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CONFERENCE ON AVIATION AND ALTERNATIVE FUELS

Rio de Janeiro, Brazil, 16 to 18 November 2009

Agenda Item 2: Technological feasibility and economic reasonableness

FLIGHT TESTS AND ASSOCIATED RESULTS

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

SUMMARY

Before 2008, the general perception, mainly outside of the air transport industry, was that aviation was fully dependent on oil to produce the appropriate fuel (kerosene). The need to demonstrate that aircraft engines can run and aircraft can fly with alternative fuels produced out of new sources of energies emerged, together with the necessity to consider this possibility through a whole life cycle of the alternative fuel, in order to develop alternative low-carbon fuels for aviation. Several flights, which covered a wide range of available aircraft-engine combinations, as well as different sources of alternative fuels were successfully performed in 2008 and 2009. They played an important part in the works that lead to publication on September 28, 2009 of ASTM D7566 entitled "Specification for Aviation Turbine Fuels Containing Synthesized Hydrocarbons". Additional work must be carried out to certify for use additional drop-in biofuels from different feedstocks and refining technologies, and to increase the approved blends for all alternative fuels, with the goal of having as many options of feedstocks, refining processes and blend levels as possible, certified for use

Action by the conference is in paragraph 5.

1. INTRODUCTION

1.1 Today, current commercial aviation is completely dependent on oil to produce the appropriate fuel (kerosene) that matches the requirements necessary to support air travel. Before 2008, the general perception, mainly outside of the air transport industry, was that aviation would continue to be fully dependent on oil to produce the appropriate fuel (kerosene) indefinitely. The non-renewable characteristics of oil resources, the availability and price of oil were presented in various articles as real challenges to the future of aviation.

1.2 However, fuel producers, engine and airframe manufacturers knew that a few alternative possibilities to oil existed. For instance, for a few decades, in South Africa, fuel for aviation has been produced from coal. Nevertheless, in the absence of mature technologies for carbon sequestration and storage, the production of kerosene out of coal gives a CO_2 balance which is worse than producing conventional fuel out of coal.

1.3 The need to demonstrate that aircraft engines can run and aircraft can fly with alternative fuel produced out of new sources of energies emerged, together with the necessity to consider this possibility through a whole life cycle of the alternative fuel, in order to develop alternative low-carbon fuels for aviation.

1.4 The paper summarizes the different flight tests that were run in the past two years (2008-2009), provides information with the results they generated and offers a perspective for future experimentation. Additional information related to the specific flight tests can be found in IP/12.

2. VARIOUS EXPERIMENTAL FLIGHTS WITH SEVERAL DIFFERENT DROP-IN FUELS

2.1 Over the past few years, sustainable alternative fuels have started to be considered as an opportunity to explore, in order to contribute to the reduction of the environmental impact of aviation. Prior to this time, the only approved alternative fuel was a blend of conventional kerosene and a maximum of 50% kerosene produced from coal (CTL).

2.2 During this time CTL(From one supplier) has been approved to 100% through a full suite of rig, engine, and aircraft tests.

2.3 Subsequently, test flights could be envisaged, to demonstrate initially the capability of aircraft to fly and engines to run on a drop-in fuel different than conventional kerosene. Several flights, which covered a wide range of available aircraft-engine combinations, as well as different sources of alternative fuels were successfully performed in 2008 and 2009.

2.4 On February 1st, 2008, an Airbus A380 performed a 3-hour test flight from Filton (UK) to Toulouse (France) with one of its four Rolls-Royce Trent 900 engines fed with a blend of 40% gas-to-liquid (GTL) synthetic fuel and 60% conventional fuel.

2.5 In February 2008, a Virgin Atlantic 747-400, powered by General Electric GE CF6 engines flew from London to Amsterdam using a 20% mix of Synthetic Paraffinic Kerosene (SPK) biofuel (Bio-SPK) from coconut and babassu oils in one of its four engines.

2.6 In December 2008, an Air New Zealand (ANZ) 747-400 equipped with Rolls-Royce RB211-524G2-T engines tested the 50% blend of Bio-SPK from jatropha oil in an engine ground run and an approximately 2-hour experimental flight from Auckland, New Zealand, in one of its four engines.

2.7 In January 2009, a Continental 737-800 equipped with CFM56-7B engines was used to test a 50% blend of Bio-SPK from jatropha and algae oils in an engine ground run and an approximately 2-hour experimental flight from Houston, Texas in one of its two engines.

2.8 In January 2009, a Japan Airlines (JAL) 747-300, equipped with Pratt & Whitney JT9D engines was used to test a 50% blend of Bio-SPK from camelina, jatropha and algae oils in an engine ground run and an approximately 2-hour flight from Tokyo, Japan in one of its four engines.

2.9 During each of these flights, the engine running on the blend of alternative and conventional fuel was highly challenged, with acceleration/deceleration phases, at different altitudes, engine windmill re-start… During the whole experimental flight, an extensive list of various parameters was recorded for further analysis.

2.10 Before each of the above test flights, the various partners involved in the exercise had performed a massive amount of work and extensive pre-test analysis of the fuel, together with substantive cooperative actions to demonstrate the viability of the fuel.

2.11 After the flights, the crew reported an excellent performance and behaviour of the engine running the test, with no major difference to the other engine(s) running 100% on conventional fuel. More detailed information about the results of these flight tests are provided through IP/12.

3. LESSONS FROM THE TESTS

3.1 The different flight tests have demonstrated that flying a large commercial aircraft with a blend of drop-in alternative fuel, up to 50%, with conventional fuel was technically feasible.

3.2 They also demonstrated that a variety of alternative fuel feedstocks and refining processes could be envisaged. The primary criteria for consideration and evaluation for these fuels must be the characteristics of their performance in aircraft engines, fuel systems and aviation fuel infrastructures, rather than the feedstocks from which they are derived. These drop-in fuels can come from a variety of fossil and bio feedstocks depending on the most important issues in the country or region where the fuel is produced and used, including fuel availability and supply, fuel security and environmental characteristics such as air quality and greenhouse gas emissions. The tests also identified some early promising alternative fuel suppliers and enabled to draw attention of additional suppliers.

3.3 The tests provided some substantive information in the process of alternative drop-in fuel qualification and certification for use by the aviation industry. They played an important part in the works that lead to publication on September 28, 2009 of ASTM D7566 entitled "Specification for Aviation Turbine Fuels Containing Synthesized Hydrocarbons", which provides criteria for production, distribution, and use of aviation turbine engine SPK fuel produced from coal, natural gas, or biomass using Fischer-Tropsch (FT) process.

4. NEXT STEPS

4.1 Additional tests are necessary to demonstrate the possibilities of additional types and blend levels of alternative drop-in fuels for aviation and establish certification for their use.

4.2 Additional tests as part of an integrated programme using labs, rigs, engines, must be performed in order to demonstrate that the repetitive usage of alternative fuels does not create challenges that could not be identified with a single flight.

4.3 Further to the issuance of ASTM D7566, commercial flights can now be envisaged, with a blend of up to 50% FT SPK fuel with conventional fuels.

4.4 Very recently, on October 12, 2009, a Qatar Airways A340-600 equipped with four Rolls-Royce Trent 556 engines performed the world's first commercial passenger flight with a 50-50 blend of synthetic Gas to Liquid (GTL) kerosene and conventional oil-based kerosene fuel, on the four aircraft engines. The more than 6-hour flight from London Gatwick (UK) to Doha (Qatar) is a major milestone in the development of drop-in alternative fuels for aviation.

4.5 Additional work must be carried out to certify for use additional drop-in biofuels from different feedstocks and refining technologies, and to increase the approved blends for all alternative fuels, with the goal of having as many options of feedstocks, refining processes and blend levels as possible, certified for use.

4.6 For all of the above milestones, availability, affordability and sustainability of sufficient quantities of feedstock are necessary, together with the associated transformation technologies and facilities.

5. RECOMMENDATIONS

5.1 The conference is invited to:

a) take note and acknowledge the technical feasibility of using alternative drop-in fuels as blends with conventional fuels as demonstrated in this paper and in IP/12;

b) encourage certification of new drop-in fuels that result in the broadest spectrum of feedstocks and refining processes;

c) encourage governments to establish public policies that:

   a. promote and protect the use of existing fuel infrastructures for drop-in certified aviation bio drop-in fuels (trucks, pipelines, airports, etc.);

   b. create clear definitions of "acceptable feedstocks" in order to remove obstacles for financial investments in alternative fuels develop, production and use;

   c. create appropriate investments and incentives for alternative drop-in fuels;

   d. accelerate R&D and commercial scale production of alternative drop-in fuels; and

   e. specifically target alternative drop-in fuel use for civil aviation

d) recommend that the ICAO support the overall process already engaged in the study, development and approval of alternative drop-in fuels for aviation; and

e) recommend that the funding to support the study and development of sustainable alternative drop-in fuels be duly considered in addition to the existing and future funding for traditional research and technology that will contribute to further improve the efficiency of air transport.

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