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CONFERENCE ON AVIATION AND ALTERNATIVE FUELS

Rio de Janeiro, Brazil, 16 to 18 November 2009

Agenda Item 1: Environmental sustainability and interdependencies

IMPACT OF ALTERNATIVE FUELS ON AIRCRAFT ENGINE EMISSIONS

(Presented by the International Coordinating Council
of Aerospace Industries Associations)

SUMMARY

Engine and aircraft manufacturers along with the supporting governments have conducted tests to assess the impact of alternative fuels on engine performance and emissions. Engine emissions and performance measurements have been made on several aircraft engines with 100% pure and blended alternative "drop-in" fuels. While having little impact on engine performance and gaseous emissions, alternative fuels use leads to large reduction in particulate matter emissions.

Note the recommendations in section 4.

1. INTRODUCTION

1.1 Alternative fuels, in comparison to petroleum-based fuels, have the potential of cutting down CO_2 emissions and particulate emissions by a significant amount. However several obstacles remain to be overcome in order to make extensive use of alternative fuels in the aviation sector feasible. The production capacity of plants to manufacture enough alternative fuels to satisfy a significant amount of aviation needs remains to be the biggest impediment to the use of alternative fuels, impact of long term as well as short-term use of alternative fuel on engine performance and reliability remains to be uncertain.

1.2 Besides determining the performance and emissions of the engine with alternative fuel as compared to conventional jet fuel, impact of alternative fuel on engine maintenance and reliability also needs to be assessed. Impact of alternative fuels on engine and fuel delivery system components has to be investigated further. Studies also need to focus on additives that could enhance the viability of using alternative fuels in aviation without impacting the benefits obtained with alternative fuels.

1.2.1 Engine manufacturers have worked with fuel manufacturers and ASTM in testing and qualifying SASOL fuel (100% synthetic as well as a 50-50% blend) for use in aviation. Significant effort

has also been expended in developing protocol for qualifying future “drop-in” alternative fuels for use in aviation. A separate WP presented by US (WP/15) will discuss the process in details.

2. TESTS CONDUCTED

2.1 Off-wing engine ground tests occurred at GE Aviation test facility in Ohio, USA and at Pratt & Whitney facilities in Ontario, Canada and Florida, USA. Rig tests have also been done at Rolls Royce facilities in UK and USA. These tests have been conducted in support of various flight tests that have occurred in the recent past for evaluating use of alternative fuel blends in aviation.

2.1.1 The purpose of the biofuels testing conducted at GE was to evaluate the impact of jatropha/algae derived Bio-SPK on engine performance, operability, hardware and emissions on the ground prior to testing on aircraft. The ground test was performed on a CFM56-7B development engine on November 4-6, 2008. Testing consisted of performing back-to-back runs comparing Jet A (baseline fuel) to two biofuel blends (25% Bio-SPK and 50% Bio-SPK). A simulated 1 Hour Flight Cycle was also performed to evaluate the 50% blend which was the identical fuel and blend ratio used during the Continental Airlines flight demonstration.

2.1.2 In support of the JAL flight test program, a Pratt & Whitney Canada engine was tested in a test-stand with Jet A-1, 50% and a 100% biofuel blends. In this case, a diesel range hydrotreated vegetable oil (HVO) was used for this research effort, which was produced by Neste Oil, and consisted of n- and iso-paraffins. Engine tests consisted of control, operability (engine start, flame-out and transient thrust characteristics) and performance, all of which tested within expected variation. Engine performance data was collected in parallel with the emissions measurements, and included measurements at six power settings. Engine operational tests, which included speed stability, dynamic performance during accelerations, acceleration time and engine flame-out points during negative fuel spiking, were reviewed.

2.1.3 Pratt & Whitney also collaborated with National Aeronautics and Space Agency (NASA) and Air Force Research Laboratory (AFRL) to conduct engine tests with synthetic alternative fuels. Blends as well as pure synthetic fuels were tested in two Pratt & Whitney engines – GTF demonstration engine and P308 engine. The tests were conducted at Pratt & Whitney’s West Palm Beach facility in Florida, USA. Extensive emission and performance measurements were made to determine the impact of synthetic fuel blend on engine performance and emissions.

2.1.4 A series of engine ground runs were conducted on an Air New Zealand Boeing 747-400 aircraft equipped with Rolls-Royce RB 211-524G2-T engines prior to the test flight including a switch of fuel at various progressions of Engine Pressure Ratio (EPR) settings. The engine showed no change in behaviour from operational perspective.

3. RESULTS

3.1 Results from the tests are shown in IP/11.

4. RECOMMENDATIONS

4.1 The conference is invited to note the progress made in testing aircraft engines with various types of alternative fuels. The conference is invited to recommend that funding bodies support further research into engine research using alternative drop-in fuels, whilst still maintaining funding levels for technology research.

4.2 The work performed by the engine manufacturers shows the viability of using blends of drop-in alternative fuels as a substitute to jet fuel. The meeting is invited to promote the production of drop-in alternative fuels for aviation.

4.3 Manufacturing industry has tested drop-in alternative fuels and the results show no adverse impact on performance of aircraft engines. While having little impact on gaseous emissions, the drop-in alternative fuels show significant reduction in smoke emissions. The meeting is asked to note that more research is needed to determine the impact of alternative fuels on areas such as materials compatibility, chemical composition, density, and to fully derive correlations between alternative fuel properties and particulate and gaseous emissions.

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