CFM56 Combustor: Borescope Inspection Guide

March 2016

Book Number: GEK 119179
This guide is designed to aid Airline Maintenance Personnel with the identification of typical visual findings during a CFM56 Combustor borescope inspection. Engine model specific limitations and detailed acceptance and non-acceptance criteria are only found in the Engine Manuals and/or Aircraft Maintenance Manuals.

Contact CFM if further assistance is needed in classification of borescope inspection findings.
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Introduction

This guide is intended exclusively for the owners and operators of CFM engines. It has been prepared as a guide for use in the analysis of borescope findings on CFM Combustor Chamber components. The purpose of the guide is to enable identification of the typical visual findings during the borescope inspection.

The data and images presented here do not supersede or replace any of the engine or aircraft manufacturer’s Instructions for Continued Airworthiness. This document and the material within it are subordinate to the Aircraft Maintenance Manual and Engine Manual.
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## Applicability

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Combustion Chamber Hardware Overview (SAC)
Combustion Chamber Hardware Overview (DAC)
Combustion Chamber Hardware Overview
5B/7B Configurations Overview

Difference between Pre-TI and TI combustor

Secondary dilution moved forward on inner / outer liners

Multi-hole patches on 3rd panel of inner liner

Difference between TI and Harsh Environment combustor

Outer Liner

Additional multi hole patches

Inner Liner
Multi-hole (Pre-Tech Insert)

Description of Pre-TI Multi-hole Patch
• Two rows of fifteen holes located behind the central primary dilution holes on Pre-TI Outer Liner
• Provides preferential cooling in areas of commonly known distress
Typical Minimally Distressed Combustion Chamber:
- Minor TBC spallation
- Some discoloration
- Some carbon build-up
- Minimal cracking
- Minimal material erosion deflectors
Inspection: All Surfaces

Inspect all combustion chamber surfaces for:
• Discoloration - permitted
• Carbon Accumulation - permitted
• TBC Spallation - permitted
Carbon accumulation

- There is no limit to the amount of carbon accumulation on any surface of the combustor assembly, including the dome venturi area.
Dome: Deflector/Sleeve Cracks

Radial cracks in the deflector or the sleeve
• Permitted, if they are less than 0.5 inch (13 mm) in length in both Boeing and Airbus CFM AMM’s

Circumferential cracks in the deflector or sleeve
• There is no limit to the number of cracks if they are less than 0.75 inch (19 mm) in length in both Boeing and Airbus CFM AMM’s

Connected cracks – permitted if within above limits. Limit is exceeded when third crack connects in both Boeing and Airbus CFM AMM’s
Dome: Deflector/Sleeve Missing Material

- Limits defined by the quantity of exposed dome cooling holes in quadrants
- Great example of BSI photo taken perpendicular to cup
- For deflector erosion, can easily count exposed cooling holes to compare to manual limits

- Less than optimal examples of deflector erosion
- BSI phothos taken at the bad angle leading to higher exposed cooling hole count than necessary
Dome: Deflector/Sleeve Distortion

Distortion of the deflector or the sleeve is permitted.
Dome: Spectacle Plate Cracks

1) Radial cracks
   • Any number up to 2 in. (50.8 mm) length and not connected to one another

2) Circumferential cracks
   • Any number up to 3 in. (76.2 mm) length separated by 6 in. (152.4 mm)

3) Connected cracks
   • Not more than (1) radial crack 2 in. (50.8 mm) long with (1) circumferential crack 3 in. (76.2 mm) long separated by 6 in. (152.4 mm)

Above limits applied for both Boeing and Airbus CFM AMM’s
Dome: Spectacle Plate Missing Material

Max. 0.06 in. (1.52 mm) x 0.06 in. (1.52 mm) at intersection of connected crack
Primary/Secondary Swirler Cracks

- Cracks in primary swirl nozzle permitted
- Cracks in secondary swirl nozzle venturi permitted
Inner/Outer Liner Axial Cracks

1) Axial Crack shown serviceable
   • 3 axial cracks, each less than one panel in length
   • One crack connected to a burn-through hole

2) Axial Crack shown serviceable
   • Crack across one panel
   • There is no limit to the number of axial cracks that are contained within one panel for both Boeing and Airbus CFM AMM’s
Inner/Outer Liner Circumferential Cracks

1) Circumferential crack shown serviceable
   • Circumferential crack not connected
   • Crack not longer than 2 dilution lands

2) Circumferential crack shown serviceable
   • Circumferential crack connected to Axial Crack
   • Multiple cracks are allowed to connect if they are contained within one panel are within the area of one dilution hole in length (per recently updated CFM SAC Airbus and Boeing AMM’s)

3) Axial crack shown serviceable
   • Axial crack connected to burn through hole permitted
Inner/Outer Liner Missing Material

Burn through holes:
• Burn through holes allowance based on axial location relative to one another (when 2 or more) and size/area of the holes
• The maximum allowable size of any single hole is not more than 5x the size of a dilution hole examples above shown serviceable
Burn through holes:
- Burn through holes shown above are smaller than 5 times the area of a dilution hole
- Burn through holes are still within AMM limits (ref. CFM SAC Boeing and Airbus limits)
Inner/Outer Liner Missing Overhang

- Limits related with burn through holes and missing overhang should be considered separately.
- If there is a burn through area that does not include overhang, burn through hole limits should be considered to examine the whole burn through area.
- If there is missing overhang (what can be a part of burn through hole), limits for Missing overhangs on the inner and outer liners should be considered to examine only missing overhang area.

Missing overhang is permitted for:
- 14 areas in each liner with these conditions:
  a) Each area is not more than 2 times the size of the dilution hole.
  b) Areas are not axially aligned across more than 3 adjacent panels.
Inner/Outer Liner Distortion

- Distortion measurement is the distance taken perpendicularly. In other situation the result could be bigger than the real value.
- All distortions are permitted if each is not distorted more than 0.5 inch (12.7 mm) from the original contour according Airbus and Boeing AMM’s
Outer Liner Cold Side Cracks

- Cold side inspection is required only when a hot side crack is longer than 3 panels.
- If crack is restricted to 3 panels (inclusive), there is no need to borescope the cold side of the liner.
- If the cracks do not extend through more than one of ribs 4, 5, and 6 and if rib 1 is not cracked through – condition is serviceable with re-inspection in 750 cycles.
Aft Support Leg Cracking

- Currently no AMM limits for this condition – not a required area to inspect and condition is found commonly on CFM SAC Liners in the shop
- Recommendation is to BSI HPT Nozzle during routine BSI intervals if significant cracking found – cracked supports may lead to faster outer liner seal post wear or leaf seals liberation
- Upgrade to HS188 inner support to significantly reduce occurrence of cracking (SB 72-0694 for CFM56-7B/SB 72-0692 for CFM56-5B)
Combustor Cracks Interpretation Guide
Quality BSI Photos

**Excellent Photo**

- Precise final conclusion
- Less time wasted on additional emails, calls etc.

**Poor Quality Photo**

- A final conclusion may not be possible
- Additional questions or multiple cases will be required
- Longer response time
**Connected Cracks Interpretation**

- **Correct Interpretation**
  - Proper interpretation of connected cracks
  - There are 4 cracks in total
  - Axial cracks are not connected as each one ends in the burn through hole

- **Incorrect Interpretation**
  - Example of incorrect interpretation of connected cracks
  - Improperly defined as 2 cracks
Combustor Cracks Interpretation Guide

Connected Cracks Interpretation

Correct Interpretation

- Proper interpretation of connected cracks

Incorrect Interpretation

- Example of improper interpretation of axial and circumferential cracks

One axial cracks

One circumferential crack

Two circumferential cracks

One axial crack
Combustor Cracks Interpretation Guide

Connected Cracks Interpretation

**Correct Interpretation**

- Proper interpretation of connected cracks
- There are 4 cracks in total
- Axial cracks are not connected as each one ends in the burn through hole

**Incorrect Interpretation**

- Example of improper interpretation of connected cracks
- Improperly defined as 2 separate cracks
Combustor Cracks Interpretation Guide

Continuous Cracks Interpretation

**Correct Interpretation**
- Proper interpretation
- There is no connection in the cracks between the panels
- Cracks do not extend across more than more than 2 panels

**Incorrect Interpretation**
- Example of improper interpretation of continuous crack
- Multiple cracks defined as one continuous crack going across 4 panels
## Acronym List

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