DRAFT

Structural Management and Inspection Criteria for Use on Large Air Tankers for USDA & DOI

(5/28/04)

Background

On May 10, 2004, the USDA Forest Service (FS) and the Department of the Interior (DOI) announced that they were terminating the contract for 33 large air tankers used in aerial firefighting due to concerns over the airworthiness of the aircraft and public safety. The decision came in response to findings and recommendations contained in the April 23, 2004, National Transportation Safety Board (NTSB) report on three previous air tanker accidents. One critical NTSB finding stated " it was apparent that no effective mechanism currently exists to ensure the continuing airworthiness of these firefighting aircraft."

The FAA has agreed to immediately provide the USDA FS broad criteria to establish the basis for an effective maintenance and inspection program for the firefighting environment.

The information below focuses on structural engineering and maintenance criteria necessary to be followed in order to assess the associated fatigue state of different model aircraft typically used through contracts by the USDA FS for firefighting. The focus of these criteria is based on the firefighting spectrum which may not have been accounted for when these aircraft were "surplused" from the military.

Corrosion and fatigue are the primary areas of concerns for these 33 air tankers based on the loading spectrum used for fire-fighting. Typically corrosion and fatigue are handled separately from an engineering perspective in terms of inspection intervals. Fatigue inspection intervals typically do not consider corrosion as an element of its fatigue state. However because of the baseline inspections required to evaluate these aircraft there may be overlap inspection areas that need to be cleared for both fatigue and corrosion.

1.0 Assumptions

The following assumptions are required as background in order to understand the current state of engineering capability and maintenance practices used by these 33 air tankers. The assumptions are based on an assessment that the 14CFR Part137 operating certificates are in good standing and that operator certificates and special airworthiness certificates are valid. It is also assumed that operator compliance is always in accordance with the Federal Aviation Regulations (e.g. using approved parts, methods, techniques and practices acceptable to the Administrator are used, component life limits are used and adhered to, trained and qualified personnel are utilized, etc.).

- For non-pressurized aircraft, the areas of focus should be considered the wing, empennage and carry-thru structure. The general fuselage structure would not see significant spectrum loading differences in a fire fighting operation to warrant new assessments within these criteria for the 2004 fire-fighting season.
- Lack of fatigue data, spectrum usage, and damage-tolerance assessments make enhanced inspections minimally effective without baseline assessment of aircraft including possible teardowns.
- It is possible that the fatigue life of some of these airplanes have been exceeded. The FAA historically has not used design life limits to manage aging airplanes.
- Corrosion Control programs have focused more on prevention without establishing a baseline of current assessment of the fleet. Corrosion in conjunction with fatigue may severely hamper the effectiveness of an enhanced inspection program.
- Because of the lack of data and service history with the increased loading spectrum, all principle/primary structural elements (PSE) areas if not replaced must assume that cracks may be present. Current non-destructive inspection (NDI) can ensure only that cracks are small versus eliminated. Specific NDI inspection procedures would need to be developed and approved for each PSE.
- Hidden structure must be assumed to have cracks that may grow to critical where detection cannot be achieved through NDI and or proper fail-safe designs. (Note: The FAA has long moved away from fail-safe without inspection.)
- Inspection programs for the fire-fighting fleet may not be of the scope and detail necessary for the fire-fighting spectrum. Additional and more frequent inspections may be necessary.
- Many of the materials used in these airplanes are more susceptible to corrosion and less resistant to fatigue and crack growth as compared to materials used in more modern airplanes. Stress corrosion cracking and intergranular corrosion is difficult to detect in hidden structure. This is often associated with the 7000 series aluminums.

2.0 Structural Criteria

2.1 Corrosion Control and Prevention Program

- For each model aircraft establish and execute a baseline level inspection program based on a zonal analysis in areas of PSE to establish that no Level 2 or Level 3 corrosion currently exists with the different model aircraft. Where Level 2 and 3 investigations have already taken place between or within the 2003 and 2004 fire seasons on established PSE, no further investigation would be necessary for continued flight.

  Level 1 corrosion is corrosion damage occurring between successive inspections that is local and can be reworked / blended-out within allowable limits as defined by the manufacturer (e.g., service repair manual (SRM), service bulletin (SB), etc.)

  Level 2 corrosion is corrosion occurring between successive inspections that require a single rework/blend-out which then exceeds allowable limits, requiring a repair / reinforcement, or complete or partial replacement of a PSE or other structure listed in the Baseline Program.

  Level 3 corrosion is corrosion found during the first or subsequent inspection(s), which is determined (normally by the operator) to be an urgent airworthiness concern, requiring expeditious action.

- For Level 3 corrosion findings, a modification program much be achieved.
- For Level 2 corrosion findings, repair and/or modification program must be achieved unless the finding can be dispositioned such that blending or other suitable methods can ensure no additional degradation of structure including degrading fatigue characteristics.
- Non-inspectable areas must be assumed to have corrosion and be dispositioned through modification or other means.

  Navy/Air Force prevention programs should be considered for longer-term solutions and should supplement--not replace--inspections.

- An on-going corrosion inspection program should be developed for each model based on the environmental threat.

2.2 Fatigue and multiple element cracking

- Consideration must be given to each model to resist and/or tolerate fatigue damage in the environment peculiar to the special purpose role of fire fighting. All information relating to fatigue resistance such as test reports, existing fatigue life limitations, fatigue oriented maintenance and inspection schedules, must be investigated. Hence, each model aircraft described below must be assessed and/or gain sufficient knowledge to understand fatigue characteristics in order to revise inspection and maintenance program(s) appropriately.
- The following models are individualized as necessary steps required based on assumptions of the level of data obtainable by operators.

P-3 Aircraft

Assumed data status: The P-3 Service Life Assessment Program (SLAP) was generated by the OEM to a more severe loading spectrum (mine dropping near harbors) and may closely represent that of a fire fighting mission with certain considerations. Those considerations should include that the military spectrum may have more inertia relief in the wings than the fire fighting mission and may not account for gust loads in the same manner as in a fire fighting mission. It should also be noted that the vertical load factor was limited to 2.5g on the Restricted Type Certificates from 3.0g used by the SLAP program to account for heavier zero fuel weights. Hence, the SLAP program may have sufficient engineering data to identify:

- fatigue state
- required inspections
- required modifications

We propose the following:

1. Obtain the results from the P-3 SLAP.
2. Adjust the SLAP inspection program and modification program to account for spectrum differences between the USDA FS fire-fighting and the military mining program. Taking a "knock down" factor on current inspection modification program requirements may do this.
3. Implement any new inspection and modification requirements into a revised aircraft inspection program.

P2V Aircraft

Assumed status: Insufficient engineering data is available to affected operators to define the fatigue state of this aircraft.

We propose the following:

1. Establish a baseline fatigue state for each airplane by using engineering assessments in conjunction with detailed inspections (including teardown as applicable), to:

   1.1.1. Where no cracks are found, a determination should be made of an appropriate NDI and inspection interval based on a fire-fighting spectrum. The area found free of cracks should then establish a damage tolerance analysis based on a .05-inch flaw size in order to develop a detectable and critical crack size. Interval inspections should allow for two changes of that flaw to be caught prior to the flaw reaching its critical crack size.

   1.1.2. Where cracks or damage are found, repair and modifications should be achieved and an appropriate NDI and inspection interval based on fire fighting spectrum should be developed. Repairs and modifications should be based on a damage tolerance assessment with a .05 initial flaw unless the structure is considered multiple load path. For multiple load path structure, fatigue principles may be followed.

2. Using the results from the fatigue baseline (established in item 1 above), complete an engineering analysis to predict future inspection intervals.

3. Use the results of item 2 above and existing NAVAIR maintenance document information to establish inspection and modification procedures that would be rolled into a revised aircraft inspection program.

Douglas Aircraft (DC-4, DC-6, DC-7

Assumed status: Service-based inspection data is available through a DC-6 Structural/Supplemental Inspection Document (SID), which identifies a baseline of the necessary inspection locations for the DC-6 previous operating history. Also it is assumed that the DC-6, with some modification areas, may be applicable to the DC-4 and DC-7 aircraft.

We propose the following:

1. Evaluate the DC-6 SID including inspection/maintenance programs to cover PSE that may have been left out originally due to the philosophy used to develop the original SID, including the main spars which may not have required SID type inspections. Data should include service experience from the manufacturer, Federal Aviation Administration, military, civil/commercial, and fire-fighting experiences. Also consider any modifications for structural health that were incorporated by the military or previous civil operators prior to entering a fire fighting operation.
2. Once PSE locations and intervals are established based on a historical analysis, then adjust the SID intervals based on fire-fighting spectrum. A "knock down" factor of less than 7 should not be used to adjust the intervals unless more advance NDI methods can be established. Any factor should also take into account material difference between 2000 series and 7000 series aluminums.
3. Perform the revised SID inspections before resuming fire-fighting missions.
4. Revise the aircraft inspection programs to reflect any changes in the DC-6 SID for on-going programs. (C-54 converted to C-54-DC and DC-7 where applicable.)

2.3 Repair Assessment

For the 2004 fire season, repairs currently approved should not be the primary focus of attention. However, enhanced inspection programs as described in Section 2.2 of this document must account for repairs and alterations that affect the ability to inspect primary structure in order to establish a baseline state of fatigue and corrosion.

3.0 Reporting

USDA FS should establish a reporting requirement with the contractors for like models. This reporting system should allow for timely disposition of significant inspection findings found on individual airplanes based on Sections 2.1 and 2.2 of this report to be dispositioned for other like airplanes. The system should not focus on findings resulting from routine maintenance stemming from normal inspection tasks.

4.0 Quality Assurance

USDA FS should ensure an effective Quality Assurance (QA) program is integrated with each operator associated with approved contractual agreements. A Quality Assurance program should allow for independent discretionary oversight of actual performed maintenance, a review of inspection records and appropriate reporting and disposition of findings based on inspection methods developed from Section 2 of this document.

USDA FS should ensure that enhanced inspection programs, as developed under Section 2.0 of this document, are incorporated through aircraft inspection programs. These aircraft inspection programs should be complied with as part of contracts, regardless of the aircraft operational purpose (i.e. public use operations).