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ANTIMISTING FUEL SPILLAGE/AIR SHEAR TESTS AT NAVAL WEAPONS CENTER

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16. Abstract

A test apparatus consisting of a large-scale airfoil located within a temperature-velocity-controlled airstream was used to evaluate the fire suppression afforded by FM9 antimisting fuel additive in Jet A. A homogeneous low turbulence airstream between 100 and 170 knots was used to obtain crash-survivable antimisting fuel kinematic data. It was demonstrated that FM9 could be an effective antimisting agent. The failure envelope for FM9 in 27°C Jet A fuel was measured for agent concentrations from 0.3 to 0.5 percent and 32°C airflow velocities between 100 and 170 knots.

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INTRODUCTION

PURPOSE

The purpose of this study was to establish the kinematic flame propagation response of antimisting fuels when released in airflow conditions representative of impact-survivable aircraft crashes.

BACKGROUND

Studies and tests aimed at development of a safer fuel have always been of interest to the Federal Aviation Administration (Reference (1)). One recent outgrowth of such work is the development of polymer "thickening" fuel additives to suppress the misting property of Jet A fuel. The practical objective stated in Reference (2) to be met by such antimisting agents during a survivable crash is to eliminate the mist of fuels under dynamic conditions and decrease the probability of ignition.

Candidate antimisting materials were evaluated in full-scale crash tests (Reference (3)) utilizing Navy A-3 and Air Force RB-66 aircraft. These tests were performed during 1972-73 at the Naval Air Test Facility, Lakehurst, New Jersey. One objective of these tests was to determine how representative air gun and catapult tests with antimisting fuels were of actual crashes. It was concluded (Reference (2)) that such tests were not representative of full-scale crash conditions.

A new potentially scalable fuel spillage test was developed at the National Aviation Facilities Experimental Center (NAFEC). A prototype test apparatus was constructed at NAFEC and sent to the Naval Weapons Center (NWC) where further development and testing was undertaken.

OBJECTIVE

The objective of this study was to conduct aircraft crash survivable fuel spillage/air shear tests with antimisting fuels to establish the interrelationships between fire and variables such as additive concentration, fuel temperature, and airflow velocity.

STATE-OF-THE-ART REVIEW

A review of the antimist fuel literature and other related activity was presented recently (Reference (4)). This excellent review summarized the then-current work being conducted by the U.S. Army, Air Force, Navy, FAA, and the U.K. Royal Aircraft Establishment. Observations made in this review, which are directly pertinent to the subject matter in this report, are as follows:

1. Antimist agents are effective to prevent the formation of flammable mist of low volatility fuels (JP-5, Jet A, JP-8) under many conditions of high-shear exposure. However, different

PREFACE

The goal to develop a "fire safe" fuel for a survivable aircraft crash landing is difficult to attain in an absolute sense since commercial fuels, once ignited, readily burn. The problem is to alter the kinematic physical properties of a fuel in such a manner so as not to affect its commercial value. This report presents test results of Jet A fuel incorporating FM-9 polymer antimisting agent. A wing test apparatus is described which utilizes a fuel expulsive airfoil in an airstream to simulate a full-scale survivable crash. Results from three series of tests are presented.

The cooperation and assistance of a number of people and organizations were invaluable. Drs. R. F. Landel and S. T. J. Peng of the Jet Propulsion Laboratory provided helpful discussions on rheology measurements, Dr. R. Mannheimer of Southwest Research Institute and Mr. A. Woodman of the Naval Weapons Center (NWC) contributed laboratory measurements, Mr. H. Brooks of Imperial Chemical Industries assisted with antimisting agent preparation, and Mr. T. Horeff and Mr. John Van Dyke of the Federal Aviation Administration gave guidance in identifying the pertinent problem areas addressed in this study. The Civil Aviation Authority, Royal Aircraft Establishment and Imperial Chemical Industries of the United Kingdom not only supplied the FM-9 additive, but also provided for its shipment to this country. The U. S. Army Mobility Equipment Research and Development Command, Fort Belvoir, Virginia, through an inter-agency agreement with the FAA, engaged Southwest Research Institute to make rheological measurements and analyses at the test site and in their laboratories.