TECHNICAL SPOTLIGHT

Subject: General Electric (GE) CFM56 and CF6 Lead Competitive Evaluation

Part Numbers:

Champion:	**CH53552-1/2 (CFM56-3)**
	CH53569-1/2/3 (CFM56-5A/B/C)
	CH53440/-1 (CFM56-7)
	CH53566-1/3 (CF6-45/50/80A/80C2/80E)
Unison Industries:	**9043185-13/14 (CFM56-3)**
	9043110-16/17/18 (CFM56-5A/B/C)
	9059110-1/-2 (CFM56-7)
	9043105-4/7 (CF6-45/50/80A/80C2/80E)

Purpose: To provide design and experienced based competitive evaluation of Champion and Competitive Ignition Lead Designs for all GE CFM56 and CF6 engine variants.

Champion Claim: When used together the Champion **CFM56 or CF6** igniter, and Champion's ignition lead designs provide lower overall cost of ownership and improved ignition system reliability from design approaches that optimize igniter life, mechanical robustness, temperature capability and ignition lead performance/survivability. From the lead perspective, the use of Champion's CFM56 and CF6 Ignition Lead designs will:

- Eliminate Dielectric Failures From Thermal Distress of Silicone Jacketed Conductor Wire
- Eliminate conduit damage at flexible to rigid transitions
- Maintain new part cooling air flow rates throughout the installed life
- Reduce Terminal Well Flashover/Dielectric Failure
- Reduce Maintenance Burden, Delays and Cancellations; Improve ATA Chapter 74 reliability

Champion CFM56/CF6 Program Background: The Champion CFM56 and CF6 large engine leads are an example of PMA parts built to address technical and reliability issues. These air cooled leads are superior to the current competitive leads by use of a patented design developed by Champion to prevent premature lead failures. Champion's lead design addresses temperature capability shortcomings inherent in the Competitive design by focusing on improving air flow through the ignition lead such that a new part and an end of life ignition lead maintain the same air flow capacity. Reduction in cooling air flow through the lead directly contributes to increased temperature exposure to sensitive elastomeric parts which are critical to dielectric protection, especially at the igniter connection. These leads provide 20% more airflow/cooling when compared with current competitive new leads and 30% improved cooling airflow as compared to competitive in-service leads.

Competitive Ignition Lead Design Issues: Champion conducted field research into the most prominent ignition lead failure modes with multiple Airline Operators. Two of the top three field issues were a result of dielectric failures in the elastomeric parts from thermal or mechanical (abrasive) distress. The third field issue was a contributor to the excessive temperature exposure. The top issues are:

- Dielectric failures in the Lead from:
  - Mechanical distress (abrasion) of silicone components
  - Thermal Distress of silicone components
- Reduction in cooling air flow rate due to innerbraid collapse leading to thermal distress

Champion Design Improvements: Champion identified three (3) major design improvements to improve life, performance and reliability over the competitive design. These three areas are:

- **Cooling Airflow Capability/Capacity**
- **Improved Dielectric Protection of the Elastomeric Conductor Wire**
- **Improved Thermal Protection of the Elastomeric Conductor Wire**

Cooling Air Flow Capability and Capacity: The ignition lead design accepts fan air through the exciter cooling duct, into the internal conduit of the lead and ultimately exhausts at the igniter to lead connection. Champion understood that a reduction in airflow capacity between new and "in-service" leads would account for increased temperature of the sensitive elastomeric insulating components in/around the igniter termination. A functional review of new and "in-service" Competitive leads gave evidence to a ~20% loss in flow capability. A quick teardown review revealed collapse of the innerbraid (due to vibration) occurred which partially blocks the airflow. An example of innerbraid collapse is shown in **Figure 1 and 2**.

Figure 1. Photo of a Competitive Lead Design with Collapsed Innerbraid Resulting in Restricted Airflow

Champion developed a patented approach to solve reduced airflow during the installed life of air-cooled ignition leads. See **Figure 3** for an illustration of the approach. This design configuration ensures the airflow at the beginning and end of the ignition lead life remains unchanged. The Champion design also improves the new part flow capacity by **nearly 10 percent** over a new Competitive design. This equates to more effective cooling of the sensitive ignition lead elastomeric components and reduces igniter seal temperatures to eliminate concerns of igniter leakage.

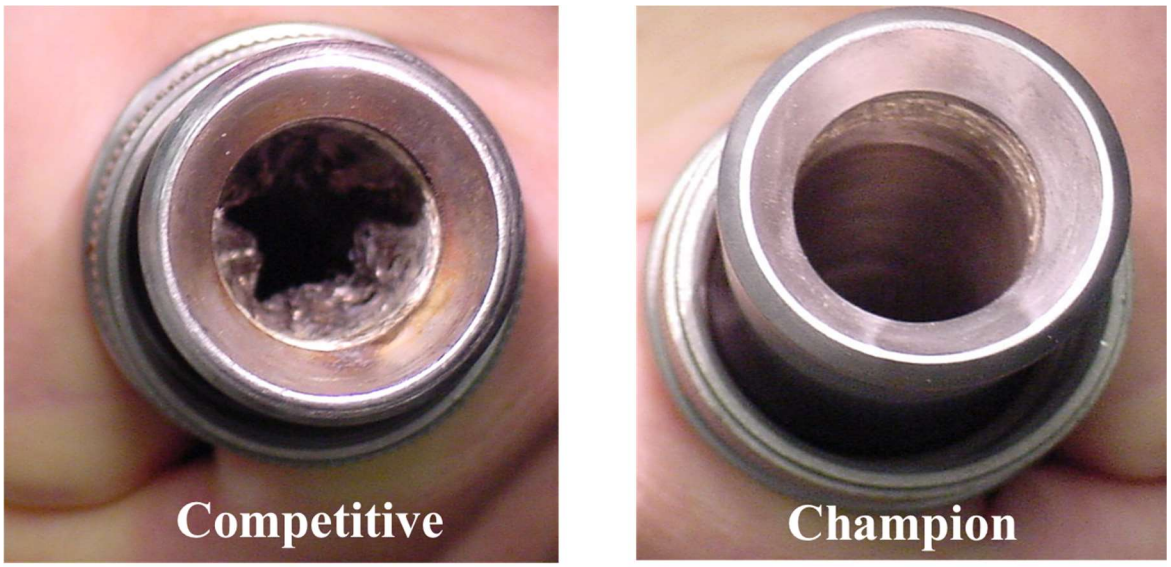

Figure 2. Comparison of Competitive (Collapsed) and Champion (Fully Open) Conduit Airflow Passage

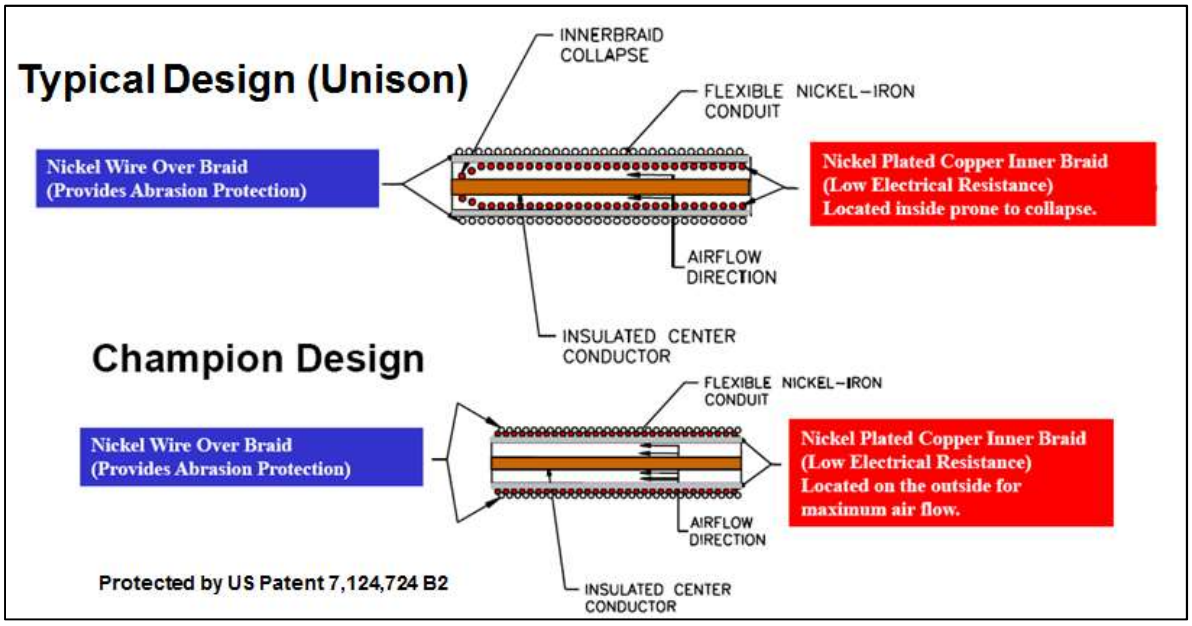

Figure 3. Comparison of Competitive (Collapsed) and Champion (Fully Open) Design Airflow Passage

Improved Dielectric/Thermal Protection of Elastomeric Conductor Wire: This improvement utilizes high temperature, high lubricity sleeving to mechanically and dielectrically protect the silicone jacketed conductor wire in key locations where high temperature or high abrasion locations exist. It provides tremendous abrasion protection and thermally/electrically insulates the conductor wire from the surrounding environment. The improved insulation of the conductor wire also decreases the Electric Field Strength between the center conductor and return path, which also reduces the Corona Effect threat in these weakened/high metal-to-conductor contact areas.

Champion Lead Design Improvement Area by Program: The Champion CFM56 and CF6 ignition lead designs implemented best practices for maintaining constant cooling air capacity and protection of temperature elastomeric components that are sensitive to thermal and mechanical distress (abrasion). **Figures 4-7** provide illustrations of design affected areas. Champion has patented the conduit design and uses this configuration on every air-cooled lead in the GE Family of Engines to provide designs that are capable of handling the demanding temperature and vibration extremes in high duty engine applications.

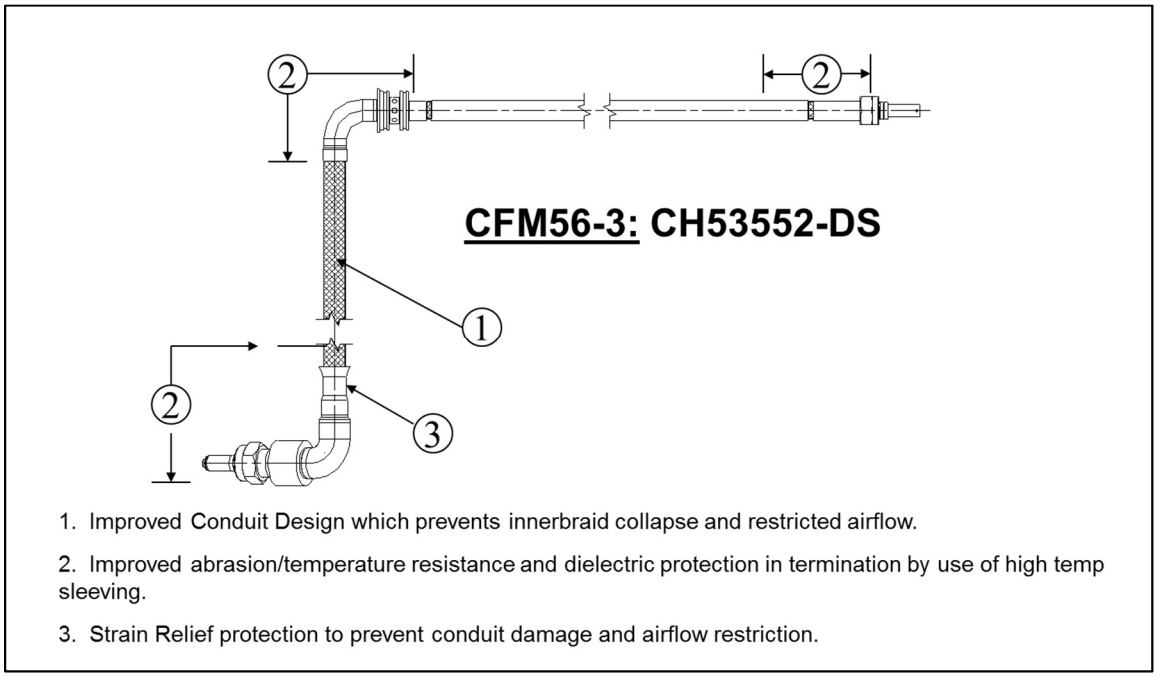

Figure 4. Illustration of CFM56-3 Lead Improvement Areas

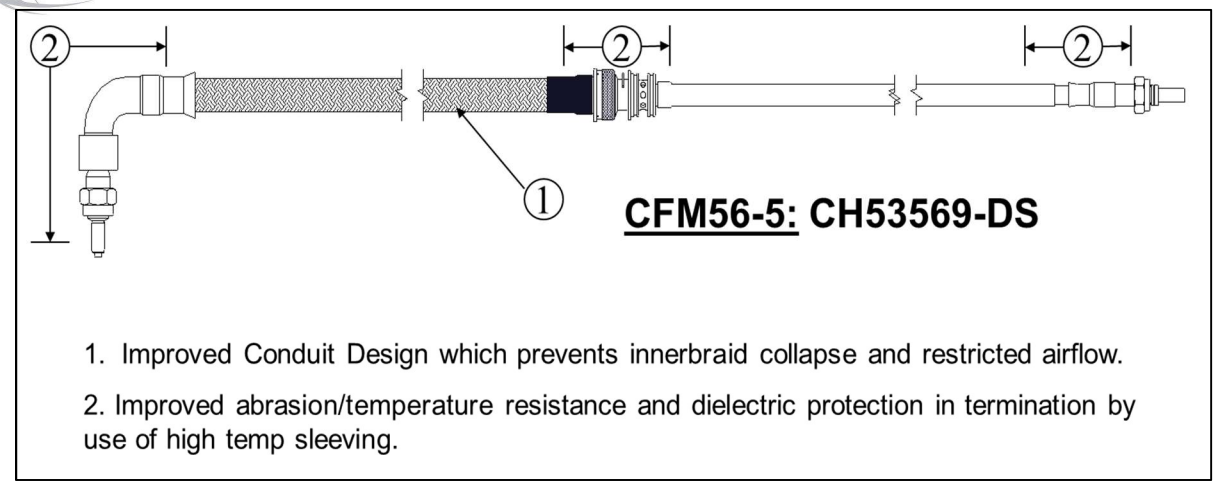

Figure 5. Illustration of CFM56-5 Lead Improvement Areas

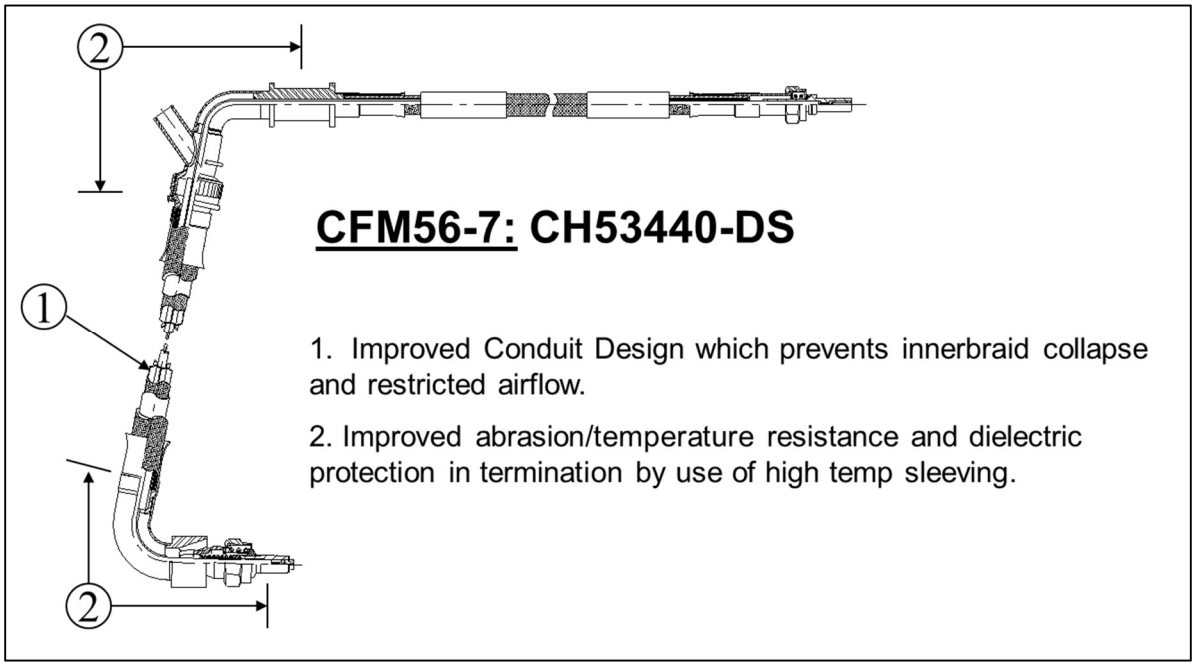

Figure 6. Illustration of CFM56-7 Lead Improvement Areas

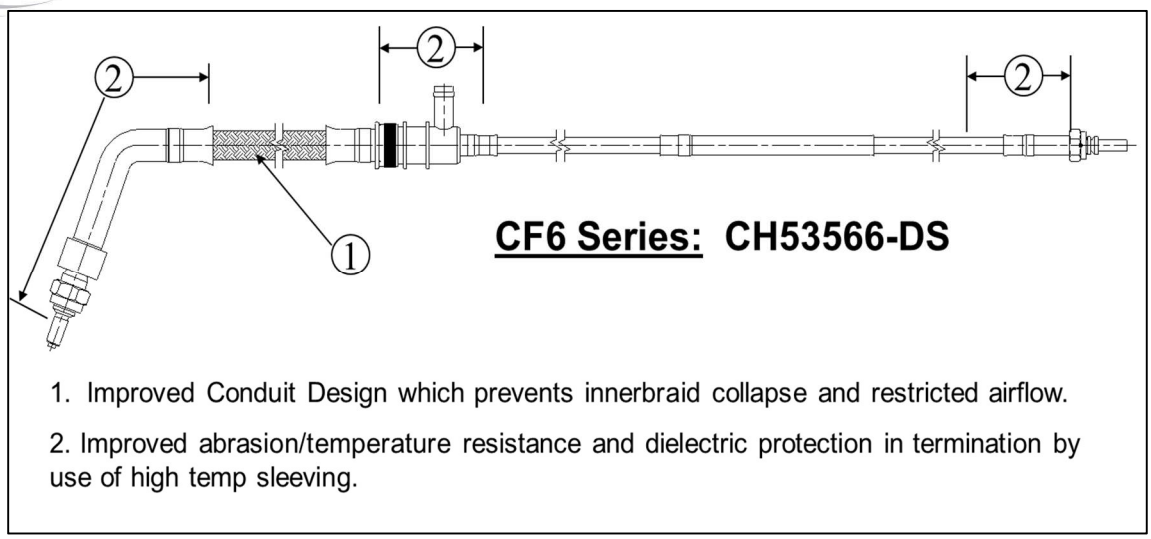

Figure 7. Illustration of CF6 Series Lead Improvement Areas