AIRFRAME CONDITION EVALUATION
CORROSION PREVENTION AND CONTROL EVALUATION

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ABSTRACT

The Aviation Engineering Directorate is the airworthiness authority for Army-developed aircraft and provides matrix support to the Program Executive Office for Aviation Programs Project/Product Managers (PM) and the U.S. Army Aviation and Missile Command (AMCOM) Defense Systems Acquisition PMs.

Through advancing technology, the Maintenance Engineering Division strives to equip the War-fighter with the best aircraft available to win battles with confidence and return home safely.

An important aspect of enhancing the performance and reliability of the Army's Helicopter fleet is Corrosion Prevention and Control. The Airframe Condition Evaluation (ACE) and Corrosion Prevention and Control Evaluation (CPCE) program conducts an annual structural evaluation used to determine candidate aircraft for induction into programmed depot maintenance. Environmental, operational, and maintenance data are collected and used for engineering analysis resulting in design improvement. ACE/CPCE data is also used for plotting the location of discrepancies in a computer assisted 3D model providing a quick reference to developing trends.

Keywords: Indicators, Condition Codes, Weights, Profile Index, Threshold

INTRODUCTION

The ACE program was created in 1974 as a means to manage repairs of the Army's post-Vietnam helicopter fleet. The practice of performing an annual evaluation provides an effective method of monitoring the rotorcraft fleet as required in Army Regulation 750-1. However, the ACE evaluation is not a substitute for required maintenance inspections.

The primary purpose for ACE is for the AMCOM to systematically select candidates for depot-level maintenance programs such as service life-extension, recapitalization, and model upgrades. Historical experience and statistical analysis have established that 8% of any rotary wing fleet should be overhauled each year to maintain maximum readiness and safety. Evaluations produce deficiency data used to calculate an ACE score based on overstress, wear, effects of age, operational usage, corrosion, and environmental exposure. The data is categorized into a set of standardized discrepancies called indicators. Each indicator is used to make an objective assessment of specific airframe distress and corrosion. The ACE data combined with 3D modeling technology provides users with a visual method of analyzing aircraft deficiencies. The ACE data is plotted on a 3D model to illustrate the location and density of aircraft distress and corrosion. Engineers use this data to discover trends and develop repairs to maintain the integrity of the aircraft and safety of its crew.

Additionally, CPCE is performed concurrently with the ACE. This evaluation identifies the number of corrosion occurrences on the airframe and includes components. The corrosion evaluation collects environmental, operational, and maintenance data. These variables enable MED to develop corrosion prevention measures to be implemented Army-wide.

This paper will discuss progress in an ongoing effort to reduce the cost of maintenance through the use of the ACE/CPCE program. Areas of discussion will include an analysis of the current ACE/CPCE methodology and the role it plays in addressing corrosion occurrences in the helicopter fleet.

DESCRIPTION OF THE ACE/CPCE METHODOLOGY

ACE/CPCE is an annual evaluation consisting of a visual inspection and a review of historical records for every helicopter in the Army. The ACE/CPCE evaluators utilize mirrors, borescopes, and other tools to aid in their evaluation. A team of two evaluators examine the aircraft based on predefined indicators.

Definitions:

- Indicators: model specific inspection locations for the structural condition of the aircraft.
- Condition Codes: descriptions of defect types and severity for each indicator (e.g. cracked, corroded, buckled).
- Weights: points associated with each unique indicator/condition code possibility based on severity of defect.
- Profile Index/ACE Score: the sum of the indicator/condition code findings for a given aircraft.
- Threshold: a predetermined point that dictates the minimum profile level requiring depot maintenance.

The ACE/CPCE is designed to provide Army decision-makers key information needed to prioritize depot maintenance inductions. These decision-makers use the ACE/CPCE results to lay out a depot maintenance induction schedule based on the allotted budget and aircraft availability for War-fighters and trainers.

The first step in the ACE/CPCE cycle is the development or modification of ACE/CPCE indicators for each aircraft. Potential indicators are selected empirically using expert engineering judgment based on aeronautical importance, depot versus field maintenance capability, and potential for continuing aircraft deterioration. These potential indicators are then analyzed using operational data from both field and depot maintenance activities. More than 50 structural indicators are currently selected for each aircraft Mission/Design/Series. Once the final indicators have been selected, appropriate condition codes are also selected. For ongoing ACE/CPCE programs, the findings from the previous year's evaluations are reviewed against actual depot findings and indicators are added, dropped, or fine-tuned.

Once the final indicator/condition code selections/fine-tuning is complete, the ACE/CPCE documentation for the evaluators is updated.

The next step is the annual evaluator training and certification. Evaluators from worldwide locations gather for a two-week session where all indicators, condition codes, and issues from the previous cycle are reviewed and discussed. An updated ACE Technical Bulletin is provided to each evaluator who will evaluate at least one example of each aircraft model during training. This is a forum for evaluators to share observations made over the course of the previous ACE/CPCE cycle with engineers. After discussions, evaluators break into teams to perform actual evaluations on the aircraft. The teams then compare their results and any discrepancies are reviewed and resolved. The goal is to insure that all evaluators are looking at and scoring the indicators to a common standard. Improved techniques for the use of mirrors, borescopes, and other inspection devices are shared with all the evaluators. Relative terms such as “excessively worn” and “moderate corrosion” are explained with both photographs and aircraft exhibits. Upon successful completion of the training, evaluators are issued ACE certifications valid for the next 12 months. Immediately following the ACE/CPCE training, evaluators begin performing their evaluations. The results of the evaluations are fed back to the master ACE/CPCE database where Maintenance Engineers analyze results and identify trends of repetitive discrepancies.

The final step in the cycle is the evaluation of the year’s ACE/CPCE results. Recommendations are made to the AMCOM through the annual Technical Review which is used to make depot candidate selections. Once the depot candidate selection and induction schedule is finalized, the cycle is complete.

CORROSION PREVENTION AND CONTROL IN ARMY AVIATION

The estimated annual cost of corrosion for Army aviation and missiles is $1.6 billion.[1] This is why the Corrosion Prevention and Control Evaluation (CPCE) is such an integral part of ACE. The corrosion evaluation includes a visual evaluation of the actual condition of the aircraft structure and components. The data collected includes component replacement history, types of corrosion preventive compounds (CPCs) used, types of surface cleaners, water source, and the aircraft and engine wash frequency. Aircraft storage (e.g. hangar or tarmac) and operating environment comparisons are considered to determine the level of preservation required for a specific operating area. The evaluators also collect aircraft condition data, including indications of corrosion such as blistering paint, pitting, exfoliation, powdery residue, etc…). All findings are recorded in the ACE database including recommended maintenance action (e.g. clean and treat or remove and replace) and level of corrosion damage. Corrosion damage is classified as mild surface corrosion, medium corrosion damage (approximately 5-10% loss of parent metal), or severe corrosion damage (more than 10% loss of parent metal).

The Maintenance Engineering Division is in place to provide corrosion prevention and control measures for the Army aviation community. ACE/CPCE analysis has directly affected the implementation of Corrosion Prevention techniques that have reduced the instances of corrosion identified during evaluations. Some of the corrosion prevention techniques currently in use by Army aircraft maintainers are: antenna gaskets, floorboard tape, CPCs, and coating systems for magnesium components.

Corrosion Prevention Techniques

A very helpful tool that the ACE/CPCE program has is 3-D Mapping. The defect data in the ACE Database, by defect location, is interfaced with a 3-D aircraft model in a computer assisted drawing program (Figure 1). This provides maintenance engineers a visual method of analyzing aircraft defect data to identify trends of repetitive discrepancies over the long term and take corrective action. User defined queries allow further analysis of correlations between defects and other ACE/CPCE reported data.

Corroded Nut plates. Figure 1 is a UH-60 3-D model of tail section corrosion reported over one ACE/CPCE cycle. The 3-D image reveals a trend of developing corrosion between nut plates and the tail cone skin at the main rotor pylon rear fairings. This discovery led to wet install of the nut plates with CA 1000 compound, providing a barrier between dissimilar metals.

[1] Report MEC70T4, *Cost of Corrosion Assessment Guidebook*, Rev. 1, LMI Government Consulting, November 2008, P. 1.

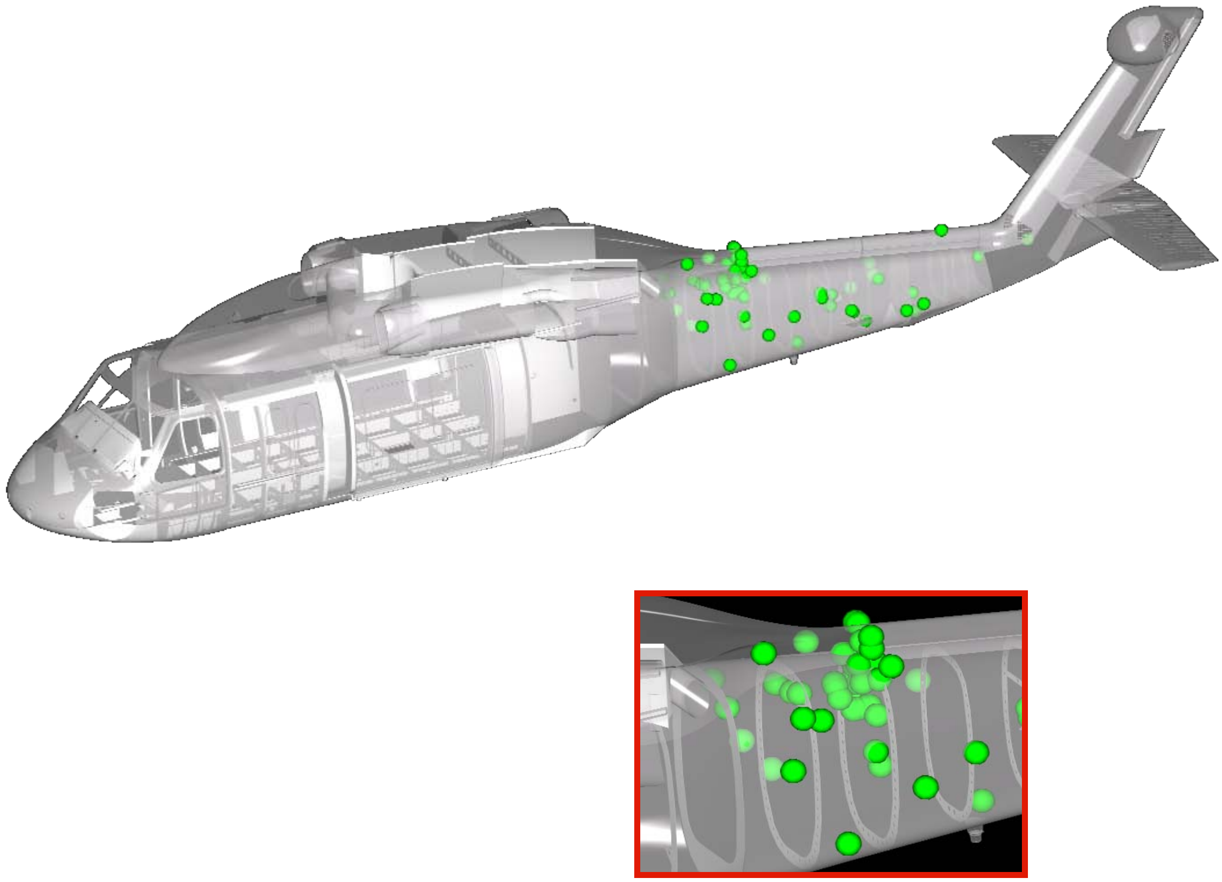

Figure 1. UH-60 3-D Mapping Tail Cone Corrosion

Antenna Gaskets. The challenge of providing a corrosion barrier between antennas and aircraft surfaces posed huge opportunities. As antennas were removed, severe corrosion was repeatedly discovered due to the conductivity requirements. The Army instituted the use of conductive gel-gaskets providing an ideal barrier between the antenna and aircraft surface. Recent ACE/CPCE data analysis has seen a reduction in corrosion around antennas since the use of antenna gaskets.

CPC Application (MIL-PRF-85054). The application of MIL-PRF-85054 in the bilge, avionics, and nose compartment areas of the H-60 aircraft has seen a significant reduction in corrosion since its initial application during Depot Level Maintenance. 3D modeling reflects a significant reduction in corrosion where MIL-PRF-85054 had been applied and no change in previous trends where it had not been applied. The use of MIL-PRF-85054 has been extended to the OEM production lines of the latest H-60 M-model. Present initiatives are to incorporate this CPC to all Army aircraft.

Floorboard Tape (HT3000). In an effort to eliminate chafing between cabin floor boards and the floor formers, a new floor board tape was introduced to replace the P/S 870 sealant. The sealant was found to be an ineffective sealant and made removal of the floor board extremely difficult causing damage to both surfaces. HT3000 is a poly-urethane surface with a gel sealant to provide ease of removal and greatly improved friction resistance.

Coating System for Magnesium Components. Although known for its strength and light weight, magnesium is highly susceptible to corrosion. P/N 750-450-004, a baked epoxy coating, is widely used on magnesium aircraft components Army-wide. The introduction of BT-C-E12-12 as a replacement for Hexavalent Chromium-VI provides a safe alternative for elimination of chromates. The combination of BT-C-E12-12 and 750-450-004 as a coating system is proving to be a superior corrosion resistant barrier. The combination is now approved for use on the AH-64 helicopter with implementation on the horizon for remaining Army aircraft.

CONCLUSION

Corrosion problems have a significant impact on overall costs, readiness, and aircraft sustainment. The ACE/CPCE program enables early detection of emerging structural and corrosion issues. ACE/CPCE data collection better defines the total impact of corrosion and aircraft stresses. The Maintenance Engineering Division is in place to provide corrosion prevention and control measures for the Army aviation community.

REFERENCES

1. Report MEC70T4, *Cost of Corrosion Assessment Guidebook*, Revision 1, LMI Government Consulting, November 2008, P. 1.