International Civil Aviation Organization

CAAF/09-WP/15
16/10/09

WORKING PAPER

CONFERENCE ON AVIATION AND ALTERNATIVE FUELS

Rio de Janeiro, Brazil, 16 to 18 November 2009

Agenda Item 3: Measures to support development and use

PROPOSAL TO ADOPT A GLOBAL FUEL QUALIFICATION AND CERTIFICATION PROTOCOL

(Presented by United States)

SUMMARY

Industry fuel specifications such as D1655 and DEF STAN 91-91 are used by the aviation fuel industry stakeholders to standardize and control the properties and quality of aviation fuel as it travels through the distribution system. Civil Airworthiness Authorities (CAAs) also rely on fuel specifications to ensure the safety of aircraft operations. The aviation fuel community has developed qualification and certification concepts and procedures to approve an alternative fuel for operation on the existing fleet. This WP describes the process being developed by the aviation industry in the United States to qualify and certify new classes of aviation fuels. The concepts presented here should be applicable to other CAAs and fuel specification-writing organizations.

The conclusions for the conference are in paragraph 5 and recommendations in paragraph 6.

REFERENCES

ASTM International Standard D1655, "Standard Specification for Aviation Turbine Fuels."

ASTM International Standard Practice D4054, "Guideline for the Qualification and Approval of New Aviation Turbine Fuels and Fuel Additives."

Defence Standard 91-91: "Turbine Fuel, Aviation Kerosine Type, Jet A-1 NATO Code: F-35 Joint Service Designation: AVTUR."

1. INTRODUCTION

1.1 Early turbine engines were designed to operate on kerosene fuels due to the wide availability, low cost, and desirable performance properties of those fuels. Over the decades since the introduction of the first turbine engines, demands for improved performance and safety resulted in aviation fuel specifications defining tightly controlled versions of kerosene. These specifications established tighter controls on the fuel properties necessary to accommodate technical advances in turbine engine design. Two aviation turbine fuel specifications used in many areas of the world are ASTM International Standard D1655 and Defence Standard 91-91 issued by the United Kingdom's Ministry of Defence.

1.2 Aviation fuel is a commodity subject to bulk transport and frequent change of ownership as it moves from its origination at the refinery to its final destination at the airplane. Industry fuel specifications such as D1655 and DEF STAN 91-91 are used by the aviation fuel industry stakeholders to standardize and control the properties and quality of aviation fuel as it travels through the distribution system. The producers must formulate the fuel to meet the specification properties, fuel handlers in the distribution system such as pipeline companies must certify that the fuel meets the specification when delivering fuel, aircraft engine designers must design their engines to operate over the range of fuel properties in the specification, and aircraft operators such as airlines must ensure the fuel loaded on to their airplanes meets the criteria of the specification.

1.3 Civil Airworthiness Authorities (CAAs) also rely on fuel specifications to ensure the safety of aircraft operations. Airworthiness regulations issued for aircraft and engines require that operating limitations be established for each type certificated design. These operating limitations typically specify the industry, military or company aviation fuel specifications that aviation fuel must meet for use on the aircraft and engine.

1.4 The existing fleet of turbine engine powered aircraft has been designed to operate on conventional aviation turbine fuel (jet fuel) that meets the major industry specifications described above. However, due to recent environmental, supply stability, and cost issues with conventional petroleum-derived jet fuel, approvals have been requested to use new, alternative fuels derived from non-conventional feedstocks on the existing fleet of turbine engine powered aircraft. In response to these requests, the aviation fuel community has developed qualification and certification concepts and procedures to approve an alternative fuel for operation on the existing fleet.

1.5 This WP describes the process being developed by the aviation fuels industry and the Federal Aviation Administration (FAA) to qualify and certify new classes of aviation fuels. The concepts presented here should be applicable to other CAAs and fuel specification-writing organizations.

2. AVIATION FUEL QUALIFICATION AND CERTIFICATION OVERVIEW

2.1 As described above, fuel specifications are an integral element of the aviation fuel infrastructure. Consequently, a new specification needs to be developed, or an existing specification needs to be revised, to enable the use of any new alternative aviation fuel in this infrastructure.

2.2 Qualification processes are used by specification-writing organizations such as ASTM International to develop new fuel specifications, or to revise existing specifications, to add a new alternative fuel. These qualification processes will include a technical evaluation of the fuel followed by

development of the specification requirements and criteria. Section 3 of this paper provides a description of the ASTM aviation fuel qualification process.

2.3 If the alternative fuel is found to have essentially the same performance properties as conventional jet fuel, then it is considered a drop-in fuel. Conversely, if substantive differences exist between the performance properties of the new alternative aviation fuel and conventional jet fuel, then the fuel is considered a non-drop-in fuel.

2.4 Drop-in fuels may be incorporated into the existing jet fuel specifications, and will therefore meet the established operating limitations for the existing fleet of turbine engine powered aircraft. In this case, amended airworthiness certification of the existing aircraft and engines is not required.

2.5 Non-drop-in fuels will require a new specification, and therefore will not meet the established operating limitations for the existing fleet of turbine engine powered aircraft. In this case, amended airworthiness certification of the existing aircraft and engines is required to incorporate new operating limitations.

2.6 Section 4 of this paper provides a description of the FAA airworthiness certification process that is being developed to accommodate the introduction of alternative aviation fuels.

3. INDUSTRY AVIATION FUEL QUALIFICATION PROCESS

3.1 The process ASTM International uses to approve a new fuel consists of a test phase to evaluate the fuel or additive, followed by an approval phase that includes ASTM International balloting on the new specification, or revision to an existing specification, for the fuel. This process is described in ASTM International Standard Practice D4054, “Guideline for the Qualification and Approval of New Aviation Turbine Fuels and Fuel Additives”.

3.2 Test Phase

3.2.1 In general, the fuel must undergo sufficient test and development to show that, under the conditions in which it will be used in an aircraft, it is compatible with typical engine and aircraft materials. The fuel must comply with the specification properties that are necessary to meet the performance and durability requirements of the airplane, rotorcraft or engine. The data should address compatibility with other fuels, lubricants, and additives that are approved for engines and aircraft. Fuels must be shown to be capable of being mixed with other approved fuels or additives at all anticipated temperatures. The fuel must be shown to maintain its properties at limiting operating temperatures to prevent blocking of fuel lines and filters.

3.2.2 The test phase includes investigations of the effect of the candidate fuel on fuel specification properties, fit-for-purpose properties, materials compatibility, component rig tests, or engine tests. The extent of the test phase depends on the chemistry of the new fuel or additive, similarity to approved fuels and additives, and engine manufacturer experience. Departure from engine manufacturer experience would require more rigorous testing. The results of the test phase will be documented in a research report prepared by the fuel formulator with oversight by the aircraft equipment manufacturers. The research report provides the data and information necessary for review of the ASTM International members who participate in the balloting process. Refer to ASTM International Standard Practice D4054,

"Guideline for the Qualification and Approval of New Aviation Turbine Fuels and Fuel Additives" for a detailed description of these test requirements.

3.3 **Approval Phase**

3.3.1 Upon completion of the test phase, the research report is reviewed by engine manufacturer representatives on the ASTM International Aviation Fuels subcommittee. If approved by the engine manufacturers, a draft specification with appropriate language and criteria is developed. This draft specification and the research report are submitted to the entire subcommittee for review and balloting. The specification and research report may go through several revisions before a final version of the specification is approved by the membership. The subcommittee ballot is followed by a committee level ballot before final approval by ASTM International and publication of the specification.

3.3.2 ASTM International is considered a voluntary consensus standards organization. These organizations are characterized by a balanced membership of stakeholders with an equal voice that participate in a well-defined process to create industry standards or specifications. Because the specifications produced by these organizations go through a rigorous technical vetting process, they are considered to provide very robust control of quality and performance. Consequently, CAAs such as the FAA utilize these standards and specifications in their regulatory oversight of aviation.

4. **FAA AIRWORTHINESS CERTIFICATION PROCESS FOR NEW ALTERNATIVE FUELS**

4.1 The FAA airworthiness certification process relies on the development and oversight of specifications and standards by voluntary consensus standards bodies such as ASTM International. As described above, these specifications are used to define the operating limitations that must be established by the aircraft and engine manufacturers to gain type certification of their product.

4.2 For new aircraft and engine designs, no additional fuel-related testing will typically be required beyond that required for the product certification program. This is because the new aircraft or engine is undergoing a complete certification compliance program using either existing jet fuel or the new alternative jet fuel. The certification of a new airplane or engine requires a comprehensive compliance plan that should encompass all the airworthiness standards applicable to fuels and should cover the complete range of operating conditions to which the fuel is exposed. Additional materials compatibility testing is required only if the new airplane or engine design contains new or unusual materials that the fuel would come in contact with that were not evaluated during the industry qualification process described in Section 3.

4.3 However, for previously certified aircraft and engines, the extent of fuel-related certification testing will be based on whether the fuel is a drop-in fuel or non-drop-in fuel.

4.4 Drop-in Fuels.: As described above, drop-in fuels will meet the existing operating limitations of certificated aircraft and engines. Typically, the operating limitations will be specified as "Jet A/A-1 Fuel", or "Jet A/A-1 Fuel meeting ASTM D1655". Because the drop-in alternative fuel will be incorporated into the existing jet fuel specifications, there will be no change required to these operating limitations and no associated certification testing. In effect, the alternative fuel seamlessly enters the fuel distribution infrastructure and requires no special treatment or identification, and is co-mingled with conventional jet fuel. From the perspective of the certificated aircraft and engine, conventional fuel and the drop-in alternative fuel provide identical performance and safety.

4.5 Non-Drop-in Fuels: The certificated operating limitations for a previously certified aircraft or engine will need to be revised to add the specification reference for the new alternative fuel. In addition, modifications to the design of the aircraft or engine may need to be incorporated to accommodate the new alternative fuel. This will require an amendment of the type certificate or a supplemental type certificate (STC) (if the applicant is not the original equipment designer). In either case, the fuel-related regulatory requirements must be re-validated by testing of aircraft and engine. In most cases, certification approval of an engine to operate with the new alternative fuel will need to be followed by certification approval of the aircraft on which the engine is installed.

5. CONCLUSIONS

5.1 The conference is invited to:

a) acknowledge the background information that has been presented on aviation fuel industry qualification and FAA certification processes; and

b) acknowledge the benefits and advantages of cooperating with other CAAs and voluntary consensus standards organizations to facilitate the approval of new alternative fuels.

6. RECOMMENDATION

6.1 The conference is invited to:

a) endorse the use of the industry qualification and FAA certification processes as the appropriate means for approving a new alternative jet fuel.

— END —