Current Procedures for Assessment of Battle-Damage Repair of Fixed-Wing Aircraft

Major Trent A. Greenwell
Department of Engineering Mechanics
2354 Fairchild Drive, Suite 6K-139
USAF Academy, Colorado, USA 80840

trent.greenwell@usafa.edu

ABSTRACT

Battle damage assessments are the key component of an effective battle damage repair program. Under the current US Air Force aircraft battle damage repair program, assessment of aircraft battle damage can be conducted by both specially-trained enlisted military maintenance technicians and military or civilian engineers. Battle damage assessments are conducted and documented following specific procedures outlined in USAF aircraft battle damage repair technical guidance and filed with owning maintenance units, aircraft system program managers, and the Survivability/Vulnerability Information Analysis Center. Specific ABDR technical guidance for each aircraft provides damage tolerance data for the purpose of assessment and repair. A basic set of tools and technical documents is necessary for the assessment process. Assessment can be enhanced by use of additional, optional tools/equipment and consultation with trained engineers and non-destructive inspection technicians.

1.0 INTRODUCTION

Rapid and accurate assessment of aircraft battle damage and repair requirements is critical to an effective aircraft battle damage repair (ABDR) program. In addition to a technical understanding of the extent of damage and associated repair options, ABDR assessment must also consider mission needs, organic repair capabilities, and manpower. Assessment procedures can be founded on different philosophies, such as the Israeli Air Force (IAF) emphasis on permanent, full-capability repairs at the expense of time or the British Royal Air Force (RAF) preference for rapid, temporary repairs to restore partial-capability [1]. The US Air Force (USAF) ABDR program follows a blend of the Israeli and British approaches to battle damage repair, balancing a preference for permanent, full-capability repairs with mission needs and time criticality. Within the USAF ABDR philosophy, assessment can be conducted by specially trained maintenance or engineering personnel following typical process steps and using common tools. When available, engineering assistance or non-destructive inspection (NDI) can provide significant benefits. Assessment procedures can be encompassed by exploring assessment philosophy, process, workforce, tools, and consideration of engineering assistance.

2.0 ASSESSMENT PHILOSOPHY

Battle damage repair philosophy is driven first and foremost by mission needs. If the threat condition is very high, it may be worth the risk of sending a temporarily-repaired or partially-capable aircraft into combat to achieve certain tactical goals. This philosophy is one that values repair speed over restoring full-capability. In conditions where the threat condition is more relaxed, it may be more economical to undertake a more time-consuming and permanent or semi-permanent repair to restore full-capability to a battle-damaged aircraft. These philosophies may change during a conflict based on changes to threat conditions.

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14. ABSTRACT
Battle damage assessments are the key component of an effective battle damage repair program. Under the current US Air Force aircraft battle damage repair program, assessment of aircraft battle damage can be conducted by both specially-trained enlisted military maintenance technicians and military or civilian engineers. Battle damage assessments are conducted and documented following specific procedures outlined in USAF aircraft battle damage repair technical guidance and filed with owning maintenance units, aircraft system program managers, and the Survivability/Vulnerability Information Analysis Center. Specific ABDR technical guidance for each aircraft provides damage tolerance data for the purpose of assessment and repair. A basic set of tools and technical documents is necessary for the assessment process. Assessment can be enhanced by use of additional, optional tools/equipment and consultation with trained engineers and non-destructive inspection technicians.

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A formal ABDR program must be designed around an underlying repair philosophy. For example, the IAF's approach to ABDR relies on aircraft structural engineers incorporated into maintenance teams who serve to assess battle damage and design permanent repairs. This approach relies on trained engineers who can develop original repairs based on engineering principals and who are not dependent on published repair manuals. In contrast to this approach is the RAF approach to ABDR employs a senior non-commissioned officer (NCO) maintenance technician as the battle damage assessor who relies on comprehensive ABDR manuals to enact expedient, temporary repairs in accordance with published technical guidance [1]. The RAF approach is complimented by their overall maintenance concept which employs engineers as maintenance officers, allowing for engineering assistance collocated with the aircraft and not requiring separate, dedicated ABDR engineers. The USAF ABDR philosophy blends both of these approaches into a robust program with both NCO assessors and ABDR engineers that allows for both rapid, temporary repairs and slower, permanent repairs depending on mission needs.

The USAF ABDR philosophy balances mission needs, manpower, available materials, tools and equipment, and time to achieve the best repair option for the situation. This approach is similar to hospital triage in that it assesses each aircraft damage and determines the necessary repair action before establishing a priority for repairs. In general, full-capability and permanent repairs are preferred; however, the USAF ABDR program is structured to accommodate rapid, temporary repairs to satisfy mission needs. Ultimately, an operational commander must dictate mission needs to maintenance commanders to ensure the most-needed aircraft and capabilities are repaired first. When no clear aircraft or capability priority exists, easy repairs are affected first and complex repairs are either sent elsewhere or delayed until convenient to mission needs.

3.0 ASSESSMENT PROCESS

The USAF ABDR assessment process requires flexibility to tailor assessment steps to every unique situation, so these process steps are more guidelines than requirements. For example, the first step in a typical process is to interview the aircrew if the aircraft was damaged in flight, but if the crew are not immediately available, this step should be skipped in order to expedite the repair. With the understanding that these steps are guidelines, the current USAF process for ABDR assessment is as follows [2]:

3.1 Interview the Aircrew

If an aircraft returns from a mission with combat damage, the crew can provide valuable information about the likely extent of the damage as well as any affected systems. For example, if the crew felt the damage occur while in a right-hand bank and the damage appears to be from ground-based small arms, the assessor can estimate the path of the projectile within the aircraft substructure and inspect for further damage accordingly. If the crew states a particular avionics system suddenly failed in flight, that could also be indicative of where to inspect for damage. The crew may also know the source of the damage, such as a missile or an anti-aircraft gun, which can help determine the likely extent of the damage. The crew may also be aware of possible sources of secondary damage, such as a fuel fire on the upper wing which may not be easily visible to the assessor.

3.2 Inspect the Aircraft for Further Damage

Whether or not the crew was available to interview, it is important to conduct a thorough inspection of the complete exterior of the aircraft as well as any accessible interior substructure. A single projectile entry hole may produce multiple shrapnel fragments which can spread out in a wide pattern of damage; concluding an inspection with the discovery of a single damage path can leave significant problems unaddressed. The inspection should be conducted in a methodical manner to ensure no damages are missed. One approach to inspection is to start at the front of the aircraft and move to the rear of the aircraft while inspecting the right-side, then return to the front while inspecting the bottom and move back and forth in this manner until the entire aircraft exterior has been inspected.

3.3 Document the Full Extent of the Damage

Full and thorough documentation of battle damage is valuable in the near term and long term to multiple parties. First, well-documented damage allows the assessor to move away from the aircraft to a more convenient location to determine required repair actions, such as away from the aircraft in a climate-controlled office away from noise and weather where technical data may be stored. Second, thorough documentation of the extent and effects of battle damage can feed an understanding of threat weapon effects allowing for improvements in aircraft survivability design. Finally, well-documented damage can assist investigators in determining the weapon used which may provide invaluable intelligence data to operational commanders and crews. Assessors should carry a digital camera with abundant memory to allow extensive photography of a damaged aircraft. Several photographs should be taken of the every damage from multiple angles using a variety of zooms and lighting.

3.4 Determine Repair in Accordance with Published Technical Guidance

Typically, USAF ABDR assessors are military senior enlisted maintenance technicians who rely on published technical guidance to develop repairs. Usually, an appropriate repair is detailed in ABDR or weapon specific structural repair manuals which a repair technician can use for guidance. If no published instructions for the desired repair exist, the assessor can outline instructions for implementation of general repair guidance for the repair technician. If available, ABDR engineers may also develop repairs from engineering principles and can publish their own technical repair guidance; ABDR engineers are not restricted to using published technical guidance.

3.5 Coordinate Mission Needs with Operations

As mentioned previously, operational commanders must dictate mission needs in order that ABDR assessors can properly prioritize repair actions. Part of the assessment process should include regular consultation with operations to determine current mission needs. For example, several easily reparable fighter aircraft may seem to be the best aircraft to repair first when, in actuality, a more severely-damaged cargo aircraft is desperately needed to airdrop supplies to ground forces trapped in a hostile area. The assessor should never assume mission needs without first consulting with operations.

3.6 Prioritize Repairs

Generally, an ABDR team has only one assessor and many repair technicians. It is important for the assessor to clearly prioritize repair actions in order to efficiently guide repair technicians in their work during the assessor's absence. Repair priorities can be subject to change based on changing mission needs or conflicts with manpower, material, or equipment. Because of these possible contingencies, an assessor should frequently circulate between operations and all ongoing repairs to guide the best actions to meeting mission needs.

3.7 Assign Repair Responsibilities Among Team

An assessor has leadership responsibilities in addition to their technical duties. The assessor is responsible for assigning specific repair tasks to individual technicians and balancing the workload of the ABDR team. For this reason, it is important that the assessor get to know his or her team members and their individual strengths and weaknesses to promote maximum efficiency in meeting mission needs.

3.8 Re-evaluate/Reassess as Required

This assessment step supports a number of previously described contingencies, such as changes in mission needs or reprioritizing repairs due to tool failures, material shortages, personnel injuries, etc. Additionally, assessors must re-evaluate ongoing repairs frequently to ensure they remain within the scope of the original assessment. Damage clean-up and mistakes during repair, such as a misdrilled hole, can inadvertently grow the original damage beyond the originally assessed limits. Preciously unassessed damages which can alter the overall damage assessment may also be discovered while affecting repairs. These situations require reassessment to assure mission needs are still met while also affecting a satisfactory repair.

3.9 Approve Completed Repair

The assessor is responsible for assuring a completed repair meets his or her specifications. Once a repair technician completes a job, the assessor must inspect the repair to assure it is satisfactory and in accordance with published technical guidance.

3.10 Document and Report All Damage and Repairs

In addition to the reasons for documenting damage discussed in paragraph 3.3 above, damages and repairs must be documented to assure they are eventually repaired permanently. If temporary repairs require periodic inspection, aircraft forms must be annotated with sufficient documentation to assure inspection requirements are met. Most field repairs of aircraft structures are semi-permanent at best because they are not able to be instilled with the same corrosion resistance as depot repairs or they do not satisfy configuration control requirements.

4.0 ASSESSMENT WORKFORCE

USAF ABDR assessors are either mid to senior-level NCOs with experience as ABDR technicians who are assigned to a Combat Logistics Support Squadron (CLSS) or ABDR-trained engineers assigned to a repair depot. To become an assessor, a maintenance technician must reach a master skill level in their maintenance specialty and receive the following training:

- Basic ABDR Technician Training
- Basic ABDR Assessment Training
- Weapon System Specific Assessment Training

To be qualified to assess battle damage unique to a specific weapon system, or aircraft model, an NCO assessor must have received training on that weapon system's ABDR assessment manuals. Because of this, NCO assessors are usually qualified to fully assess only one or two aircraft models and to perform only limited assessments of a general nature on other aircraft models. The USAF ABDR program employs weapon system specific ABDR teams within each CLSS, so assessors are usually assigned to teams whose primary focus is the aircraft model the assessor is qualified to assess. These teams are usually employed only to repair their designated aircraft models; assessment and repair of other aircraft models is conducted only in unusual circumstances.

USAF ABDR engineers receive the same training as the assessors with the addition of ABDR Engineering training which focuses on thin-walled structural analysis and fastened joint design. ABDR engineers are typically assigned from weapon system program offices within depot repair facilities. Because ABDR engineers are allowed to deviate from published technical guidance, they are not limited to assess specific aircraft models as are NCO assessors. ABDR engineers are assigned to support specific CLSS teams and will deploy with the team as required. ABDR engineers are also assigned to expeditionary aircraft maintenance units to act as Depot Liaison Engineers (DLEs) capable of providing engineering support on any deployed weapon system in need of repair.

5.0 ASSESSMENT TOOLS AND AIDS

Assessors must be equipped with some specialized tooling to conduct a proper assessment. These tools fall into three general categories: must haves, nice to haves, and enhanced/engineering tools. In addition to assessor tools, non-destructive inspection, when available, can aid damage assessment.

5.1 Must Have Assessment Tools

The tools in this category are the bare minimum tools required to assess battle damage in the field and prescribe repairs.

- Flashlight – the brighter, the better. An extremely bright flashlight can penetrate the darkness of internal structures such as integral fuel cells and highlight subtle damages like cracks and panel buckling. Also, a bright flashlight used to cast shadows on aircraft skin panels can highlight warping, buckling, and other damage.
- Ruler or tape measure – damage measurements are critical to determining reparability.
- Calipers – necessary for accurate measurements of structural components.
- Sheet metal thickness gauge – necessary for accurate measurement of skin panels.
- Blind rivet depth gauge – necessary to prescribe the proper repair fasteners.
- Inspection mirror – most damages are not visible from both sides; using a mirror allows inspection of both sides regardless of internal access.
- Ink marker, or “Sharpie” – pencil should NEVER be used on aircraft metals as it promotes corrosion. Sharpie markers, however, do not cause corrosion and allow assessor notes and diagrams to be drawn directly on the aircraft.
- Basic and weapon system specific ABDR assessment manuals.

5.2 Nice to Have Assessment Tools

The tools in this category are not necessary to conduct ABDR assessment, but are valuable to allow conduct of a more in-depth assessment.

- 10x magnifying glass – for detailed inspection of damage areas for cracks.
- Blue flashlight filter – blue filters help highlight cracks to the naked eye.
- Coin – one of the best tools for assessing the integrity of bonds between metal panels and the integrity of a composite panel is a simple coin used to ‘tap’ along the material surface. This tapping coupled with an astute ear can identify a hollow sound associated with a disbond. An assessor should practice this method on a known disband to learn the difference in sound.

5.3 Enhanced/Engineering Assessment Tools

The tools in this category are not included in a typical tool kit either due to cost or practicality for the NCO assessor. These tools are extremely useful when conducting an assessment, however, and are invaluable for engineering repairs.

- 5+ Megapixel digital camera with abundant memory – one of the single most useful tools for thorough documentation and engineering assessment is a digital camera. Comprehensive photographs of aircraft damage are immensely useful when referencing parts breakdowns and manufacturing drawings to develop a a repair. Several photographs should be taken of each damage area to capture the full extent of the damage. This is especially true if the on-site assessor is coordinating repairs with an engineer located elsewhere. A picture is truly worth a thousand words and can dramatically speed repair in this situation.
- Laptop computer with internet connectivity – even without internet connectivity, an available computer with common analytical software such as a spreadsheet program, presentation program, and a photo manipulation program can be used to perform and record repair calculations and develop repair instructions. Internet connectivity can be well-worth the economical investment and is extremely useful for outside consultation with depot engineers, the aircraft manufacturer, or other references data available online. Internet connectivity can allow assessor access to depot online data repositories for the following useful documents; these documents can and should also be stored on the laptops hard drive in case internet connectivity is unavailable.
  - Aircraft Integrated Parts Breakdown (ICD).
  - Aircraft Structural Repair Manual (not the same as the ABDR assessment manual).
  - Aircraft Electrical Maintenance Manual.
  - Aircraft Corrosion Maintenance Manual.
  - Aircraft Manufacturer Stress Analyses, if available.
  - Aircraft Manufacturing Drawings, if available.
- Scientific calculator – for the ABDR engineer to perform repair analyses.
- Satellite Telephone – if remotely deployed, a satellite telephone is extremely useful for consulting depot engineers or the aircraft manufacturer for assistance in damage assessment and repair. It is also useful for consulting with operations as to the mission needs surrounding the aircraft under assessment. Battle damaged aircraft are likely to make emergency landings at the nearest airfield or even a remote area of flat terrain, so assessors should always be prepared to travel in order to conduct their job.

5.4 Non-Destructive Inspection as an Assessment Aid

Generally, battle damage is isolated and can be adequately assessed with the naked eye. Battle damage can, however, promote substantial additional damage, such as cracks around fastener holes, due to impact loading or overloading caused by changes in load paths around damaged areas. If NDI-trained personnel are available, they can add significant fidelity to an assessment. Dye-penetrant or eddy current inspections can identify cracks and determine their length. Because aircraft wings and pressurized fuselages are loaded differently in flight than on the ground, a long crack can be hidden from the naked eye by compressive loading. NDI can highlight the presence of these cracks. NDI equipment can also be used to measure electrical conductivity of metal skins and structures to determine the extent of fire or heat damage. Aluminum aircraft skins are heat-treated to achieve specific material properties. Exposure to elevated temperatures can alter this heat-treatment and leave the aircraft vulnerable to overload failure. Camouflage and dark-colored paints do not undergo significant discoloration due to fire or heat exposure and can mask the extent of heat damage. Electrical conductivity tests using eddy current NDI test equipment can detect changes in metal conductivity indicative of altered heat treatments.

6.0 ENGINEERING CONSIDERATIONS

Engineers are crucial to the success of a full-spectrum ABDR program. ABDR and structural repair manuals are limited in scope to relatively common repair actions which can be conducted by maintenance technicians leaving additional options for repairs that may not be covered in the published technical guidance. This is where the ABDR engineer becomes an asset. ABDR engineers are capable of designing repairs outside the scope of the repair manuals to create original and unique repair options. Usually the engineer need not be on-site with the damaged aircraft to provide this capability, but being on-site provides considerable time savings which is the fundamental reason to deploy ABDR engineers with ABDR teams. No specific data regarding ABDR engineer time savings are available to support these assertions; however, data gathered by USAF Depot Liaison Engineers assigned to expeditionary maintenance units since 2007 show over a 90% reduction in aircraft downtime for maintenance versus corresponding with engineers at the depots. In addition to expedient repairs outside of repair manual guidance, ABDR engineers can also act as an additional assessor on the ABDR team since all ABDR engineers are also trained assessors.

ABDR engineers can at times be a hindrance to repair efforts if not used properly. Because engineers are trained to analyze and design repairs from scratch, they can add considerable time and complexity to affecting repairs which are available in published technical guidance. If NCO assessors are available, they should only involve ABDR engineers in repairs that are outside the scope of repair manual guidance or damages that pose a significant challenge to the assessor. Otherwise, the repair outcome is likely to be like surgery where a simple splint would suffice.

7.0 CONCLUSION

Good assessment is the key to effective ABDR. A properly trained and equipped ABDR assessor is the lead entity in defining aircraft damage, determining repairs, and ensuring mission needs are met. Experienced ABDR technicians or engineers can fill the role of ABDR assessors given ABDR assessment training and access to assessment tools.

8.0 REFERENCE

[1] Maj Darrell H. Holcomb, USAF, “Aircraft Battle Damage Repair for the 90s and Beyond,” Air Research Institute Report, March 1994

[2] United States Air Force. Technical Order 1-1H-39. *Aircraft Battle Damage Repair*. 15 Sep 2002

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Presented to:

NATO RESEARCH and Technology Organization (RTO)
Applied Vehicle Technology (AVT) Panel

RTO- AVT-156

Current Procedures for Assessment of BDR in Helicopters

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STRENGTH THROUGH TECHNOLOGY

Distribution authorized to DoD and DoD contractors only; Critical Technology; August 2001. Other requests for this document shall be referred to the U.S. Army RDECOM, ATTN: RDMR.

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Presented by:

Mr. Kevin Rees

Chief, Maintenance Engineering Division (MED)
Aviation Engineering Directorate (AED)

Aviation and Missile Research, Development and Engineering Center

May 2010

Current Procedures for Assessment of BDR in Helicopters

BATTLE DAMAGE ASSESSMENT AND REPAIR (BDAR)

BDAR is the use of specialized aircraft damage assessment criteria, repair kits, and trained personnel to modify peacetime aircraft maintenance standards. The concept includes the safe return of damaged aircraft to a safe location and eventually to battle as soon as possible.

Battlefield Damage Assessment and Repair (BDAR) Manuals For US Army Rotorcraft:

- TM 1-1520-237-BD UH-60 Blackhawk Series
- TM 1-1520-240-BD CH-47 Chinook Series
- TM 1-1520-248-BD OH-58 Kiowa Series
- TM 1-1520-251-BD AH-64 Apache Series

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General Information on Battlefield Damage Assessment and Repair (BDAR)

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- Abide by Highlight in the Manual on BDAR Fixes
- ACM/BDAR – Aircraft Combat Maintenance/Battle-Damage Assessment and Repair
- Scheduled Maintenance/Unscheduled Maintenance and inspections
  - Necessary lubrication
  - Servicing
  - Operational Checks will be performed.
  - When conditions permit, over-flown inspections will be completed
- Scheduled battle-damage inspections will not be deferred

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Unscheduled Maintenance

AMRDEC STRENGTH THROUGH TECHNOLOGY

- Repair of Systems and subsystems not Mission Critical
  - Deferred
  - Further damage
- Accomplish Designated Missions
- Contribute to the Battle
- Deferment of Repairs for a “One Time” Flight or Self Recovery
  - Maintenance Officer or Assessor will make Decision
  - Overall Mission Requirements and Airworthiness of Aircraft

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Battle-Damage Assessment

AMRDEC STRENGTH THROUGH TECHNOLOGY

- Classification Method: TRIAGE
  - Deferment
  - Using Approved Battle-Damage Repair Techniques
  - Extensive repair – 4 to 24 hours, aircraft set aside and repaired as manpower and parts available
- Assessor
  - Ideally Unit aircraft Technical Inspector's will be used as BDR Assessors
  - Identify and Assess Damage and failed aircraft subsystems
  - Isolation, repair methods and procedures
  - Serviceability Standards

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"TRIAGE" Chart Example

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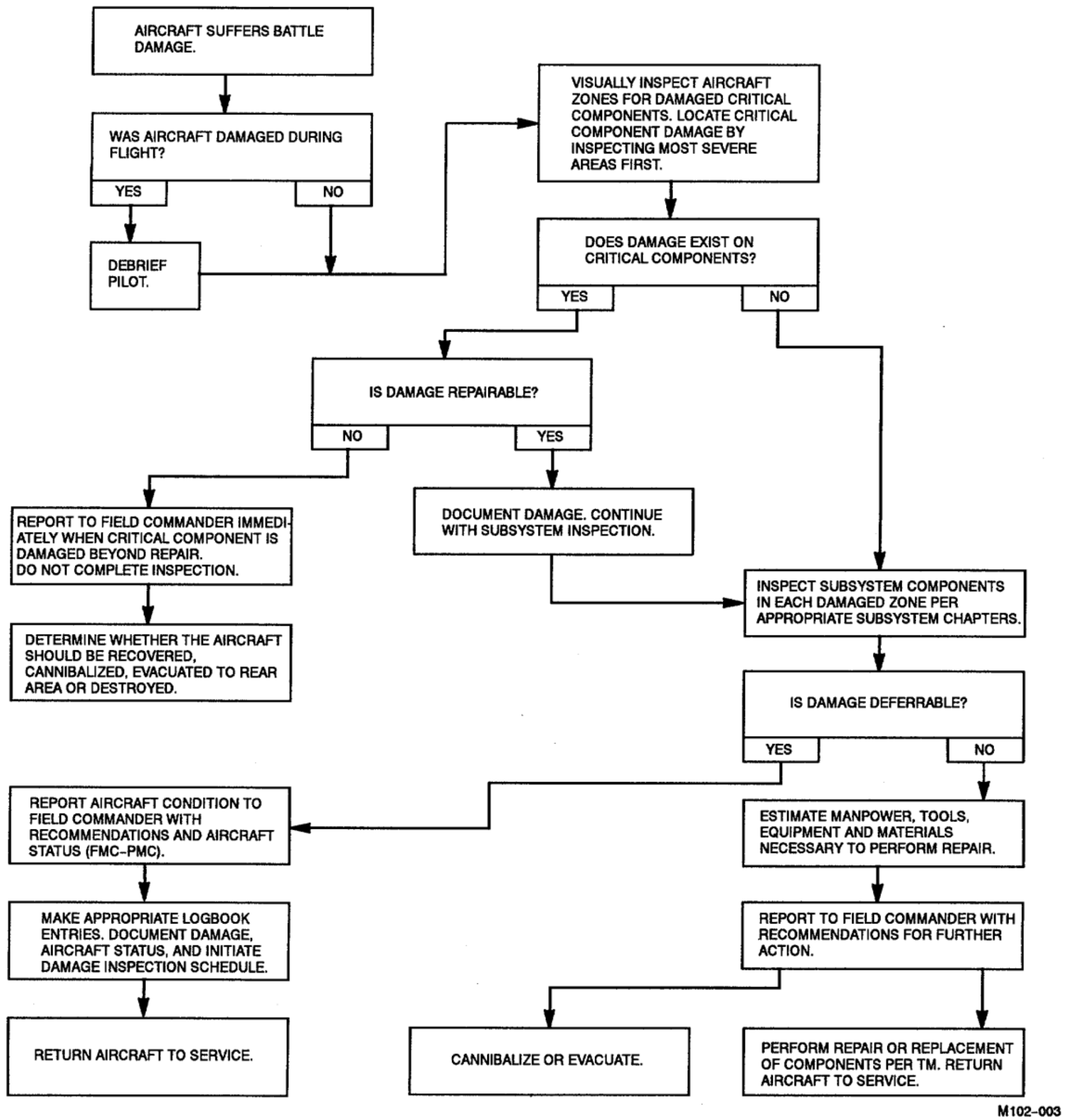

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

BDAR tools and Materials

- Simplicity and Speed
- Use Authorized Tools and Materials where possible
  - BDAR Kits
  - TM/DMWR List of Expendables/Consumables
- AVUM/AVIM Manufactured Tools, with precautions
- BDR techniques are limited only by:
  - Safety considerations
  - Experience and skill of repair personnel

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Battle-Damage Assessment Technique

AMRDEC STRENGTH THROUGH TECHNOLOGY

- Damage Inspection
  - Inspecting for Damage
  - Labeling of Damaged Parts & Components
  - Damage Report
- Damage Evaluation
  - Commander can defer noncritical airframe damage
  - Individual structural members are classified as serviceable or failed
  - Deferred up to 100 hours within limits of manuals
- Repair Deferability Assessment
  - Warning in BDAR Manual
  - Deferment for “One Time” flight or up to 100 hours of combat service with periodic monitoring

Projectile Flight Path and Fragmentation patterns

- **AP-Armor Piercing**
  - **Energy to pass through most airframe structures**
  - **Primary Damage caused by Penetrator**
- **API-Armor Piercing Incendiary - Same as AP plus Fire and Heat Damage Hazard**
- **High Explosive Incendiaries-Complex Threat**
  - **Blast and Overpressure**
  - **Fragmentation**

Battle-Damage Assessment Technique, cont'd

- **Battle Damage Inspection**
  - **Clean Area**
  - **Look for Imbedded Particles**
- **Entrance and Exit Wounds**
  - **Armor Piercing (AP) and AP Incendiaries (API) projectiles**
  - **Delay Fused High Explosive Incendiaries (HEI) projectiles**
  - **Proximity and Point-Detonation HEI Projectiles**
  - **Bomb and Artillery Shell Fragments**
- **Fragmentation Patterns**

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Battle-Damage Assessment Technique, Exit Wounds

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- No Exit Wounds
- Larger then Expected Exit Wounds
  - Broke apart
  - Produced shrapnel
- Exit Wounds not Aligned with Flight Path
- Exit Wounds Smaller then Expected
  - Broke apart
  - Pieces still in aircraft

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Structural areas of inspection

AMRDEC STRENGTH THROUGH TECHNOLOGY

- Cracks
  - Projectile Impact or Penetration
  - Blast Damage
  - Severe Loads
- Structural changes
  - Buckling
  - Misalignment
  - Crippling
- Discoloration - 300 degrees F

Damage Evaluation

- Determines if Structural Member(s) are Serviceable or Failed
  - Passes certain limit
  - Continued service will bring it to that limit
- Damage to each member must be measured
- Primary members
  - Allowable damage size
  - Allowable damage spacing
- Secondary Members - Terms of an Allowable Net Loss of Section: Measured as a Fraction of the Element Cross-Section

Measuring Damage Size

- Measure after smoothing of area if required
- Measure to nearest 1/10th inch
- Include all radiated cracks
- Include hole if damage extends into fastener hole
- Damage between areas
  - Applies to actual damage measured
  - X5 or X10, Damage between two areas applies to largest distance specified by BDAR Manual for that component

Damage Evaluation

- Chapter 2 of TM 1-1520-237/240/248/251- BD is Airframe chapter of repairs
- Section 1 - General
- Section 2 - Battle Damage Assessment Techniques
  - Inspection, locating wounds, locating damage
  - Inspecting for cracks, structural changes, imbedded materials, fire damage, measurement, and evaluation etc.
- Section 3 – Airframe Repairs

90% of all Sheet metal damage was repairable "within the scope of TM 1-1500-204 series repairs"

PC Officer: 1ST-101ST

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AH-64 Battle Damage

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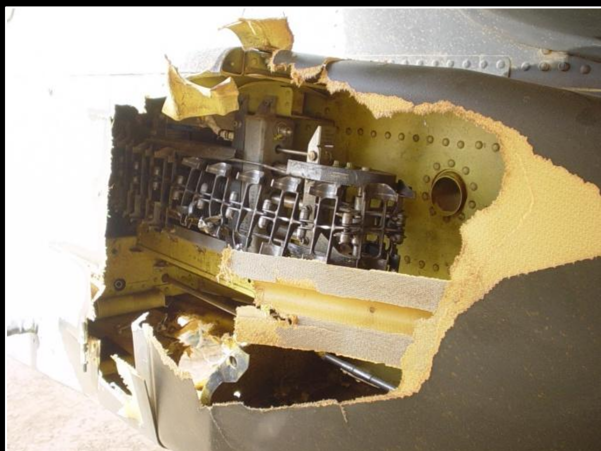
STRENGTH THROUGH TECHNOLOGY

AIRCRAFT 9000288 BDA REPORT
A/C HRS 1977.0



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AH-64 Battle Damage

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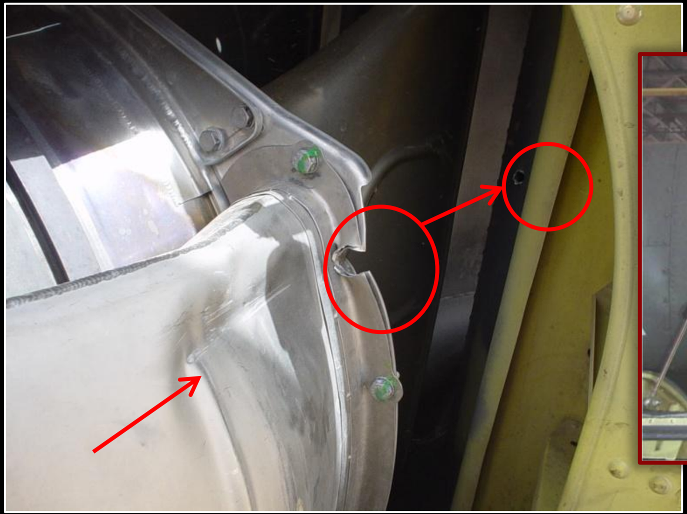
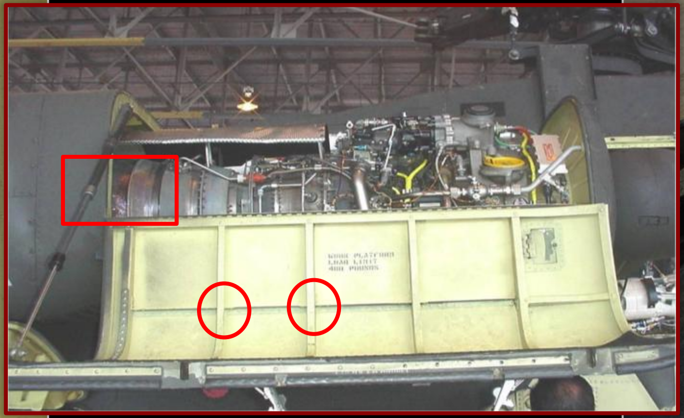
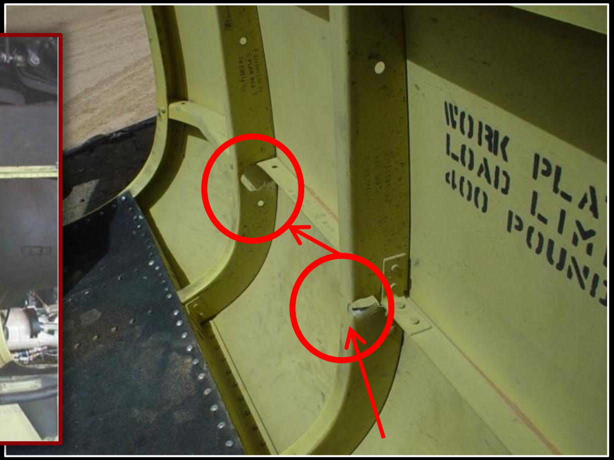
STRENGTH THROUGH TECHNOLOGY

AIRCRAFT 8900220 BDA REPORT
ACFT HRS 1948.1







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OH-58 Kiowa Battle Damage

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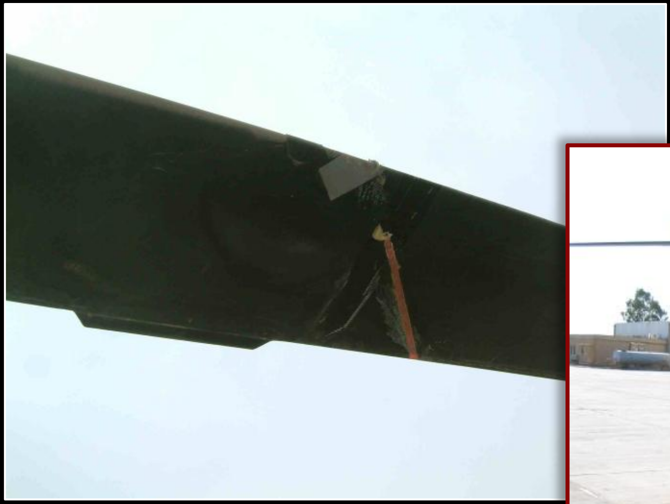

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Liaison Engineer's (LE) in Theater Support

- Serve as on-site AED Airworthiness Liaison Engineer (LE)
- Empowered to provide on-the-spot decisions on a wide variety of aircraft maintenance issues
- Call-back to AED (Redstone & Corpus Christi Army Depot) as necessary for technical guidance.
- Provide units with Maintenance Engineering Calls (MECs) to authorize nonstandard repairs, to address field exigencies, and to resolve crash and battle damage repairs.
- AED LE's have completed over 2000 MECs supporting OIF/OEF in FY09 alone

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Liaison Engineer's (LE) in Theater Support, cont'd

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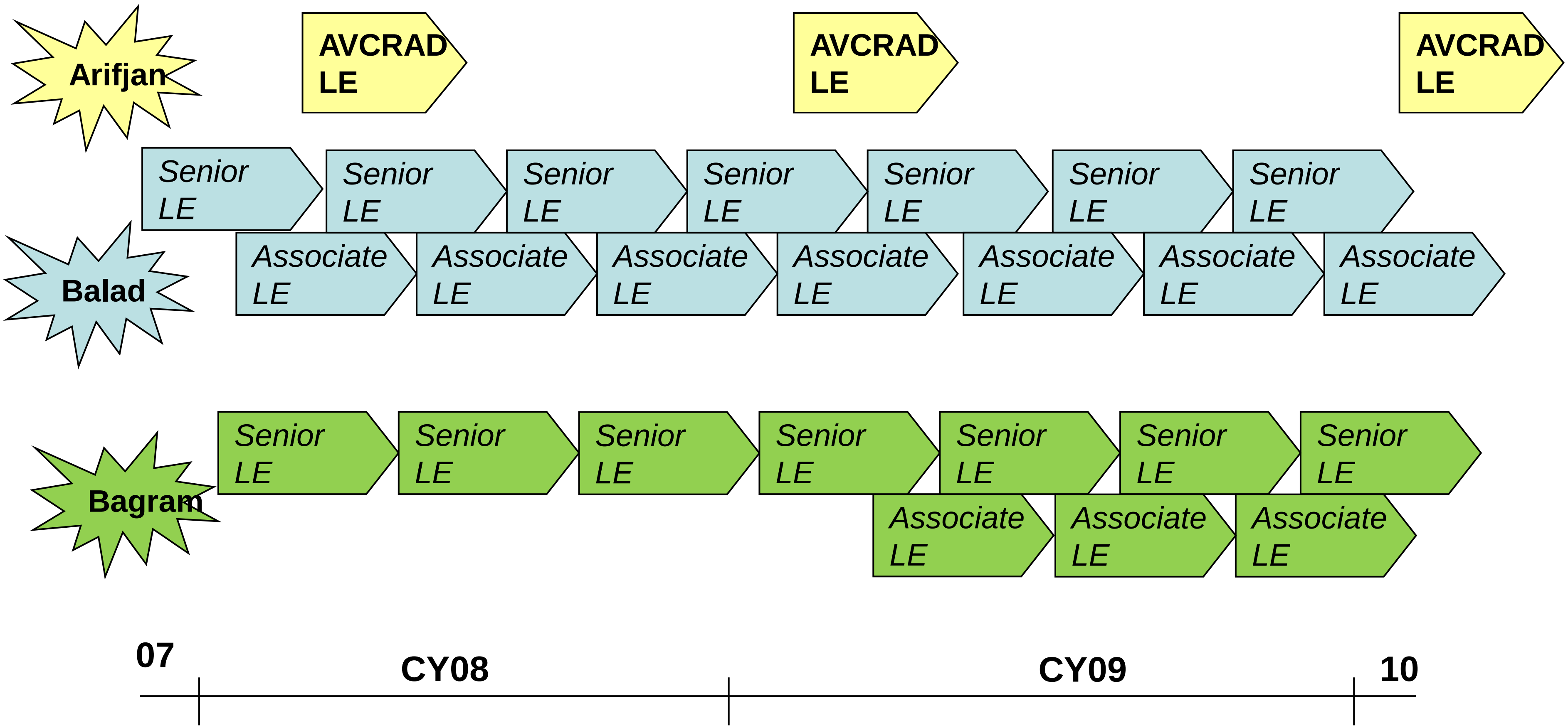
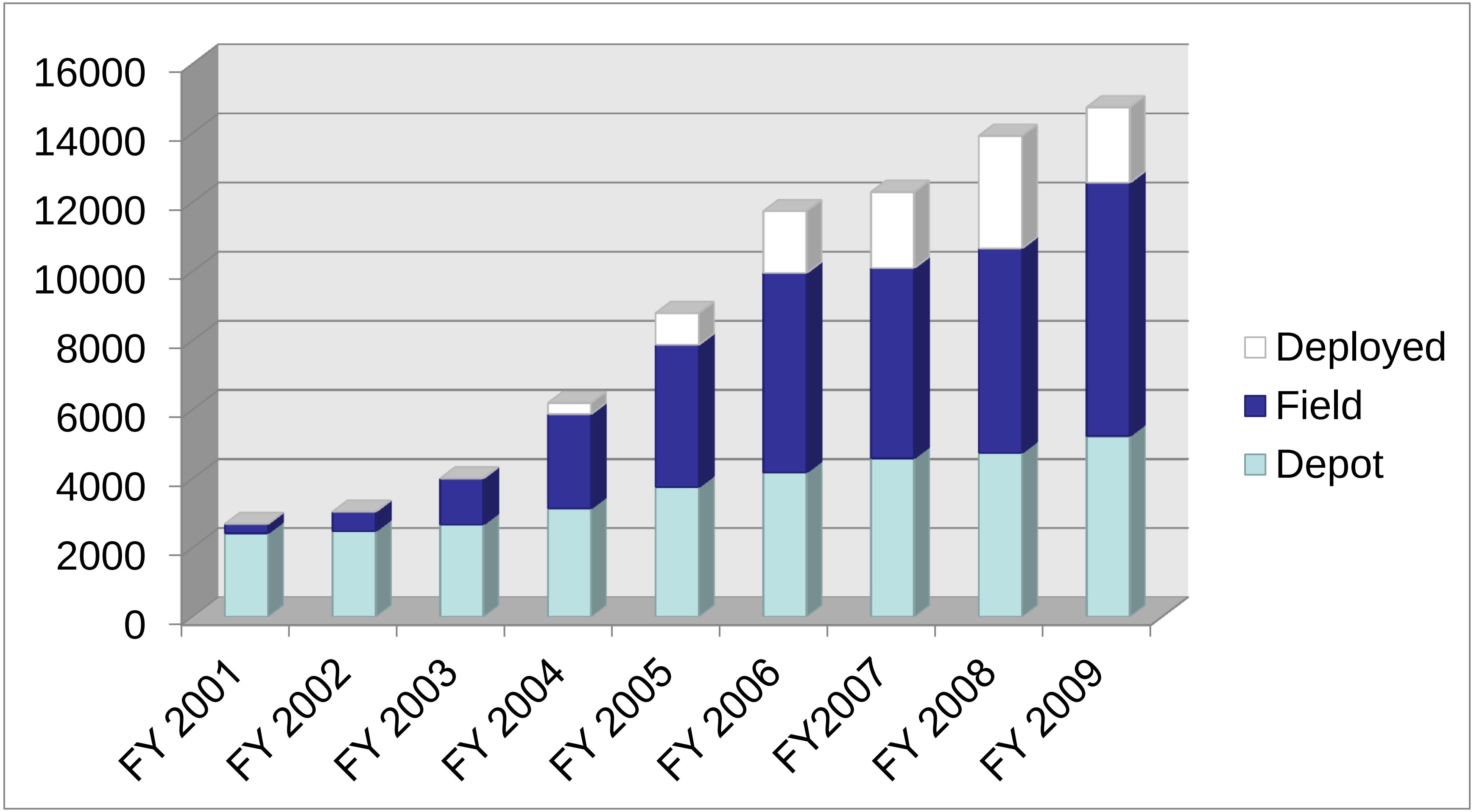


- **Providing Continuous On-Site Engineering Support**
- **120-Day Overlapping Rotations to Both OIF/OEF**

Liaison Engineer's (LE) in Theater Support, cont'd



> 2000 MECs supporting OIF/OEF in FY09

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Field Maintenance Support

AMRDEC STRENGTH THROUGH TECHNOLOGY

- **Aviation Main Officer (AMO)** – Officer in Charge (OIC) of unit aircraft maintenance.
  - BAMO (Brigade/Battalion)
- **Logistics Assistance Representative (LAR**) – assigned to units to assist with maintenance logistics.
  - Usually has a history as an experienced maintainer
  - Submits MECs and works as engineering's link to the unit
  - Electronics LAR (ELAR) supports EOMS/PNVS, also supports Air Warrior.
- **Contractor Field Service Rep (CFSR)** – provides platform specific support from the Original Equipment Manufacturer (OEM).
  - On site at many larger Forward Operating Bases (FOB), some are stationed with units.
  - Access to OEM proprietary data and maintenance engineers.
  - Lockheed-Martin, Boeing-Philly, Boeing-Mesa, Rockwell Collins, BFT, Bell, etc

Field Maintenance Support, cont'd

- **CCAD Representative** – provides link to CCAD specific support
  - Field teams and parts
- **Theater Aviation Maintenance Program (TAMP)** – highest level resource for aviation maintenance in theater.
  - Oversees AVCRAD, engineering, CCAD reps, team of CFSR, etc…
  - Organizes AVCRAD for ACE/A3T inspections, on-site maintenance, and other functions.

Theater Aviation Maintenance Program (TAMP)

One-Stop Shop for All Aviation Supply, Maintenance, and Technical Assistance Above the Combat Aviation Brigade (CAB) Level

- The TAMP is a centrally coordinated Theater Aviation Logistics Program
- Life Cycle Management Command LCMC
- Battle damage assessment & recovery (BDAR)
- Component Repair
- Aviation Classification Repair Activity Depot (AVCRAD's)
- Depot Level Repair Teams
- Back-up Aviation Intermediate Maintenance (AVIM) / Aviation Unit Maintenance AVUM
- Theater Aviation Supply Support Activity (SSA)
- Retrograde Management
- Aviation Ground Support Element (AGSE) Maintenance Teams
- Airframe Condition Evaluation (ACE) – Army Aviation Assessment Team (A3T)
- Rapid Prototyping
- Logistics Assistance Representatives (LAR's), Contractor Field Service Rep (CFSR's) and AMRDEC Liaison Engineers (LE's)

RESET

- Phase +
- Heavy Cleaning
- Med-to-Heavy Airframe
- Modifications (MWO's)

Restore aviation equipment to a fully mission capable condition in accordance with Army Regulation AR700-138 using special technical inspection and repair procedures outlined in Army Technical Bulletins (TBs). Assist Program Managers in fleet configuration control through the application of outstanding Modification Work Orders (MWOs) and perform limited depot repairs.

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ACE/ A3T: AIRFRAME CONDITION EVALUATION – ARMY AVIATION ASSESSMENT TEAM

AMRDEC STRENGTH THROUGH TECHNOLOGY

- Airframe Condition Evaluation (ACE)
  - Purpose is to identify candidate A/C for depot overhaul.
  - Performed annually on every A/C in inventory.
  - Addresses airframe distress/defects only (not components).
  - Uniquely tailored to each Mission Design Series (MDS).
  - Indicators are defined based on engineering evaluation and experience
  - Each aircraft "score" is an accumulation of points assigned to each detected indication.
  - The higher the score, the worse the condition of the aircraft.
- Army Airframe Assessment Team (A3T)
  - Purpose is to decide if aircraft can remain in the fight for another 12 mo.
  - Aircraft that pass A3T as defined as “Stay Behind Equipment" (SBE).
  - Performed annually on every deployed A/C near the end of its rotation.
  - Objective is to identify A/C that must return for repair.
  - Relies on ACE indicators for bulk of specific assessment activity.
- Analysis has shown that aircraft damage in theater (A3T data) is comparable to aircraft damage at home station (ACE data) when normalized for flight hours.