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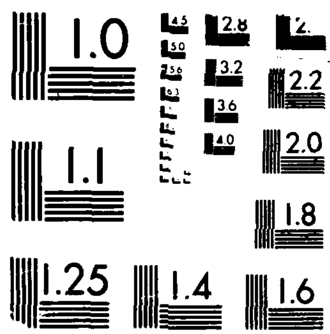

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STUDENT REPORT

Aircraft Battle Damage Repair: Organic or CLSS Support

Major William E. Moseley 88-1905

"insights into tomorrow"

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The aircraft battle damage repair concept is a proven way for a unit to generate additional sorties during wartime. This project compares the effectiveness of CLSS versus organic teams in proving responsive battle damage repair.

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PREFACE

Effective and timely aircraft maintenance contributes to the overall war-fighting capability of combat units. There is, however, concern about the utility of peacetime maintenance practices in a war environment. Thus, a different and unorthodox approach--aircraft battle damage repair--emerged as a means of enhancing the unit's contribution to the war effort. Several studies support the value of a rapid and responsive repair capability. This paper uses results from these studies as a foundation for further analysis of battle repair concepts. The main thrust is war-fighting sustainability. Aircraft maintenance is a contributor to a unit's wartime staying power. Because maintenance covers such a broad spectrum, this paper is limited to the impact of unit-level maintenance in the combat environment. Examples used are not all inclusive, but they support and clarify the paper's theme.

Several sources provided data and opinions to assist the research effort. However, a special thanks goes to Major Hank Taylor (Faculty Advisor), Major Gary Saniford, Lieutenant Jon Hull, Senior Master Sergeant Thomas Locklayer and the Defense Logistics Studies Information Exchange for their assistance. An additional thanks goes to Chris Bruce for superb administrative support.

ABOUT THE AUTHOR

Major William E. Moseley entered the United States Air Force in 1974 and received his commission from Officer Training School. After completing the Aircraft Maintenance Officer Course, he served tours of duty at Altus AFB, Oklahoma; Maxwell AFB, Alabama; Clark Air Base, Republic of the Philippines; and Dover AFB, Delaware. His first assignment was to the 443d Field Maintenance Squadron as Officer-in-charge of the Propulsion Branch. Subsequent jobs include Flightline Duty Officer, Officer-in-charge of the Flightline Branch, Officer-in-charge of the Job Coordination Center, and Maintenance Supervisor. While at Altus AFB, he developed a program to maximize the service life of C-141 aircraft engines. After a career broadening assignment as an Instructor at Squadron Officer School, he served as Maintenance Supervisor for the 3d Equipment Maintenance Squadron. In this job, he spearheaded the first Aircraft Battle Damage Repair Program in the Pacific Air Command. He also managed an initiative at a C-5 aircraft wing which enhanced the unit's productivity by capitalizing on the untapped potential of the aircraft's crew chief. This program evaluated the feasibility of crew chiefs increasing maintenance efficiency and responsiveness by performing certain on-equipment specialist tasks. He has experience on C-5, C-141, C-130, F-4E/G, F-5, T-33, CT-39, F-15, F-16, and A-10 aircraft.

He has a Bachelor of Science Degree in Mathematics and a Master of Art's Degree in Management. Other education includes Airlift Operation's School, Academic Instructor's School, F-4 Familiarization Course, C-5/C-141 Jet Engine Technician Courses, Squadron Officer School, and Air Command and Staff College.

Major Moseley is married and has two children. His decorations include the Meritorious Service Medal (2 OLC), Air Force Commendation Medal, Air Force Outstanding Unit Award, and the Master Aircraft-Munition Maintenance Badge.

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EXECUTIVE SUMMARY

REPORT NUMBER 88-1905

AUTHOR(S) MAJOR WILLIAM E. MOSELEY, USAF

TITLE AIRCRAFT BATTLE DAMAGE REPAIR: ORGANIC OR CLSS SUPPORT

I. Purpose: This paper treats the effectiveness and responsiveness of the Air Force's current approach to aircraft battle damage repair. The ultimate goal is to pursue ways that the aircraft maintenance community could enhance the unit's war-fighting survivability and sustainability.

II. Problem: The current maintenance structure and repair approach might not provide timely repair of combat damaged aircraft, especially during the early stages of the war. Lack of a sufficient number of battle-damaged repair trained technicians rather than lack of technological advancements contributes to the problem.

III. Data: Past wars resulted in massive destruction of property and heavy loss of lives. There is nothing which indicates that these results will be any different in future wars. Compounding the destructive nature of war is having to face an adversary who may possess a numerical advantage in forces. In such an environment, high aircraft losses would affect the unit's war-fighting capability. A key to victory will be how effective a unit can sustain its capability by quickly returning combat damaged aircraft to the battle. Historical events and studies point to the aircraft battle damage repair approach as one way a unit enhances its combat punch. This is a proven way of generating additional aircraft sorties. Currently, aircraft battle damage repair teams from the Combat Logistics Support Squadron (CLSS) support this mission. However, CLSS responsiveness during early stages of the war is critical. So, commands stress survival and sustainment through a unit level battle damage repair capability. To achieve this maintenance posture is not without cost, especially in the training area. Yet, it is feasible for units to develop and train organic teams. The unit level maintenance capability has to be effective and efficient in supporting the war-fighting effort. As such, the unit could off-set the adversary's advantage and contribute to victory.

IV. Conclusions: Technological improvements have not eliminated the fact that aircraft are susceptible to combat damages. In wartime, peacetime repair practices will not result in rapid aircraft generation which could decrease a unit's war-making and sustainability efforts. Responsive and timely battle damage repair enhances the unit's war-fighting ability. Having unit level ABDR capability during future wars will off-set the cost incurred in developing such a maintenance posture. Thus, the ability to rapidly repair combat damaged aircraft is vital for units to maintain wartime aircraft availability.

V. Recommendations: Major commands should increase the emphasis on units developing organic ABDR capability. Units should send ABDR assessors to formal training and subsequently use them as the core to a unit's training program. Training should be realistic and apply to peacetime mission aircraft. In units tasked to deploy, all techni-ians should have an understanding of and skills in rapid aircraft battle damage repair.

Chapter One

INTRODUCTION

Supportability, maintainability, survivability, sustainability--these ideas have received increased significance in recent years as we analyze the factors which influence the nature of war. One of these factors is the threat caused by "potential adversaries who possess vast quantities of sophisticated weapons" (22:1) to use in wartime. In view of our war-fighting capability, this threat has a special impact on the logistics community. As stated in Air Force Manual 1-1, Basic Aerospace Doctrine, "Our war-fighting capability is not credible without the logistics capability for sustained combat operations." (25:4-9) The logistics community must continue to pursue ways of meeting the threat with positive results. These results are summarized in the following:

> To employ effective airpower against these numerically superior forces, the USAF must be able to generate many sorties per aircraft in a short time . . . launch with no warning, recover, reservice, reload and relaunch several times a day in an intense combat environment. (15:v)

This author and many other logisticians feel that the answer to increased war-fighting capability is improved logistical support capability--a capability focused on sustainability, maintainability, and supportability.

As part of the logistics community, the Air Force's aircraft maintenance system is designed to keep its equipment in a safe and serviceable condition, and properly configured to accomplish the mission. (24:1) However, analysis of historic combat data and studies of the effect of the battle damage on aircraft generation highlight a problem inherent in our current maintenance practices. In peacetime, maintenance standards and repair criteria are geared to sustaining the operational life of the aircraft and restoring the structure to its original strength. During future wars, current maintenance techniques will not be responsive enough to support increased sortie generation requirements or to offset the attrition rate associated with battle-damaged aircraft. (5:2) What is the answer?

The solution to increased maintenance capability during future wars is the aircraft battle damage repair (ABDR) concept. This concept is "to use temporary but sound repairs to make the aircraft safe for flight, . . . and enabled it to fly at least one more sortie and contribute to the war effort at the time." (17:2c) This paper will address the aircraft battle damage repair concept as it relates to enhancing our war-fighting capability. To do this, the following problem statement will be analyzed:

> Should each unit have organic ABDR capability, or should they rely on Combat Logistic Support Squadron (CLSS) teams?

The author will answer this statement by looking at five areas: (1) trace the background of the ABDR concept; (2) analyze the effectiveness of the ABDR concept in generating additional aircraft sorties; (3) present data on the unit's capability to support and train ABDR teams; (4) compare using CLSS and organic teams in wartime conditions; and (5) develop recommendations for unit Deputy Commanders for Maintenance. As General Curtis LaMay stated, "logistics provide the muscle for an air force to deliver [and sustain] its war-fighting potential." (4:10) Looking into the history of the ABDR concept, one can see how it allows the maintenance system to support its wartime mission and provide the "muscle" for the Air Force to deliver its war-fighting potential.

Chapter Two

HISTORY OF THE ABDR CONCEPT

From the early days of airpower to the present, historical events have impacted and shaped a maintenance system which is capable of supporting our wartime requirements across the spectrum. The key is wartime. Our first experience with attempting to fix battle-damaged aircraft occurred during World War I. Although small in scope, aircraft mechanics returned some of these airplanes back to service using an early form of battle damage repair such as replacing aircraft parts with those from discarded farm machinery. (15:1) Not until World War II, however, did we realize the value of airpower to warfare. Our current maintenance system grew from the early Army Air Force structure to one that will provide the foundation for increased war-fighting capability. Part of this structure was the Air Force Logistics Command which assumed repair responsibility for battle-damaged aircraft. This support of battle-damaged aircraft gave birth to the aircraft battle damaged repair program. From the early years of airpower to the present, the underlying theme of the maintenance system has been to enhance the Air Force's war-fighting capability.

From WWI to WWII

Of particular interest is the heavy emphasis on maintaining a wartime support capability. Events during World War I influenced this war-fighting emphasis. For example, the Air Service was not prepared for air warfare when the US entered the war. Because the Army saw little importance and utility in air warfare, the Air Service had just a few out-moded airplanes which were in poor shape. Because of this and the lack of spare parts, many times mechanics would improvise and in some cases use parts from discarded French farm machinery to keep airplanes flying. (15:1) This was perhaps the beginnings of the aircraft battle damage repair concept. However, most significant are the ideas of self-containment and mobility during war. These ideas continue when the Air Force published the first Air Force Regulation 66-1, Maintenance Management Policy, in 1953. This regulation became known as the "maintenance management Bible."

As with earlier directives, Air Force Regulation 66-1 further defined maintenance concepts and organizational structure. Not surprisingly, repair responsibility still focused on wartime effectiveness, survivability and sustainability. In discussing maintenance, this regulation states:

> . . . It balances peacetime economy, readiness, and responsibility with wartime effectiveness, flexibility, survivability, and ease of sustainment. . . . maintenance capability which can be applied to produce mission-ready systems . . . theater repair which produces unit mobility and self-sufficiency. (24:1)

The organizational structure retained the concept of three levels of maintenance--organizational, intermediate and depot. However, to achieve this capability, major maintenance and aircraft modifications occurred at one of several depot facilities--each responsible for the repair and maintenance of specific aircraft.

As the Air Force grew, early directives discussed the ability of the maintenance system to "improve the efficiency and performance of the unit." (31:45) Interestingly, there was heavy emphasis on sustaining a war-fighting capability. For example, the basic policies of the maintenance system were as follows:

> Be capable of meeting wartime requirements with the least changes from peacetime operations; be capable of achieving satisfactory results by an average level of ability during war; be self contained within the scope of the unit's responsibility; in tactical organizations, be capable of operating whenever the tactical units are deployed; provide central control at each command level of all maintenance for which that command is responsible. (31:45)

Evolution of ABDR in the Air Force Logistics Command (AFLC)

During WWII, increased use of airpower led to growth in the overall logistics community and eventually to the birth of the ABDR program. Military leaders were beginning to see the contribution of airpower to warfare. The importance of airpower grew as did the importance of the aircraft maintenance capability to support it. (1:62) With an increase in the use of the aircraft during the war came an increase in the number of aircraft which sustained battle damage and required maintenance at one of the depots. As one would conclude, the workload increased at these depot facilities; thus, resulting in the expansion, rapid growth, and complexity of the maintenance system. As a result of this expansion and growth, the Air Force established the Air Force Logistics Command. (1:178) This command was responsible for depot level maintenance and support of aircraft when the Air Force entered the war in Southeast Asia (SEA).

However, the AFLC maintenance program was not structured to support the repairs of all combat damages inflicted on aircraft in SEA. So, when PACAF requested help from AFLC to recover two crash damaged F-105 aircraft, they formed and sent an Advanced Rapid Area Maintenance team consisting of civilian contractors. (15:5) The number of aircraft which sustained some type of crash or battle damage began to increase when the Air Force intensified its activities and expanded the scope of its operations in SEA after the Tonkin Bay incidents. Initially, the civilian contractors sent to Western Pacific facilities absorbed a great deal of this new workload. Limited facilities, however, soon became saturated and forced AFLC to develop a new program to support PACAF's rapidly growing aircraft repair needs. (1:179)

AFLC formed a team which developed the "AFLC Aircraft Maintenance Mobile Repair and Crash/Battle Damage Recovery Plan." (1:178) This was necessary because the initial response to the problem was to send mobile field maintenance vans, especially equipped with tools and materials to support battle damage repair, to PACAF units. However, this nor the depot repair practices supported the tactical forces' requirements while in the deployed mode. A new plan outlined procedures for organizing, equipping, and deploying mobile maintenance or Rapid Area Maintenance teams. A key aspect of the plan focused on the maximum number of working days or man-hours which a maintenance unit could use to repair a specific type of damaged aircraft at the site of the incident, back at the home base, or at one of the depots (now Air Logistics Centers). For example, the F-4C on-site repair limits were 30 days or 1200 man-hours as compared to 90 days or 2500 man-hours for repairs done at the depot. The plan also addressed using mobile rapid area maintenance teams who returned damaged aircraft to a like new condition or made repairs for one-time flight status. (1:179) However, this plan was not responsive enough in a war-fighting environment where rapid aircraft battle damage repair is a must to enhance sortie production.

When AFLC recognized the need to get more involved with direct combat support, they developed the Combat Logistics Support Squadrons (CLSS). The primary mission of CLSS was "to provide highly trained worldwide deployable military teams to accomplish rapid aircraft battle damage repair." (26:1) These teams were ready to respond on short notice and to provide the type of support needed to sustain the fighting power of combat aircraft.

Unit Level ABDR

The Project Warrior emphasis touched every facet of the Air Force and addressed the need for a war-fighting orientation at all levels of the organization. (6:56) The birth and subsequent growth of ABDR concept support the Project Warrior ideals. For example, Air Force Regulation 66-8, Aircraft Battle Damage Repair, states:

> The AF developed a command concept for aircraft battle damage repair which complements the commands wartime tasking. . . . For units tasked to deploy or fight in-place in squadron sized elements, the ABDR capability should be developed as an integral part of the squadron. For units tasked to disperse or deploy in elements smaller than squadrons, the capability should be developed to be an integral part of the accompanying support element. (18:8)

There is a clear and distinct emphasis on the unit enhancing its war-fighting capability by employing the ABDR concept.

Although AFLC provides ABDR augmentation to theaters of operation during war through elements of the CLSS, several major commands have developed programs to further incorporate the ABDR capability within their operations. In each case, there is strong emphasis on establishing a unit level capability to sustain the wartime mission support role within the aircraft maintenance environment. (22:2; 27:1; 29:20; 28:1)

Summary

In some ways, the aircraft battle damage repair concept has been a part of the maintenance system from its inception to the present. There is nothing new or mystical about fixing damaged aircraft. From the early days of aviation to the present, the aircraft maintenance system has been responsible for providing this war-fighting capability. For example, mechanics during World War I had to use ingenuity and keen mechanical skills to keep aircraft flying. In some instances, they returned aircraft to service using techniques which resemble today's aircraft battle damage concept.

From the early Army Air Service Corps days to the birth of the Combat Logistics Support Squadron, the maintenance system has focused on providing a repair capability which enhances wartime effectiveness. During the Southeast Asia conflict, increased use of airpower resulted in an increase in the number of aircraft which sustained some type of combat damage. The Air Force Logistics Command was responsible for returning these crash-or battle-damaged aircraft to service. However, it was not responsive enough and out of this dilemma grew the birth of the Combat Logistic Support Squadrons--each responsible for repairing specific types of aircraft which were damaged in combat. Their primary mission was ABDR during wartime. This enhanced the Air Force's war-fighting sustainability. As a result of Project Warrior emphasis, several commands addressed a unit level aircraft battle damage repair capability. Whether centralized or at the unit level, the ABDR concept is a proven way to enhance unit effectiveness in wartime.

Chapter Three

EFFECTIVENESS OF THE ABDR CONCEPT

The ABDR concept is a proven way to enhance the unit's war-fighting capability by generating additional aircraft sorties at a time airframes are most needed. (17:2) Several experiences during WWI and WWII support the idea that aircraft rapidly repaired and returned to the war-fighting environment could offset an otherwise superior enemy force. The British and Israeli Air Forces have also experienced the effectiveness of the aircraft battle damaged repair concept in generating sorties which could mean the difference between winning or losing a war. Also, several studies of actual and simulated battle damage repair cases support the effectiveness of ABDR. Whether through historical experiences or simulations, it is obvious this maintenance capability enables the unit to generate additional sorties from battle damaged aircraft. Results of these experiences, coupled with studies of actual repair cases, demonstrated the effectiveness of ABDR in enhancing the unit's war-fighting capability. (36:1)

As mentioned previously, the threat caused by a numerically superior adversary presents a special challenge for the maintenance community. (22:1) When hostilities break out, the Air Force can expect the need to generate many sorties in a short time to offset the numerical advantage of the adversary. Current maintenance techniques will not be responsive enough to quickly generate, recover, and regenerate the increased sorties necessary to offset this advantage or the attrition caused by combat damages. (15:4-5) Since it is not reasonable to expect the industrial base to crank out additional aircraft in large quantities with little notice, we must be ready to go to war with what we have. (37:1-4) The Air Force will have to fly many sorties per aircraft to meet mission requirements. Thus, a unit with ABDR capability will provide that edge to effectively counter the threat.

Past Experiences

Several historical events support the effectiveness of ABDR during combat when the attrition rate, due to losses and battle damage, is high. During World War II, the United States decided that Germany posed the greatest military threat to allied forces and required the emphasis in air assets. While in the Pacific, the plan was to hold the Japanese with the remaining aircraft. This forced the Army Air Force and the Navy to struggle to keep their aircraft in the air. Yet, they did it by making maximum use of their resources. (15:3) Analysis of historical combat data suggests that two to four aircraft returned to base damaged for every aircraft lost. (3:2) This situation meant that the maintenance team had to make repairs rapidly and on the spot to sustain any type of airpower. Their quick and timely repairs of battle damaged aircraft created the combat edge--which is what ABDR is all about.

The British also used their unorthodox approach to maintenance to counter the German Luftwaffe which was twice their size during the Battle of Britain. A retired Royal Air Force Vice Marshal concluded that this feat was possible because of repairing battle-damaged aircraft on the spot. (15:1) He said:

> During the Battle of Britain every garage and workshop was called in to carry out repairs. All over the south of England, damaged aircraft parts were rapidly restored by a make shift organization that paid little attention to normal service procedure. From this improvisation, grew an enormous machine that was able to cope with the vast needs of the RAF. (15:1)

Likewise, the Israeli Air Force used ABDR techniques to return battle damaged aircraft to combat within 24 hours during the 1973 Yom Kippur War. Out-numbered and with limited resources (15:3), they developed and used an effective battle damage repair approach to offset their lack in numbers of aircraft. Again, rapid on-the-spot repairs helped to sustain their airpower. For every two F-4 aircraft lost in battle, nine returned home with some type of battle damage. In the first week, for example, 100 separate cases of major battle damage were recorded. This is equivalent to five squadrons of fighter aircraft taken out of the battle. However, early and effective battle damage repairs made the difference in Israel's war-fighting capability. (19:91)

It is not difficult to see how having an aircraft battle damage repair capability could enhance sortie generation. The British used an ABDR capability during its fight with Argentina for the Falkland Islands. They elevated ABDR to something just short of a pure art. (5:15) Several situations support the effectiveness of this approach to maintenance. For example:

> In one case a two-gallon oil can was used to replace a bleed air duct that had blown off in an explosion. . . . One mechanic used carbon fiber to replace broken fuel lines. . . Another used epoxy to secure a piece of clear plastic over a hole in a plexiglass canopy. . . One mechanic faced with an electrical problem had to rewire around some damaged circuits. Instead of cutting into the fuselage, he taped the new wires to the outside of the airplane. (5:15)

These may seem to be strange types of repairs, but the important thing was not their appearance but their effectiveness. This is one way ABDR differs from the standard maintenance repair practices. (15:5)

Some feel that the British were able to sustain their flying operations, which eventually led to victory, because they used an ABDR approach to regenerating aircraft. Of the 40 aircraft damaged in combat, 36 were repaired and flown on additional sorties. (5:15) Quickly returning 90 percent of their force to the skies to further engage the enemy is clear testimony to the effectiveness of ABDR. Because of the nature of the repairs, the pilots initially questioned the integrity of the systems. Yet, after several successful flights, there were few who questioned the repairs. (5:15)

ABDR Studies

Several studies of simulated and actual aircraft battle damage repair support the effectiveness of the ABDR concept. One of these studies, The Impact of Battle Damage on A-10 Availability and Sortie Rate, analyzed the effects of combat damage on close air support aircraft availability and on the combat sortie generation rate. This particular study addressed the sortie potential of two (48 aircraft) A-10 squadrons. Although the A-10 is designed to tolerate damage and be easily repaired, the two squadron's sortie production will still decrease when operating in an environment consisting of radar directed anti-aircraft artillery guns, radar guided and infrared homing surface-to-air missiles. Most of the aircraft damaged by these weapons will, however, have a high probability of returning to the base. (10:12; 21:2) This is when units test the effectiveness of the ABDR concept in generating additional sorties.

Three factors affect the number of sorties the aircraft can fly: servicing the aircraft and loading ordnance, performing unscheduled maintenance, and repairing combat damage. Combining the first two factors with a 12-hour flying day, 3 percent attrition, and 1.5-hour sorties, the two A-10 squadrons could amass 777 sorties during a 10-day period. With a 13 percent combat damage rate, maximum sorties drop to 600. (10:12-13) Now, the task for the maintenance unit is to recover the 177 sorties. Previous studies indicate that this is a classic case to employ ABDR techniques. However, what is the most effective way to produce these sorties?

Using standard procedures to repair damages caused by enemy ground-based air defenses, 50 percent of the damaged aircraft could be repaired in 18 hours. However, studies indicated that temporary repairs of this type of damage could save significant time without compromising the safety or mission effectiveness of the aircraft. (10:13) Since most aircraft components are built with a 150 percent safety margin, repairs don't have to be as strong as the original specification. (5:15) So using temporary repair procedures will result in 50 percent of the aircraft being repaired within 6 hours. (10:51) These temporary repairs represent the type of maintenance which underscores the effectiveness of the ABDR concept.

Furthermore, the Air Force Human Resources Laboratory conducted an F-16 combat simulation which analyzed the impact of different repair approaches on aircraft sortie production. Scenarios ranged from a combat unit using CLSS teams for ABDR support during the first day of hostilities to a unit with no ABDR capability. The results of these simulations were not surprising. For example, a unit with CLSS support on day 1 or with organic ABDR capability would increase its 30-day sortie production 2½ times. The difference in these approaches was the response time it took to return a significant number of battle-damaged aircraft to service. (14:28-31) Currently, the ABDR program requires CLSS teams to be ready to deploy within 48 hours of mobilization to effect battle damage repair. (36:1) Of course, the CLSS deployment teams will have to rely on MAC airlift--a capability which is already overtasked according to the 1981 Congressionally Mandated Mobility Study. This document established 66 million-ton-miles per day of airlift as the minimum wartime support needs in the European theater. Moving the CLSS teams to the theater becomes part of this airlift requirement. However, with the current airlift capability of 48 million-ton-miles per day (45:--), one could quickly see that this shortfall would lead to some type of airlift priority system. What would receive the lower priority? If the CLSS deployment package is not among the higher priority missions, then it is unlikely (in the author's opinion) that CLSS teams will be in-place on the first day of hostilities. Is this a problem?

Well, the F-16 simulation indicated a corresponding relationship in airframe availability and the start of the ABDR capability. Since the capacity of a unit to provide rapid repairs impacts sortie generation, one could easily see the value of having an organic ABDR capability during the first days of hostilities. Data from Southeast Asia aircraft combat damage incidents further supports this idea.

During the Southeast Asia conflict, the Battle Damage Assessment and Reporting Team collected on-site data of US aircraft combat damage incidents. Their comprehensive report analyzed the effectiveness of actual battle damage repair cases of selected aircraft. Although battle damage affects all aircraft systems, a study indicated 91 percent of the incidents involved the structural area. (9:15) Therefore, this paper primarily limits examples to structural repair. The following represents examples of these combat damage incidents. (See note below)

Battle Damage Cases

The first case is repair of a battle-damaged A-37 aircraft. Damage occurred when two A-37 aircraft were tasked to strike hooches suspected to be housing enemy troops. They made three passes of the target, the first as an orientation and the next two to deliver BLU-27 Napalm bombs. On one of these passes, a 7.62 millimeter projectile hit the under surface of the leading edge of the right wing. It penetrated the inner liner of the leading edge, making an approximately 1-inch hole, and proceeded through the outboard leading edge fuel cell, denting the upper surface of the wing. To regenerate this aircraft, flush patches were placed on the lower and upper wing surfaces, and the inner liner and the damaged fuel cell were replaced. These repairs started approximately 30 minutes after the aircraft landed. Within 28 hours, specialist from the fuel, structural repair, and flightline maintenance shops had returned the aircraft to service.

"Note: These cases are taken from the Aircraft Battle Damage and Repair, Volume 1: A Survey of Actual Combat Experience, technical report No. AFWAL-TR-86-3064, pages 9-131, edited by Major W. E. Moseley."

The next example is actual repair of a battle-damaged AC-130 aircraft. Damage occurred when this AC-130 was on a night reconnaissance mission over a mountainous area. While orbiting the area, the aircraft sustained a hit from a 37-millimeter gun emplacement. One projectile entered the lower fuselage belly near the crew entry door, blew a large hole in the skin, and damaged adjacent bulk head support structures. Fragments continued through the fuselage floor panel and exited through the upper right side of the fuselage. The entry hole was 16 inches in diameter and the three exit holes were about 2 inches each. Fragments also damaged a circuit breaker in the area, cut the doppler radar coaxial cables under the floor panels, and caused minor damage to the rear doppler antenna cover on the aircraft's belly. Lower fuselage skin panels were replaced, stiffeners were added to the damaged bulkheads, and the doppler antenna cover and coaxial cables were replaced. Additional repairs included skin patches on the three exit holes and the holes in the floor panels, and a new circuit breaker. Again, squadron maintenance technicians, mostly sheet metal and electrical, made necessary repairs. This aircraft was ready to fly again in 12 days.

The final case is actual repair of battle-damaged F-105D aircraft. Damage occurred when this aircraft was one of a flight of four F-105D aircraft on a strike mission in the valley of a rugged terrain area. On the first pass of the target, they experienced hostile ground fire from 23-millimeter and 37-millimeter guns. A projectile damaged the forward edge of the lower speed brake. It made a small entry hole and exploded in the inner skin. Fragments caused damage to the eyelid area of the lower section of the engine's afterburner, the left hand speed brake segment, and the upper speed brake segment inner panel. To recover this aircraft, the right speed brake segment was replaced, scab patches applied to the top hinge fairing of the left speed brake, the afterburner replaced, and the inner skin on the engine's left sucker door and speed brake were repaired with scab patches. Field Maintenance Squadron technicians, mostly sheet metal and flightline mechanics, made the repairs. This aircraft was back in commission in 79 hours from the start of the maintenance actions.

These examples represent just a small portion of the 1,625 incidents involving battle damage repair techniques during the Southeast Asia conflict. Although the teams collected data on 11,836 incidents, the final report only concentrated on those incidents which are relevant to ABDR techniques. (9:2-3) This paper uses three of these examples which represent a cross-section of the types of US Air Force aircraft damaged in Southeast Asia. However, there is something common in most of these 1,625 battle damaged incidents--the threat and type of damage caused by this threat. As previously mentioned, an analysis of combat experiences in Southeast Asia and in Israel indicated that the primary threat is the enemy's ground-base defense which consist of anti-aircraft artillery and small arms fire. Projectiles from these sources usually enter the aircraft's skin and cause mostly structural and electrical damages. However, an Air Force Wright Aeronautical Laboratory technical report revealed that against this threat, the aircraft's structure was hit 91 percent of the time by a single projectile and over 96 percent of the structure was damaged by fragments from this projectile. (9:15-16) Thus, it is easy to understand how most of the combat battle damage occurred to the aircraft's structure--most of which is within the local unit's repair capability. So, having unit level repair capability is a key to sustained sortie production during a combat situation. (21:3)

Summary

Enhanced sortie production is the primary objective of ABDR. (18:1-1) Several studies, as well as combat experiences by the British and Israeli Air Forces, support the effectiveness of the ABDR concept. Although many of the repairs to combat damaged aircraft during the Southeast Asia conflict were within technical data guidelines, others were modifications or new techniques focused on returning damaged aircraft to mission-ready status as quick as possible. (9:173) From analyzing actual combat damaged aircraft incidents and several simulations, one could readily conclude that an "ABDR capability is vital to our ability to maintain wartime aircraft availability and sortie rates." (17:2c) The bottom line is that the ABDR concept is effective in generating additional aircraft sorties. Since this is proven, then the question becomes can a unit support and train ABDR teams?

Chapter Four

CAN UNITS SUPPORT AND TRAIN ABDR TEAMS?

There is little disagreement that by using ABDR techniques a unit can enhance its effectiveness during wartime, especially by quickly returning battle-damaged aircraft to service. As previously discussed, several studies, simulations, and actual combat experiences support the effectiveness of the ABDR approach. Since effectiveness is not the key dilemma, then the major focus shifts to support and training. More specifically, can field units support and train their people on how to use the ABDR approach to fix battle-damaged aircraft? From reviewing Air Force and several major command ABDR directives, one would quickly conclude that having a unit level ABDR capability is not only feasible but it is also necessary to produce maximum sorties during a combat situation. (17:1) A study of combat damage aircraft in Southeast Asia further substantiates the role of unit level ABDR in generating additional combat sorties. (9:--) Training, of course, is a key. Once trained, technicians form a core of workers who could enhance the unit's ABDR capability and ultimate role in supporting its mission.

Directives Provide Basis

Several Air Force and major command directives establish the basis for a unit level ABDR capability. Recognizing the impact of this capability on enhanced aircraft sortie production, the Air Force revised the Program Management Directive for ABDR in 1983. It addressed ABDR as "an integral part of in-place and deployed forces." (17:2c) Like in previous taskings, the unit had to expand its support capacity without additional resources. However, a unique aspect of ABDR was that it was viewed as "another sortie producing effort" (15:1) which gave theater commanders more flexibility in supporting wartime requirements. (15:6)

Air Force Regulation 66-1, Maintenance Management Policy, also establishes a basis for unit level ABDR as it states:

> It varies by command equipment, and mission, . . . it balances peacetime economy, readiness, and responsibility with wartime effectiveness, flexibility, survivability, and ease of sustainment . . . may authorize theater repair with emphasis on unit mobility and self-sufficiency . . . . (24:5)

Self-sufficiency and wartime effectiveness are part of a theme which continues in Air Force Regulation 66-8, Aircraft Battle Damage Repair. This regulation addresses ABDR as "an integral part of sortie production in wartime." (18:2) As such, it complements a command's wartime tasking as follows:

> For units tasked to deploy (or fight in-place) in squadron sized elements, the ABDR capability should be developed as an integral

> part of the squadron. For units tasked to disperse or deploy in elements smaller than squadrons, the capability should be developed to be an integral part of the accompanying support element. (18:8c)

Several major command directives build on this guidance. For example, they direct units to:

> Provide a pool of trained and equipped technicians to support ABDR in a contingency at a deployed location or at home station (22:3) . . . capitalize on the inherent repair capability of operational units while minimizing additive tools, equipment and training (28:1) . . . ensure an adequate ABDR capability is available when required (29:20) . . . use ABDR teams to augment organic capability and use CLSS teams to satisfy shortfalls or added capability (27:1).

These examples support the emphasis which several commands place on unit level ABDR capability. This emphasis is not without foundation. Several studies of battle damaged aircraft incidents support the idea that units can provide effective ABDR capability. According to data collected by the Battle Damage Assessment and Reporting Teams, many of the battle-damaged aircraft during the Southeast Asia conflict were repaired using organic capability and existing technical order instructions. (9:--) For example, the A-37 and F-105 aircraft cited in Chapter 3 are just two examples of the 1,625 documented cases where field level repairs returned battle-damaged aircraft to combat-ready status. "Most of the repairs . . . were accomplished in accordance with existing technical order instructions but, sometimes modified or new techniques had to be applied." (9:173) In either case, technicians require training to adequate assess and repair battle-damaged aircraft rapidly under combat conditions.

Training Enhances Unit Level ABDR

Training maintenance technicians to make rapid repairs at the unit level could enhance that unit's ABDR capability. The basic ABDR technical order and other weapon-system-specific technical orders, such as 1F-4C-39, provide the general guidelines and repair instructions for battle-damaged aircraft; thus providing the foundation for the ABDR training program. (3:4; 36:1-2) Currently, a general training course and several specified training course at Field Training Detachments emphasize ABDR assessment skills and repair techniques. (36:--) However, since ABDR techniques represent a significant departure from traditional aircraft maintenance practices, all maintenance personnel should be educated on the new techniques and philosophy which enhance this war-fighting capability. Through technical schools and unit level on-the-job training programs, many technicians are often exposed to repair techniques which are also practiced at ABDR courses. For example, formal technical schools in the structural repair, pneudraulic, and electrical fields provide the foundation for the type of repairs used in the ABDR approach. As one field expert summarized:

> The entry level structural repair course teaches the use of scab patches, flush patches, and doublers to make structural repairs . . . . Likewise, entry level electricians are taught how to repair electrical wiring using techniques which are basically the same in the traditional peacetime maintenance environment, or in the wartime ABDR environment. So, most technical school graduates come with some basic skills used in ABDR. . . . Daily maintenance actions using applicable technical data strengthen these basic skills. (40:--)

These basic skills, coupled with ABDR technical orders provide the core of a unit's repair capability. This capability is further enhanced through training.

Several commands recognize the value of training to the unit's ABDR capability. For example, the Tactical Air Command has an extensive recurring training program with the ultimate goal of training all intermediate shop technicians, such as structural repair, hydraulics, and airplane generalist, to use ABDR techniques. (19:100-103) Another has a similar program which emphasizes training existing maintenance technicians to acquire organic capability. (20:--) The common theme in these programs is to "encourage innovation but provide training and technical guidance on how to make structurally and functionally sound repairs." (13:3) By using effective unit level training and ABDR technical orders, the unit can ensure that repairs are based on sound engineering principles, skill, and the judgment of trained technicians. As previously stated, ABDR impacts all areas of the aircraft, but this paper focuses primarily on structural areas since studies indicate 91 percent of combat damage occurs in this area. (9:15) Yet, this does not limit unit training to the structural repair area. For example, unit capability exists to make expedient repairs to hydraulic lines using heat-to-shrink, H-fitting, or permaswage techniques--approaches used in ABDR. (19:65-67)

This author concludes that once trained, units could effectively support ABDR. "The ABDR technical orders (-39 series) are intended to provide additional guidance to train ABDR technicians and assessors." (37:5) With instructors who have expertise in structural repair, avionics, electrics and aircraft general, units could use the general guidelines and instructions of the basic ABDR Technical Order 1-1H-39 to train other technicians.

This may seem overly simplified, but such a training program would be quite effective. While researching the training aspect of ABDR, the author found a TAC unit which used this simple approach to train ABDR technicians and assessors. They developed a simple lesson plan which focused on building a unit level ABDR capability without using formal training. One key to the success of this program was using instructors with previous CLSS experience. Another factor was the quality and expertise of the people in the unit. For example, having weapons-specific knowledge aids the technician in making safe and functional repairs. Once instructors and highly skilled technicians are trained in ABDR techniques, a local program could support other training needs. (43:--)

How is this done at unit level? First, training begins after an Explosive Ordnance Disposal team, or specialist using a recently developed devise, simulate damage from a 23-millimeter high explosive round on an old aircraft or hulk. (37:5, 10) In this case, technicians then use TO 1-1H-39 to assess the damage and effect rapid repairs. Again, using the structural repair area, this manual provides the following:

> General purpose data which may not be available in a combat environment . . . information on fasteners, metal selection, damage cut-out dimensions, repair part dimensions, and the repair of external and internal structural members. (37:6)

To aid the assessor and technicians, guidelines are presented by categories of structure and classes of damage. For example:

> Category 1 structure: Primary airframe structural members which are absolutely essential to maintain an aircraft structural integrity. These include main longerons, bulkheads, spar and ribs, tongue boxes in high stressed areas, and stress panels. . . . Class A, Degraded capability - permit restricted use. . . . Class B, Repairable Damage - Permit structural repair, Restore static strength and stiffness. . . . Class C, Acceptable Damage - No restrictions with no repairs. (11:1-5)

In other areas, such as electrics, unit technicians could use new devises like the computer aided diagnostic system developed to enhance and simplify the identification of wiring damage in systems on the aircraft. This devise features a hand-held data processor programmed with all the wiring data of a particular type of aircraft. It's designed so a 5-level technician could easily and quickly locate wiring damage. Tests have indicated that technicians using this devise could locate damages in 90 seconds as compared to up to 6 hours for a highly skilled technician using traditional trouble shooting techniques. (12:--) With trained instructors, simple to use technical guidelines, and newly developed tools, this means that a unit could train its technicians in ABDR. Once trained, the unit could make a greater contribution to the overall war-fighting capability.

Seeking ways to enhance war-fighting capability is not a new or mythical endeavor. In the past, studies like Air Force 2000 and Future Look addressed the need to change the current maintenance approach. (31:--) Response to this dilemma was the Rivet Workforce initative which was the Air Force's project to establish a more broadly skilled and flexible maintenance workforce. So, the project's main thrust was to develop theater repair capabilities to perform maintenance not normally done at operating locations. (32:--) In other words, the ideas was to have units with greater sustainability and organic repair capability. A by-product of this posture is a leaner workforce which is still capable of supporting the unit's war-making ability. A leaner workforce equates to reduced airlift needs. This seems, in the author's opinion, to parallel the benefits of ABDR.

Recognizing the benefits of ABDR, the Canadian armed forces developed an ABDR program which was basically a unit effort. "For the past six years, [their maintenance] squadrons in Europe have been making steady progress in developing ABDR capabilities to the. . . of carrying out. . . ABDR repair schemes." (19:73) An interesting point with Rivet Workforce and Canadian's ABDR progress is the emphasis on units enhancing their war-fighting capability through organic means.

Summary

As discussed previously, ABDR could be a key to increased sortie production during wartime. Several directives and studies emphasize unit level ABDR and how this capability could enhance the unit's war-fighting ability. To enhance its war-fighting capability, units could support and train ABDR teams. How? Training at technical schools and the ABDR technical orders provide the tools which trained instructors could use to teach ABDR techniques to others. This process results in a unit which should be more effective in a wartime environment.

Chapter Five

CLSS OR ORGANIC ABDR TEAMS

At this point, most would agree that an ABDR capability would enhance a unit's ability to generate required aircraft sorties during wartime. As previously discussed, studies of simulated and actual combat experiences support the effectiveness of this approach to maintenance. However, one might pose a couple of questions on how a unit might best employ an ABDR capability. First, should a unit rely on the CLSS to provide rapid battle-damage repair during wartime or develop an organic ABDR capability? Secondly, will the CLSS teams be responsive enough to meet the unit's battle-damage repair needs during the early days of hostilities? These questions are interrelated for "the capability to rapidly repair combat damage is vital to our ability to maintain wartime aircraft availability and sortie rates." (17:3) In the event of a future conflict, the requirement for missions will be very high, especially in the initial phase of hostilities. (21:3) This implies that responsiveness is one of the variables which impact the effectiveness of ABDR and "could make the difference between victory or defeat." (3:6) As one command pointed out:

> Without an effective capability to rapidly repair battle damaged aircraft, the theater commander can expect to lose a significant number of missions due to damaged aircraft awaiting repair actions. (21:3)

So, can a unit afford to wait for CLSS teams to accomplish battle-damage repairs or should it develop an organic ABDR capability?

ABDR Support Through CLSS

The primary purpose of ABDR is "to restore sufficient strength and serviceability to permit damaged aircraft to fly additional operational missions [sorties]. . . within time to contribute to the outcome of the on-going battle." (21:2) This is one of the primary missions of CLSS is as they form highly trained, worldwide deployable military teams to accomplish rapid ABDR as previously mentioned, these teams are available for deployment within 48 hours of mobilization, if they obtain adequate and timely airlift. Again, airlift seems to be a key factor to a unit achieving responsive ABDR capability in the field during wartime. Because units need this capability at the onset of hostilities, airlift is probably the most effective means for the unit to obtain a battle damage repair capability when it is most needed. Another factor is the total force concept which relies on all elements of the active and reserve forces to prosecute the war. At this point, it is interesting to note the distribution of CLSS teams in the active and reserve forces. For example, with 60 percent of the ABDR force as part of the Air Force Reserve (5:14), one might question the responsiveness of CLSS teams in accomplishing its mission. Let's look at the responsiveness issue in more depth.

Several sources question the responsiveness of CLSS teams in wartime. For example, the Program Management Directive for ABDR states "that in an intense war environment we cannot rely on AFLC's Combat Logistics Support Squadrons to deploy in time to meet all the needs for ABDR." (17:1) The Military Airlift Command stressed that "not enough CLSS teams exist to fulfill all major command requirements." (20:1) This is understandable since each CLSS team possesses unique skills to provide ABDR support on a specific type of aircraft. In wartime, these "teams would split up and deploy to different locations to take full advantage of each team's specialized knowledge." (5:14) For example, CLSS teams at the Ogden Air Logistics Center are responsible for ABDR support for F-4 and F-16 aircraft. So, the number of teams trained on ABDR for F-4 aircraft is limited to the number of CLSS teams at Ogden. Will this meet wartime needs?

Some commands are unsure of the responsiveness of CLSS teams in meeting their mission support needs. For example, "USAFE and PACAF are unsure of the ability of the CLSS teams to deploy after hostilities began because lack of transport availability and enemy interdiction could inhibit CLSS deployment." (14:31) This was highlighted during Team Spirit '87, a PACAF joint service exercise, where results indicated an ABDR capability was critical during the early stages of the war. The fact that CLSS augmentation is airlift dependent helped to influence this conclusion. (19:90-93) The responsiveness of CLSS was also analyzed in the F-16 combat simulation previously discussed. This study indicated a corresponding relationship between aircraft availability and the start of an ABDR capability. Since in-place CLSS teams are not likely, delayed CLSS support could adversely affect sortie production. (14:28-31) So, limited sortie production could conceivably impact a unit's war-fighting capacity. Enhancing a unit's war-fighting capacity--returning combat damaged aircraft to service--is one objective of ABDR. (18:1) However, the value of having a responsive ABDR capability is stressed by the following:

> The time required to restore a damaged aircraft to full mission capability is dependent upon having skilled maintenance personnel available and ready to tackle the repair job immediately upon return of the damaged aircraft to the base. These personnel must be fully prepared to assess the extent of damage . . . and then quickly develop the approach to completing the repair. (9:173)

This points to units possessing an organic ABDR capability.

ABDR Support with Unit Teams

To sustain a unit's war-fighting capability, several sources emphasize the need for ABDR support during the early stage of hostilities. So, the author suggests filling this need with unit level ABDR teams because of constraints facing CLSS teams, such as responsiveness and airlift support. For instance, during contingency operations, strategic and tactical airlift units plan to meet this need by deploying mobility teams with ABDR trained people (22:1) "ABDR kits, personnel, and support equipment are [considered] an integral part of a unit's maintenance mission." (16:7) As such, units will:

> Provide a pool of trained and equipped technicians that may be selectively deployed to recovery or beddown sites. . . . provide a ready work force for repair of damaged aircraft at home station (22:3) . . . be prepared to repair initial damage until supplemental ABDR augmentation forces become available. (21:4) . . . concentrate their capabilities on accomplishing on-equipment repairs through rapid in-place repair . . . (21:5)

This also points to a unit ABDR capability "developed as an integral part of a squadron." (18:3)

The idea that "ABDR concepts are designed to capitalize on the inherent repair capability of operational units" (28:1) is also part of the Tactical Air Command's philosophy. For example, command directives specify that units select a minimum of 6 ABDR assessors for each mobility package of 24 primary assigned aircraft. The remainder of the team consists of fuel, pneudraulic, electrics, structural repair, and airplane general (APG) specialists. (28:2d) TAC's ultimate goal is for its unit to have all of these specialists trained in ABDR. (19:102) This is important because "aircraft damages and the capacity of maintenance operations to provide rapid and effective repairs impact sortie generation." (14:28) For most TAC units who deploy as a complete package, sortie generation rests with the unit's inherent capability to quickly repair damaged aircraft and regenerate them for additional combat missions. (5:15; 19:100) Again, the basic thrust is high emphasis on unit ABDR teams.

An Army study of the assessment and repair of battle damage to helicopter airframe structures also points to a unit level ABDR capability. It concluded that:

> Development of combat damage and repair concepts and the dissemination of this information to field-maintenance operatives [units] are technically, economically, and logistically practical . . . . the skill requirements necessary to effect the repair must not be high or specialized to any degree. . . . Applying the repair concept should ideally require only those skills and tools that are presently available at the AVUM/AVIM [Army field levels of maintenance]. (8:84)

The objective was "to develop a battle-damage assessment technique for helicopter airframe structures useable by Army maintenance personnel in the field environment." (7:14) During a battle-damage assessment demonstration, all four structural repair technicians, having no ABDR training, appeared to grasp the concept with little difficulty and made reasonable repairs. (7:34-44)

This points out that ABDR for helicopter structures is within the capabilities of Army field level maintenance. (7:--)

Although simulations and studies like the one the Army conducted support the unit level repair capability, probably the most convincing measure of effectiveness is to test skills in the field. Surveys of actual combat experiences in Southeast Asia and the combat experiences of the British and Israeli armed forces highlight the effectiveness of a unit level repair capability. However, the author experienced situations where the unit level repair capability was tested to the limit. The first case involved the damage to a C-5 aircraft wing from a direct hit by lightening during a thunderstorm. Although a CLSS team did most of the work to replace the outer wingbox, several unit level specialists from the electric, fuel, engine, and repair and reclamation shops contributed to the overall repair effort. These technicians did not have depot maintenance experience or ABDR training, yet their technical school skills enabled them to provide support which resulted in the team completing the project ahead of schedule and with successful functional check flight results. The other case involved repair of an F-4E at an overseas location which sustained damage to the engineer's afterburner section and surrounding structural panels. After confirming repair actions with a depot structural engineer, unit level technicians replaced the engine and fabricated a special panel in which holes were drilled to simulate cooling fins found on the original panel. One of the most astonishing things about this incident, in the author's opinion, was how the structural repair technician could use ingenuity and basic knowledge of the aircraft to effect an acceptable repair. Another point was that none of the technicians had formal ABDR training. In this case, which resembles a possible combat situation, repairs were not only responsive but also very effective. Because of their efforts, this aircraft returned to service in less than 24 hours and had an uneventful flight across the ocean to the home base. Both examples highlight the unit's inherent repair capability.

Summary

In future wars, an ABDR capability could enhance the unit's ability to regenerate battle-damaged aircraft. ABDR is the primary mission of CLSS in wartime and a proven way to sustain a unit's war-fighting capacity. However, the absence of CLSS teams during the early stages of combat could adversely affect this capacity. Since units need this thrust in war-fighting capacity at the onset of hostilities, organic ABDR teams could provide the edge which results in victory. Examples abound which support going to war with an organic ABDR capability.

Chapter Six

CONCLUSIONS, RECOMMENDATIONS, AND SUMMARY

The purpose of this paper was to explore the effectiveness of the aircraft battle damage repair concept and to determine if each unit should go to war with organic ABDR capability or rely on CLSS teams to meet mission needs. From this research effort, the author drew several conclusions which, if properly treated, should satisfy this purpose. The treatment of these conclusions results in recommendations which could enhance a unit's war-fighting capability. A brief summary will conclude this paper.

CONCLUSIONS

Throughout this research paper, the author approached the problem statement cited in the first chapter with the aim of finding ways which a unit could enhance its war-fighting capability. Accepting that this capability is a function of readiness and responsiveness, one could see how a weakness in either would adversely affect the unit's overall war-fighting capability. In future wars, aircraft maintenance, especially ABDR, could be the key to sustaining this posture. Through research, the author drew several conclusions by addressing the following objectives:

- Trace the history of ABDR.

- Analyze the effectiveness of ABDR.

- Determine if units can provide capability.

- Compare CLSS and organic ABDR support in wartime.

Conclusions

The treatment of the first two objectives combine to illustrate the effectiveness of ABDR. Historical documents, studies of actual and simulated battle damage repair, and war experiences of the British and Israelis highlight the utility of ABDR. This concept also contributes to the wartime effectiveness, survivability and sustainability of a unit. As such, ABDR evolved into a capability which is mainly provided by CLSS during wartime. The bottom line is that ABDR is a proven way of generating additional sorties during a conflict. However, neither the CLSS teams nor the traditional maintenance practices will be responsive enough to quickly regenerate combat damaged aircraft. Units need an ABDR capability at the onset of hostilities.

The next objective focused on units supporting an organic ABDR capability. Air Force has recognized that ABDR enhances a unit's readiness and responsiveness in wartime. Several major commands have also emphasized unit level ABDR capability. Historical data and studies indicate approximately 80 percent of battle damage repairs are within unit level repair capability. Since 91 percent of repairable damage is in the structural area, most advancements and training are in this area. ABDR technical orders provide the foundation for training which combines a new repair philosophy with basic technical skills. Using ABDR experienced instructors and the technical guidance, units have the foundation for a training program. Unit training provides expertise which enhances war-fighting capability. However, research did not indicate how an increased training workload would impact a unit.

The next objective analyzed ABDR application in wartime. A unit could use CLSS augmentation or organic teams to provide an ABDR capability. Sixty percent of the ABDR workforce is part of the Air Force Reserves. Several commands are unsure of the ability of CLSS forces to deploy within 48 hours of mobilization since augmentation is airlift dependent. However, organic ABDR will decrease airlift requirements. Directives emphasize organic ABDR capability. Repairs, especially in the aircraft structural area, are technically feasible and practical for unit level operations. The number of ABDR teams to support a particular aircraft is limited to those CLSS teams trained on that aircraft. Finally, an organic capability capitalizes on the inherent repair capability of units and enhances their war-fighting capacity.

RECOMMENDATIONS

Several recommendations treat the dilemma posed in the preceding conclusions. These actions could enhance a unit's war-fighting capability. So, the author offers the following recommendations:

- Major commands should increase emphasis on developing unit level ABDR teams.

Those assessors and technicians already trained in ABDR could serve as the nucleus for unit teams. Since units are responsible for battle damage repair until augmented by CLSS forces, each unit should form, equip and train enough teams to meet its most stringent mobility taskings. This will create a more flexible and broadly skilled work force to meet future employment needs while capitalizing on inherent organic repair capabilities.

- With CLSS assistance, units should develop local ABDR training programs.

Local programs should capitalize on the unit's repair capability and build ABDR expertise more efficiently. Use formal schools for only assessors and 7-level highly skilled weapon system technicians who could later serve as unit instructors. Expose newly assigned personnel to ABDR techniques during local weapon system familiarization courses. This approach could increase the unit's training workload; however, the benefit of enhanced war-fighting capability should offset any workload increases.

- The Air Force should permit units to apply ABDR techniques to make temporary repairs on mission aircraft.

The units senior maintenance official could authorize ABDR techniques as temporary repairs while awaiting critical parts, such as airframe structures, wiring harnesses or fluid lines. Of course, control of unorthodox repairs is important. So, a special list could outline permissible repairs on a particular weapon system. This could enhance the unit's war-fighting capability by building wartime skills through increasing peacetime hands-on experience.

SUMMARY

In the next war, the adversary could possess a numerical edge in conventional forces. To achieve air superiority, US forces must have the capability to generate many sorties per aircraft, particularly during the early phase of combat. Past experiences indicate the maintenance workload will be high because of damaged aircraft returning to base. In this scenario, the difference between victory or defeat may depend on the unit's ability to sustain its war-fighting capacity by regenerating these damaged aircraft. For the maintenance community, the answer lies in the rapid aircraft battle damage repair concept. However, the question of how to most effectively apply ABDR in wartime is depicted in the following problem statement:

- Should each unit have organic ABDR capability or should they rely on CLSS teams?

The capability to rapidly repair combat damaged aircraft is vital to the unit's ability to meet wartime aircraft needs. Rapid implies responsiveness. So, for maintenance to be responsive in the combat environment, units must emphasize developing an organic ABDR capability. This is not unrealistic since past combat experiences and studies support the effectiveness and feasibility of organic ABDR.

By implementing the recommendations discussed in this paper, one could ultimately enhance a unit's war-fighting capacity. There is not doubt that a combined organic and CLSS battle damage repair capability will achieve the greatest effectiveness. However, the constraints associated with CLSS support drive the pendulum toward organic ABDR. It is not difficult, then, to envision how a strong and effective unit ABDR capability could lead to a credible war-fighting posture. In the next war, organic ABDR could provide a big boost to the wartime capability of maintenance.

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GLOSSARY

1. Aircraft Battle Damage Repair (ABDR). Maintenance actions taken in wartime to return battle-damaged aircraft to some degree of mission capability, through effective use of maintenance resources to assess, defer repair, repair, or cannibalize those aircraft.

2. Aircraft Battle Damage Repair Assessor. Personnel from aircraft maintenance career fields who have been trained to evaluate the extent of battle damage, estimate repair times, specify the repairs to be accomplished, and estimate the resultant capability of the aircraft. Personnel will have attained at least the seven-skill level before entry into assessor training.

3. Aircraft Battle Damage Repair Technical Order. Technical orders (in the -39 series) which provide engineering data necessary for damage assessment and the techniques to repair such damage.

4. Aircraft Battle Damage Repair Technicians. Personnel from aircraft maintenance career field (Air Force Specialty 32XXX, 42XXX, and 43XXX) who have been trained in ABDR techniques. Personnel should have attained at least the five-skill level before entry into ABDR training.

5. Combat Logistics Support Squadron (CLSS). HQ AFLC organizations, including Air Force Logistics Command gained Air Force Reserve CLSS, composed of military personnel in selected maintenance, supply, and transportation career fields. One active duty and one reserve CLSS are assigned to each of the Air Logistics Centers. Teams of varying size are formed from each CLSS, and unit type codes have been defined for each team.

6. Rapid Area Maintenance Team. A large (usually over 100 personnel) team of maintenance, supply, and packaging skills, composed of aircraft battle damage repair teams tasked by unit type code and formed into a repair center work force.

"Items 1-6 above are taken from Air Force Reg 66-8, Aircraft Battle Damage Repair, Washington, DC: Government Printing Office, 29 Nov 84, pages 1-2, and edited by Major W. E. Moseley."

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Other Key Terms

7. Traditional (Peacetime) Repair. Maintenance aimed at restoring non-mission capable aircraft to full structural integrity and systems mission capability. Maintenance actions are designed to preserve lifetime fatigue strength, corrosion resistance, operational safety, and systems availability. (19:63)

8. Rapid Wartime Repair. Maintenance and operation aimed at rapid restoration of non-mission capable aircraft to sufficient structural integrity and minimum essential systems capability so as to generate at least one more effective operational sortie or one-time flight to a repair center. (19:63)

9. ABDR Augmentation Teams. AFLC Combat Logistics Support Squadron maintenance personnel, specially trained in rapid ABDR and organized into deployable teams of varying size and skill composition. Teams are capable of rapid deployment to augment unit ABDR capability in wartime. (19:64)

10. Depot. An establishment for storing supplies or records, for maintaining equipment, or for assembling and processing personnel, or any combination of these three activities.

11. Depot Maintenance. The maintenance, repair, or modification given aircraft or other equipment requiring major overhaul or complete rebuilding of certain parts, and usually provided for only at an air depot.

12. Sortie. Any flight or sally into enemy-held territory or airspace, or any flight undertaken against the enemy, whether enemy airspace is actually reached or not. The sortie endures between take off and the end of flight.

"Note: Items 10-12 are taken from The USAF Dictionary, Air University Press, 1956, pages 162 and 478, and edited by Major W. E. Moseley."

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