FAA Research of Incandescent Source Standardization for Composite Structure Lightning Testing

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ABSTRACT

As aircraft industry moves from traditional metal construction to advanced composite materials, there is a concern in the ability to detect lightning-caused sparks within fuel tanks that may ignite fuel vapor due to the difference in physics involved. Existing standard Society of Automotive Engineers (SAE) Aerospace Recommended Practice (ARP) 5416A defines two test methods for detection of voltage sparks in metallic structures: first is ignition of a standard hydrogen/oxygen/argon gaseous mixture and, second, is detection of light, which is a simpler and less hazardous approach; both techniques requiring to be related to a 200 microjoule minimum fuel ignition threshold induced by discharge of a standard voltage spark source. The standard defines the pass criterion either by demonstrating the absence of light detected by camera or by no ignition of the flammable gas mixture. These 200 μJ voltage sparks are considered to be generated as a result of sparking occurring between metallic components. However, when carbon fiber composite materials are involved, incandescent particles and hot gases ejected from fastener joints present another source of sparking, which presently has not been properly characterized in regard to ignition of aircraft fuel. The challenge is in characterizing these incandescent particles, hot spots, and edge glow by the heat energy they impart to the fuel vapor; however, the existing ignition source detection methods outlined in the SAE ARP 5416A are not very closely linked to the heat energy of these ignition sources. This project investigates feasibility of utilizing time-integrated digital photography imaging (photographic method) for predicting the ignition conditions of the standardized flammable gas mixture imposed by an incandescent heat source. The study showed that the ignition can be predicted by analyzing the hue histogram of the detected light emission source. Thus, based on the research findings to date, appearance of the yellow hue alongside the incandescent heat signature has been observed to be coincident with ignition of standardized gas mixture for several investigated materials. As an outcome, development of a new or augmented test method suitable for characterization of composites and metal ignition sources simultaneously is envisioned to be developed with the purpose of supplementing or superseding the existing standard. The project development is carried out under the continuous monitoring by FAA and in a close partnership with the SAE AE-2 and WG-31 Lightning Committees.