Emerging Technologies and processes for an increased SAF production

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ASTM International is a 127-year-old mission-oriented, non-profit organization that provides an open, transparent process for individual members around the world to collaborate in the development of global technical standards. At present, our 30,000 volunteer technical members representing 150 countries create standards that underpin the safety and performance of more than 90 industry sectors, including the energy industry. These standards help ensure safety, foster trust, promote innovation and address sustainability concerns while enabling global trade.

ASTM's individual membership model and consensus standards development process ensure every voice is valued, and the voting power of stakeholder groups is balanced. Through the ASTM process of classification and voting rights assignments, a large organization has the same voting power as an individual. We believe this approach ensures the process is free of undue influence while creating the strongest technical specifications required of a given industry. A 2021 report from the Paris-based Organization for Economic Co-operation and Development (OECD)[1], highlighted the unique features and benefits of ASTM's agile, independent process for developing global standards.

A section of the OECD case study specifically covered ASTM's role in the standards setting activities around sustainable aviation fuels (or synthetic aviation turbine fuels (SATF), noting "ASTM International standards in sustainable aviation fuels encompass the entire life-cycle of the production process."

The ASTM standards that support SATFs are created to specifically address the technical quality and performance of the fuels to ensure safety of flight. By focusing on flight safety for new and emerging fuels, ASTM standards accommodate sustainability in the varied contexts of regions, countries, and municipalities, and can serve as a helpful tool when addressing the European carbon emission mandates that require a reduction of at least 55% in net greenhouse gas emissions by 2030.

Additionally, the OECD report acknowledged that "the international standards produced by ASTM International support the scalability of this market and, by extension, help to drive down the costs of SAFs."

The ASTM standards for this industry are managed by ASTM's subcommittee on aviation fuels (D02.J), a diverse group of more than 800 members from around the world, representing a wide-variety of stakeholders including major engine and aircraft manufacturers, testing labs, fuel producers, airlines and regulators. The subcommittee strives for the broadest participation and inclusion possible in its standards development activities due to the critical nature and global applicability of standards related to aviation Fuels. The subcommittee develops standards, including specifications, test methods, and practices, to help ensure that aviation fuels are fit for purpose and remain clean and dry before use. The subcommittee creates and maintains specifications for Jet A and Jet A-1 fuel and synthetic alternative drop-in fuels.

1 https://web-archive.oecd.org/2021-09-10/597825-irc-astm-case-study.pdf

This task has taken on more significance with the current widespread focus on reducing carbon emissions from aviation fuels, along with efforts to eliminate the use of lead in aviation gasoline. There is now much greater global interest in the ASTM standards development process. This interest is especially true in Europe, where pending environmental mandates for increased use of Sustainable Aviation Fuels (SAF) and proposed regulatory constraints on the use of leaded aviation gasoline have given new urgency to develop alternative fuels, along with the specifications that control and define those fuels. The rigor of the ASTM consensus process has led most of the global aviation expertise to coalesce around ASTM Subcommittee D02.J and associated standards. Air worthiness authorities rely on these same ASTM standards, and other national standards bodies align their aviation fuel standards with these ASTM standards. The open, consensus-based approach utilized by ASTM accommodates the technical deliberations necessary for industry to continue to provide safe, fit-for-purpose aviation fuel that supports this global industry.

In April 2025, ASTM D02.J held a week of aviation fuel related events in Brussels, Belgium. More than 250 members and interested stakeholders from around the world took part in a full-day seminar on SAF. The seminar included a robust overview of the SATF process, an in-depth review of each of the key standards for the industry, a question-and-answer session about clearinghouses established by the United States, United Kingdom, and the EU, presentations from EASA and the FAA, and an OEM panel discussion.

The three key standards that support this industry include:

1) **Standard Specification for Aviation Turbine Fuels** (D1655)
2) **Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons** (D7566)
3) **Standard Practice for Evaluation of New Aviation Turbine Fuels and Fuel Additives** (D4054)

D1655 defines the minimum property requirements for Jet A and Jet A-1 aviation turbine fuel and lists acceptable additives for use in civil and military-operated engines and aircraft. D7566 covers the manufacture of aviation turbine fuel that consists of conventional and synthetic blending components, also known as synthetic aviation turbine fuel (SATF). The specification is designed and structured to control the alternative raw materials, processes and final blending used to make alternative jet fuels. The specification supplies criteria for new synthetic aviation jet fuels to allow these new fuels to fit within the existing jet fuel supply and operational infrastructure.

D4054 provides procedures to develop data for use in research reports for new aviation turbine fuels, changes to existing aviation turbine fuels, or new aviation turbine fuel additives. These research reports are intended to support the development and issuance of new specifications or specification revisions for these products. It describes the evaluation process and data required to develop specification criteria for new drop-in alternative jet fuels. It is a key element of the process to validate that a new alternative jet fuel is safe to use on aircraft and can be qualified as a 'drop-in' fuel, i.e. a fuel equivalent to conventional petroleum-derived aviation turbine fuel.

D4054 is a rigorous technical evaluation that facilitates the broad industry review required to evaluate proposed fuels. Ultimate approval to use any fuel or additive on an aircraft or engine is the responsibility of the original equipment manufacturers (OEM), working with aviation regulatory authorities. New fuels, or pathways of fuel production, require review to ensure safety and operability (fit-for-purpose). OEMs need technical data to conduct review and provide a basis for approval decisions. D4054 provides guidance to the fuel producer on the procedures to develop the necessary data package for the OEMs and, subsequently, the full range of stakeholders to review and develop consensus.

At present, there are multiple D4054 evaluations in process from organizations around the world, including in Japan, India, Austria, Finland, Denmark, and several in the United States. To assist in this process, SAF Clearing Houses have recently been established in the EU and in the UK to coordinate with the previously existing US Clearing House. They aim to support SAF producers in bringing their products to market and negotiate the process, including applying the ASTM standards and enabling OEM technical review. All three clearinghouses work closely to support the industry in deploying sustainable aviation fuels. The ASTM D4054 practice is acknowledged as the appropriate procedure for evaluation of new synthetic aviation turbine fuels (SATF) and fuel additives. The standard practice

details the expected participation from stakeholders and their interaction with global airworthiness authorities.

Currently, D7566 includes eight annexes, or pathways, for creating a synthetic blend component to add to conventional jet fuel. Within each of these pathways, there is a definition of acceptable feedstocks, the conversion process, the blending component makeup, and the actual blending criteria. The approved pathway results in a fuel that complies with the requirements of the ASTM standard specification for aviation turbine fuels (D1655). If the new alternative jet fuel is added to ASTM D7566, it will now have met the minimum standard to be considered a Jet A/A-1 fuel and meet the certificated aviation fuel operating limitations of virtually all jet-powered aircraft. The open, consensus-based ASTM process facilitates collaborative and thorough OEM engagement with aviation fuel producers and other stakeholders. ASTM evaluates SATF by issuing specification criteria after making a technical determination that the synthetically derived material, when blended with conventional blending material, produces Jet A/A-1 fuel. The fuel now fits the existing approval requirements by air worthiness authorities and can be used without any limitations, restrictions, or special handling provisions. It can seamlessly enter the jet fuel supply chain without any additional approvals.

An additional consideration for addressing carbon emission mandates is through co-processing. Co-processing, the combination of conventional and synthetic feedstocks, is also included in D1655. In the recent ASTM Aviation Fuel Seminar, speakers discussed the impact of co-processing because of its potential to support the growing demand for SAF in a shorter timeframe, with lower capital expenditures. It allows fuel producers with years of experience to introduce SATF into the market, while new specialized processing units, that require significant investments and long lead times, work to become commercially viable. There are several benefits to co-processing, including the ability to use existing facilities, and a shorter timeframe with lower capital expenditures. The standard lists three co-processing feedstocks, which include mono, di-, and triglycerides, free fatty acids, fatty acid esters such as animal fats, plant oils and greases, certain synthetic hydrocarbons made from carbon monoxide and hydrogen gas. There are several co-processing feedstocks that are currently under ballot or evaluation by several ASTM task forces. These include pyrolysis oil from recycled rubber tires, mixed waste plastics, and generic feedstocks from any source.

Due to the global nature and requirements of the industry, aviation fuel must be an internationally uniform product. Unlike other transportation fuels, which have significant regional and country variations, jet fuel must be consistent worldwide. Aviation fuel quality control relies on industry oversight, and industry relies on fuel specifications. The open, consensus-based ASTM process facilitates collaborative and thorough OEM engagement with aviation fuel producers, air worthiness authorities, and other stakeholders. Using the ASTM rigorous consensus process, the aviation fuel industry can confidently evaluate SATFs through the development of specification criteria arrived at through technical deliberation and data. The approach utilized by ASTM accommodates the unbounded technical deliberations necessary to maintain the outstanding safety record of aviation fuel. ASTM's subcommittee on aviation fuels seeks to address environmental, sustainability, and supply security concerns through the focus on safe, fully vetted synthetic alternative jet fuels that integrate seamlessly into the existing fleet and supply infrastructure, while constantly looking toward the future. ASTM International remains committed to serving as a valuable resource for the global aerospace community and encourages participation from all interested parties — being at the table means having a direct hand in shaping the standards for the jet fuel of tomorrow.