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Powerplant & Propulsion Fire Protection Fire Modeling

Jason Damazo[1], Philipp Boettcher[2], Brad Moravec[3]

1 Boeing Shock Physics, Tukwila, WA 98108, USA
[2] Boeing Research & Technology, Golden, CO 80403, USA
[3] Boeing Commercial Airplane Propulsion, Everett, WA 98204, USA

Computational modeling is an effective way of analyzing aircraft powerplant and propulsion fires. While testing based on the FAA AC 20-135 guidelines has traditionally been used to demonstrate safe operation, reactive flow computational fluid dynamics (CFD) of fires can better assess the thermal threat to the airplane structures during a fire scenario if the analysis is appropriately validated. This presentation will discuss requirements on validation and propose best practices in performing fire CFD analyses.

Reactive flow CFD models and results must be rigorously validated using test data. Some validation data is available from industry studies, but validation is challenging in situations where there is little or no direct test data at the conditions required for certification, such as an inflight engine nacelle fire. Of particular interest are regions that are oxygen limited, like under ventilated fire zones, and realistic modeling of fuel spray fires, including ignition of the fuel spray and the steady state thermal loads.

A thorough methodology for model validation requires that the following aspects are covered: theoretical basis and assumptions, environmental conditions and fire scenario, mathematical and numerical robustness, model uncertainty and accuracy, and model limitations. Finally, the full validation to satisfy regulatory authorities requires: general discussion of the industry guidelines for fire modeling, compartment benchmark tests, subscale tests, model sensitivity, and in-service experience.