contractor was required in order to maintain his risk to that which was originally negotiated. The escalation dollar adjustments were summed and converted into an equivalent flight hour program reduction, sheet "E". Hence, if the ASO Escalation Model was contractually used instead of the DCAA Van Nuys escalation rates, then for Lots I through VII inclusive, a reduction of 15,508 pump hours warranty coverage with a risk value of $32,117, would have been required in order to maintain buyer/seller risk in equilibrium. Thus, the pump warranty hours would have been reduced from 730,500 to 713,559 or 2.3%. Sheet "F" graphically displays the model escalation rates and program pump hour adjustments.

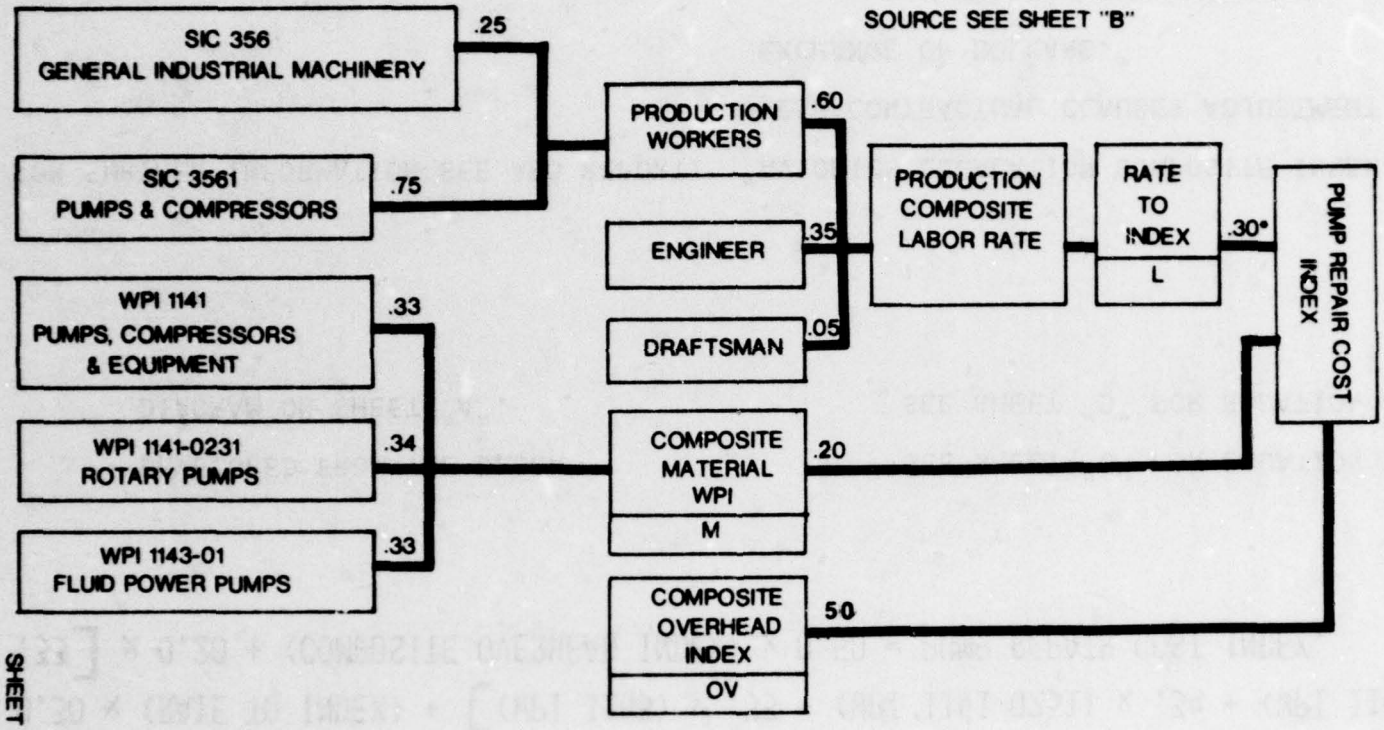
In conclusion, the differences thus far between the DCAA Van Nuys and the ASO Model for Escalation are small enough to consider each as being responsive to past economic changes. However, the ASO Escalation Model

is a dynamic non-linear indicator because, it periodically samples the economic conditions (inflation and recession) during the contract as opposed to a straight line or incremental linear projection/guesstimate (inflation or recession) projected from available past economic data. On this basis, the ASO Escalation Model is considered as being more equitable, more sensitive, and more responsive to changes in economic conditions, and provides a basis to reduce RIW costs by keeping added contractor risks due to anticipated inflation from increasing his proposed costs to a seller.

The results of this inflation study were applied to the economic comparison between the Abex pump's RIW and its most likely support alternative, Abex Corporation RIW Mid Contract Evaluation Contract N00383-73-C-3318, Report No. ASO TEE-2-77, enclosure XIII refers.

ESCALATION MODEL BLOCK DIAGRAM

FOR MODEL EQUATION AND REFERENCE SOURCE SEE SHEET "B"



SHEET "A"

* WEIGHTING FACTORS

ESCALATION MODEL EQUATION*

$$\{[(\text{SIC 356}) \times .25 + (\text{SIC 3561}) \times .75] \times 0.60 + (\text{ENGINEER}) \times .35 + (\text{DRAFTSMAN}) \times .05\} \times 0.30 \times (\text{RATE TO INDEX}) + [(\text{WPI 1143}) \times .33 + (\text{WPI 1141-0231}) \times .34 + (\text{WPI 1143-01}) \times .33] \times 0.20 + (\text{COMPOSITE OVERHEAD INDEX}) \times 0.50 = \text{PUMP REPAIR COST INDEX.}$$

DEVELOPED FROM THE BLOCK DIAGRAM ON SHEET "A".

SEE SHEET "C" FOR EQUATION INPUTS.

SEE SHEET "D" FOR EQUATION RESULTS.

* FOR FURTHER INFORMATION SEE ASO REPORT; "AVIONICS ESCALATION COMPOSITE INDEX, MULTI-YEAR CONTRACTUAL CLAUSES ADJUSTMENT WITH NO EXCHANGE OF DOLLARS."

PLANNING WORK SHEET
NAVMAT-GEN-5200/1 (REV. 9-66)
S/N 0195-LF-202-1101

BLS TELEPHONE DATA (215-596-1154)

SEE NOTE →	WPI 1141 #1	WPI 1141-0231 #2	WPI 1143-01 #3		SIC 356 #4	SIC 3561 #5	ENGINEERS V #6	DRAFTERS II #7	OVERHEAD INDEX #8
CY									
1973	127.5	120.5	106.5		$4.57	$4.48	$9.41	$4.72	154.8
1974	153.0	151.1	118.6		4.91	4.80	9.91	5.01	170.1
1975	187.4	181.0	133.4		5.36	5.28	10.76	5.38	184.1
1976	197.8	195.4	143.0		5.73	5.73	11.56	5.77	196.8

NOTES: #1: Wholesale Price Index (WPI) 1141 defines wholesale material prices of pumps, compressors, and equipment. Values are average yearly with 1967 as 100.00.

#2: WPI 1141-0231 defines average yearly wholesale material prices of rotary pumps with 1967 as 100.00.

#3: WPI 1143-01 defines average yearly wholesale material prices of fluid power pumps with Dec 1970 as 100.00.

#4: Standard Industrial Classification (SIC) 356 identifies the average annual hourly rate of General Industrial Machinery workers.

#5: SIC 356 identifies the average annual hourly rate of pumps and compressors workers.

#6: Engineers V is defined in BLS Bulletin 1837 (National Survey of Professional Administrative, Technical and Clerical Pay - PAT Survey) and is the average annual hourly rate.

#7: Drafters II is defined in BLS Bulletin 1837 - PAT Survey and represents the average annual hourly rate.

#8: "Overhead Index for Aircraft Manufacturing" report by American Power Jet Company, Ridgefield, NY, report #APJ 761-217 prepared for NAVAIR 5063 under contract N68335-75-C-1088.

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TEE-3 AUG 77
PLANNING WORK SHEET
NAVAIR-GEN-5200/1 (REV. 9-66)
S/N 0195-LF-202-1101

ESCALATION EQUATION RESULTS

CY	1973	1974	1975	1976	
WPI 1141 INDEX	1.000	1.200	1.470	1.551	
WPI 1141-0231 INDEX	1.000	1.254	1.502	1.622	
WPI 1143-01 INDEX	1.000	1.114	1.253	1.343	
WPI 1143-0101 INDEX	1.000	1.082	1.158	1.228	
SIC 356 INDEX	1.000	1.074	1.173	1.254	BLS DATA SEE SHEET "C"
SIC 3561 INDEX	1.000	1.071	1.179	1.279	
* OVERHEAD INDEX	1.000	1.099	1.189	1.271	Indices obtained by dividing year in question by the base year 1973 value of the WPI or SIC as applicable
DRAFTERS II INDEX	1.000	1.061	1.140	1.222	
ENGINEERS V INDEX	1.000	1.053	1.143	1.228	
PRODUCTION COMPOSITE LABOR INDEX	1.000	1.065	1.164	1.255	
YEARLY INCREASE	--	6.5%	9.9%	9.1%	LABOR INDEX
COMPOSITE MAT'L WPI INDEX	1.000	1.190	1.409	1.507	Index values obtained using formula on sheet "B"
YEARLY INCREASE	--	19.0%	21.9%	9.8%	MATERIAL INDEX
OVERHEAD INDEX	1.000	1.099	1.189	1.271	
YEARLY INCREASE		9.9%	9.0%	8.2%	OVERHEAD INDEX
PUMP REPAIR COST INDEX	1.000	1.107	1.226	1.313	
YEARLY INCREASE	--	10.7%	11.9%	8.7%	COMPOSITE INDEX

SEE SHEET "E" FOR PROGRAM ADJUSTMENTS

SEE SHEET "G" FOR GRAPH RESULTS

* From Overhead Index for Aircraft Application Report APJ 761-217 prepared under N68335-75-C-1088 and NAVAIR 5063.

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PLANNING WORK SHEET
NAVMAT-GEN-5200/1 (REV. 9-66)
S/N 0195-LF-202-1101

ESCALATION PROGRAM ADJUSTMENTS

	LOTS I - IV 1973	LOTS I - IV 1974	LOTS I - IV 1975	LOT V 1976	LOT VI	COST ELEMENT		
Audit Approved Escalation	4%	4%	4 1/3%	6%		LABOR		SEE NOTE #1
ASO Model Escalation	--	6.5%	9.9%	9.1%				
Escalation Adjustment		1.5%	4.6%	2.1%				SEE NOTE #2
Negotiated Total Labor	←		$400,753.00		→			SEE NOTE #3
Dollar ADJ. Favor Contractor	←		$ 8,837.00		→			SEE NOTE #4
Audit Approved Escalation	5%	5%	5%	5%		MATERIAL		
ASO Model Escalation	--	9.9%	9.0%	8.2%				
Escalation Adjustment		3.9%	3%	2.2%				SEE NOTE #2
Negotiated Total Material	←		$628,373.00		→			SEE NOTE #3
Dollar ADJ Favor Contractor	←		$ 22,003.00		→			SEE NOTE #4
Audit Approved Escalation	4%	4%	4 1/3%	6%		OVERHEAD		
ASO Model Escalation	--	9.9%	9.0%	8.2%				
Escalation Adjustment		4.9%	3 2/3%	1.2%				SEE NOTE #2
Negotiated Total Overhead	←		$50,671.00		→			SEE NOTE #3
Dollar ADJ Favor Contractor	←		$ 1,272.00		→			SEE NOTE #4
Total Dollar ADJ Favor Contractor			$32,112.00			TOTALS		
Pump Hours Per Dollar Procured	0.457		0.669	0.583				SEE NOTE #5
Program Reduction in Pump Hours	8871		5193	2877				SEE NOTE #6
Tot Pump Hrs Prog Reduction Lots I - VI				16941				
Tot Pump Hours Procured Thru Lot VI				730,500				
Pump Hours Reduction Thru Lot VI				2.3%				

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ESCALATION PROGRAM ADJUSTMENTS

NOTES

1. Approved contractual escalation rates per Defense Contract Audit Agency (DCAA), Van Nuys, CA.

2. A plus or minus one percent risk sharing band exists about a predetermined fixed escalation (auditor's rate in this case). This band compensates for the data precision and administrative efficiency of developing the indices. For further information, see ASO Report on the Escalation Model.

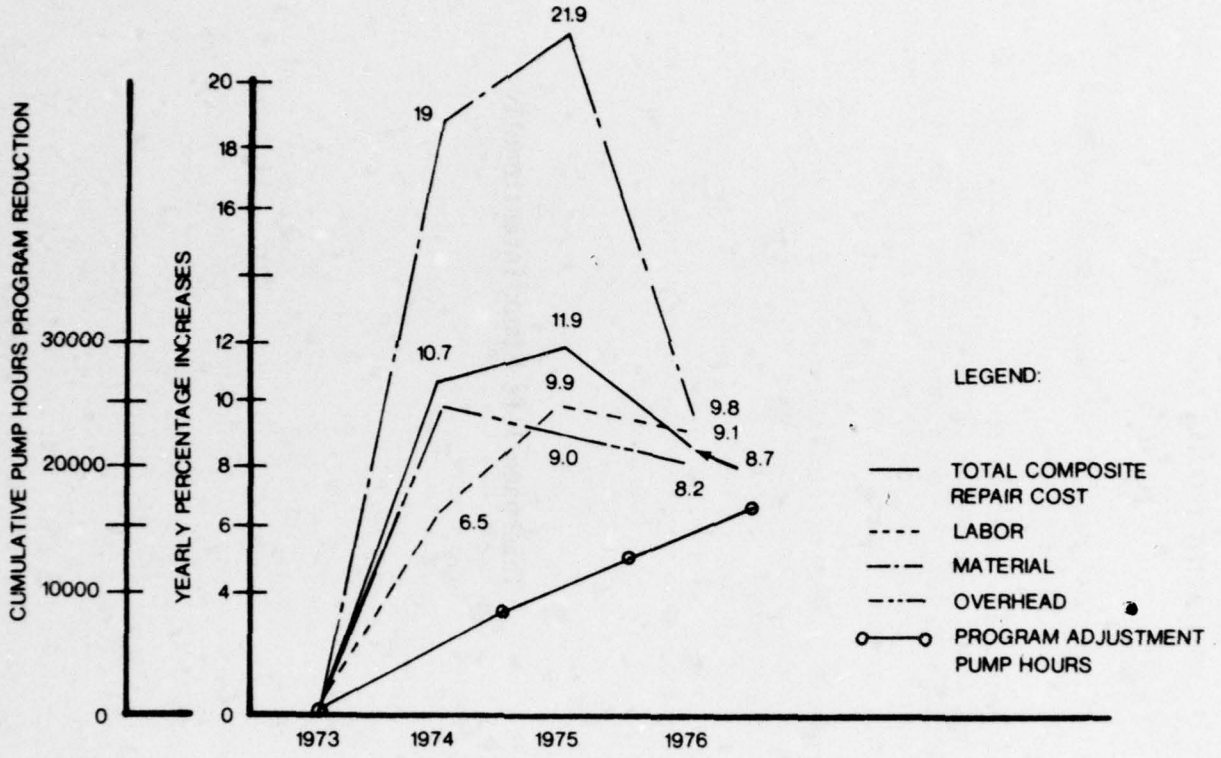
3. Audit reports and negotiated clearances were used to extract labor material, and overhead costs by year in order to compute escalation program adjustments. A cumulative cost for Lots I through VI is shown in lieu of the individual yearly costs. These cumulative costs are shown in order to prevent a competitor from obtaining an unfair advantage by reverse engineering to hourly rates, burdens, etc. This is also in conformance with title 18 USC 1905 which prohibits release to the public of any contractor information contained in audit reports.

4. Dollar adjustment is in favor of the contractor because the ASO model indicates in each case that the escalation was greater than the contractor anticipated/auditor approved rates. Therefore, an adjustment in favor of the contractor is required to return his economic risks to that which was negotiated. Dollar adjustments were calculated by multiplying the yearly negotiated (labor, material, or overhead) rate by the corresponding percentage escalation adjustment. A cumulative dollar adjustment in favor the contractor is recorded in lieu of yearly adjustments for the same reasons described in Note #2 above.

5. This ratio was generated from the information in Table II of the main report.

6. Program reduction in pump hours coverage due to an escalation adjustment was calculated by multiplying the yearly pump hours per dollar by the corresponding yearly total dollar adjustment. The ASO Escalation Model provides for a program utility adjustment rather than exchange of dollars. Dealing in dollar adjustments can lead to day one negotiation re-hashing and trade offs for contract adjustment modifications. Using program utility adjustments (flight hours, equipment hours, miles, landings, etc.), eliminates this problem. For further information, see the ASO Report on the Escalation Model.

F14 RIW HYDRAULIC PUMP
YEARLY ESCALATION PERCENTAGE INCREASES AND PROGRAM ADJUSTMENTS FROM ASO MODEL *



*SEE REFERENCE IDENTIFIED ON THE BOTTOM OF SHEET "B"

SHEET "F"

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(18) (19) **REPORT DOCUMENTATION PAGE**

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: ASO TEE-2-77 (6)	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER: (RIW)	
4. TITLE (and Subtitle): Reliability Improvement Warranty ABEX CORP. RIW MID CONTRACT EVALUATION,	5. TYPE OF REPORT & PERIOD COVERED: MID CONTRACT APRIL 73 TO AUGUST 77
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): (10) OSCAR MARKOWITZ, PE, CPL	8. CONTRACT OR GRANT NUMBER(s): (15) N00383-73-C-3318 New
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Abex Corporation 3151 West 5th St., Oxnard, CA 93030	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: (9) Rept. for Apr 73 - Aug 77
11. CONTROLLING OFFICE NAME AND ADDRESS: Aviation Supply Office 047160 700 Robbins Ave., Philadelphia, PA 19111	(11) 15 OCTOBER 15, 1977
	13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): Naval Air Systems Command Department of the Navy Washington, D.C. 20361 (12) 137p.	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This report provides a case history for RIW contracting to the mid contract point. The RIW contract was the first of its type in DOD combining long term warranty with contract support responsibilities.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

WARRANTY, LONG TERM WARRANTY, FAILURE FREE WARRANTY, RELIABILITY IMPROVEMENT WARRANTY, LOGISTICS, SUPPLY SUPPORT, LIFE CYCLE COSTS, CONTRACTOR RISK, GOVERNMENT RISK, ESCALATION MODEL, RELIABILITY GROWTH, FIELD RELIABILITY, CONTRACT INCENTIVES, CONTRACTOR INCENTIVES, CONTRACT PENALTIES.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

RIW (Reliability Improvement Warranty) is considered by DOD (Department of Defense) as being in a trial phase during which the philosophies, techniques and applications could be wrung out. The Abex RIW contract, about which this report deals, innovated features of no exclusions, support, as well as early timing in the sequence of the life of an item. Thus, the report on this Abex RIW contract is meaningful in terms of evaluating RIW results against other most likely results should an otherwise normal

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support mode have been selected rather than RIW.

The pre-contract history is provided as well as the main conditions and terms of the RIW contract itself. Each area of interest (Program, Administration, Engineering, Logistics and Economics) is reviewed and quantified from data developed for the RIW contract purposes as well as data from other Navy sources obtained for evaluation purposes. Throughout the report, results obtained within the Abex contract are compared against non-RIW alternatives as well as other experiences obtained with other equivalent engine driven hydraulic pumps supported without benefits of RIW.

Conclusions to date can be made that the RIW goals anticipated were more than met and the RIW contract has, in fact, resulted in a most cost effective support alternative available to the Navy. Additionally, the RIW alternative has provided superlative support to the fleet within a Navy investment considerably less than other comparative units used in other front line Navy aircraft. The report provides considerable supportative detail and analysis to back up the above conclusions.