Research and Demonstration Project on the Use of Renewable Kerosene at Airport Leipzig / Halle (DEMO-SPK)

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Regulatory Requirements for Production, Blending, Logistics, Storage, Aircraft Refuelling, Sustainability Certification and Accounting of Sustainable Aviation Fuels (SAF)

Operational requirements derived from the DEMO-SPK project conducted by DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH, on behalf of the Federal Ministry of Transport and Digital Infrastructure of Germany

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Management Summary

This document describes existing gaps in rules and regulations as well as in operational procedures – including, but not limited to EI / JIG 1530 – for the supply chain of Sustainable Aviation Fuel. These gaps, together with an inconsistent market without the ability to guarantee a continuous supply, prevent airlines from buying SAF for their daily flight operations as part of their conventional jet fuel supply. This situation also prevents their business partners, including logistics companies, storage companies, airport fuel depot operators and aircraft refuelling operators from handling Sustainable Aviation Fuel along the supply chain (production, blending, transportation, storage and aircraft refuelling). As a result, managing documentation for billing, proof of tax exemption and sustainability requirements for accounting in greenhouse gas regulation systems is another issue that is yet to be solved.

In this document, the needs for action are expressed in so-called “recommendations”. The recommendations are addressed to the relevant bodies, such as the Joint Inspection Group, one of the voluntary international bodies setting global standards for safe jet fuel handling. However, not all recommendations outlined in this document are directly associated with JIG’s tasks and business activities. Airlines and fuel suppliers are tasked with determining the adequate institutions and ruling bodies which, in turn, can close the gaps by setting industry-wide recommendations and/or enacting new legislation. In addition, this document recommends that governments represented by the International Civil Aviation Organization (ICAO) officially take part in developing a global approach to certification (both aviation fuel and sustainability certification), production and handling of Sustainable Aviation Fuel. The ICAO should share responsibility for conducting safe aircraft fuel supplies and aircraft operations with other executive and private bodies such as the European Commission, the International Air Traffic Association and the IATA Fuel Quality Pool. The addressees of our recommendations are named in bold letters following the numeric recommendation number. Other parties not mentioned in this document but which are involved in safe Sustainable Aviation Fuel production, storage, distribution and usage are also invited to contribute.

Executive summary of the DEMO-SPK project

DEMO-SPK is a research and demonstration project that investigated the use of renewable jet fuel at Leipzig / Halle airport. As a model project of the Mobility and Fuels Strategy (MFS), it was financed by the Federal Ministry of Transport and Digital Infrastructure (BMVI). The following summary of the DEMO-SPK project is geared towards answering public-sector questions and thus presents the project's basic components, results and recommendations in a simple and straightforward way.

What was the motivation behind the DEMO-SPK model project?

The necessity to reduce and prevent emissions in the German aviation industry has been addressed in the Mobility and Fuels Strategy of the German Government. In addition to technical and operational measures to reduce emissions, it focuses on substituting conventional fossil-based jet fuel with sustainable aviation fuels (SAF). For this purpose, new manufacturing processes, as specified in an international ASTM standard, are used instead of conventional oil refining processes. As the synthetic paraffinic kerosene (SPK) composition may differ from that of conventional fossil kerosene depending on the process used, market introduction is subject to certain restrictions. For example, synthetic kerosenes may not yet be placed on the market in their pure form. Instead, they have to be mixed ("blended") with fossil-based JET A-1.

Today, various SPK manufacturing processes have already been approved in accordance with the ASTM standard (e.g., HEFA-SPK, ATJ-SPK, FT-SPK, SIP). Other processes (e.g., HFP-HEFA) are currently in the process of standardization. In the medium term, airports in Germany are expected to be supplied with jet fuel containing varying proportions of different types of SPK. Since individual batches of jet fuel from different sources are usually transported and stored together within an airport's supply infrastructure, there is no physical separation of the delivered batches. This inevitably results in intermingling and mixing. As only specification-compliant JET A-1 may be used, this is formally permissible. However, the mixing behavior and compatibility of JET A-1 blends containing varying proportions of different types of SPK ("multiblending") had yet to be studied in Germany and internationally.

What were the objectives of the DEMO-SPK project?

The primary objective was to investigate and verify the behavior of mixtures of several renewable jet fuels under realistic conditions within the supply infrastructure of a major airport. The aim was to successfully demonstrate the deployment of the multiblend JET A-1 in the general fuel supply infrastructure, from procurement to aircraft refueling. In addition to analyzing the properties of the jet fuel, the project measured emissions, conducted life cycle analyses, analyzed the sustainability documentation and studied verification and credit allowances for the renewable fuels as part of European emissions trading. Furthermore, legal questions were clarified and organizational framework conditions were created.

What are the specific highlights of DEMO-SPK?

Thanks to the participation of more than 20 international partners from industry and academia, the MFS model project has been the first of its kind to succeed in:

- supplying nearly 600 tons of multiblend JET A-1 and utilizing this in flight operations at the Leipzig / Halle airport
- reducing (i) particle emissions in ground runs by approx. 30 to 60 % and (ii) CO_2 equivalent emissions by approx. 35 % through the use of multiblend JET A-1 in aircraft instead of pure fossil-based JET A-1 fuel

- preparing SPK using PTL (power-to-liquid) so that key requirements of the ASTM specifications can be met.

What is multiblend JET A-1 and how is it produced?

Multiblend JET A-1 is a blend of conventional fossil JET A-1 that is ASTM D1655 compliant, and at least two other ("multi") renewable jet fuels that are in line with ASTM D7566.

Two important criteria were taken into account in the DEMO-SPK project when selecting the renewable jet fuels and their suppliers: (i) the current version of the ASTM approval process and (ii) their availability on the international market at the time of the preliminary investigations and the scheduled demonstration at Leipzig / Halle airport. The renewable jet fuels HEFA-SPK and ATJ-SPK, which were only available in the US, were used in the demonstration. The fossil-based JET A-1 was purchased from a refinery in Lingen. These components were used to produce approximately 600 tons of multiblend JET A-1 for DEMO SPK.

Current specifications do not explicitly cover multiblending, however successive mixing is implicitly permitted. In order to comply fully with the applicable regulations, the renewable jet fuels were added successively to the fossil-based JET A-1 to produce the multiblend JET A-1, and a fuel sample was taken after each mixing process. It was accepted that there would be additional work involved, as compliance with the ASTM specification had to be formally ensured in every case. The multiblend JET A-1 used at Leipzig / Halle airport was produced at a tank farm in Speyer. As jet fuel tanks normally do not have a mixing device, the tank farm's infrastructure was adapted to the mixing task through the installation of a mixing device in a spherical tank that had previously been flushed several times.

How was the use of multiblend JET A-1 in the infrastructure of a major airport verified?

In preparation for demonstrating the provision and use of multiblend JET A-1, preliminary investigations were carried out on various multiblend formulations. It was shown that multiblends can be produced in line with specifications and that the chemical and physical variables can be precisely calculated as long as the pure fuels are known. No separation occurred, nor did the properties change when stored for a period of six months. Likewise, there was no decline in the quality of the fuel. Results obtained for lab-scale mixtures can be transferred.

Based on these findings, production began in Speyer on the multiblend JET A-1. The renewable jet fuels and the JET A-1 were supplied through combined logistics. The multiblend JET A-1 was delivered by railroad tank wagons in accordance with the specific requirements and conditions at the Leipzig / Halle airport. The fuel was stored there in an above-ground tank. In order to demonstrate the compatibility of a multiblend JET A-1 with the actual supply infrastructure of an airport, it was subsequently handled in the same manner as fossil-based JET A-1 for the purpose of aircraft refueling. This was the first time it could be verified anywhere in the world that multiblend JET A-1 can be used operationally in the same way as fossil-based JET A-1 without restrictions.

DEMO-SPK also planned to conduct comparative emission measurements on an aircraft turbine in a ground run. The quantities of multiblend JET A-1 and JET A-1 required to do this were transferred to field tank trucks, which are regularly used in aircraft refueling.

Does the use of multiblend JET A-1 contribute to a reduction in emissions and pollutants?

The DEMO-SPK project was able to demonstrate a reduction in emissions and pollutants in two ways. Both ways show which notable reduction potentials are possible in the short to medium term.

Measuring pollutant emissions. Comparative emission measurements were carried out on an aircraft turbine in an engine testing facility at Leipzig / Halle airport. Two ground runs were conducted based on a fixed measurement protocol that included a fossil JET A-1 reference measurement and a measurement with the multiblend JET A-1. The use of the multiblend JET A-1 reduced soot in relation to particulate mass by approx. 30 to 60 % for different operating points. The soot reduction was not associated with a "trade-off" in any other emission parameter. This was verified by comparative investigations in the technical laboratory.

Life cycle analyses for the renewable jet fuels and the multiblend JET A-1. In accordance with the methodology guidelines of the Renewable Energy Directive (RED), the specific greenhouse gas reduction emissions (as CO_2 equivalents) of the renewable jet fuels were balanced and their reduction was determined in the multiblend JET A-1. The findings showed that the use of multiblend JET A-1 on its own can reduce greenhouse gas emissions by 35 % compared to fossil JET A-1.

How were sustainability aspects taken into account by DEMO-SPK?

There is a consensus that only sustainable renewable jet fuels will be used in aviation. In the European Union, the sustainability criteria that have to be respected in practice are firmly anchored in the Renewable Energy Directive. It specifies which raw materials can be used and stipulates the methods and minimum requirements of greenhouse gas reduction potentials over the fossil reference. Based on these standards, so-called life cycle analyses were also conducted for the renewable jet fuels used in DEMO-SPK. Their specific greenhouse gas reductions ranged from 57 to 96 %. The multiblend JET A-1, which contained fossil jet fuel, still achieved reductions of 35 %.

Furthermore, it was determined that the sustainability documentation criteria required by the certification process, which already apply to biofuels used in road traffic, can be transferred to the use of renewable jet fuel in multiblend JET A-1. DEMO-SPK also found that sustainability requirements and standards differ significantly from one another around the world. In a growing global market for renewable jet fuels, this can lead to additional administrative requirements for market participants. A solution to this problem lies in the mutual acknowledgment of existing systems and the development of so-called meta standards.

In addition, life cycle analyses of various sample supply chains were conducted with respect to cost sustainability. It was found that renewable jet fuels are likely to be much more costly than fossil jet fuels in the foreseeable future and will therefore not be competitive without specific incentives. An optimized logistics supply chain demonstrates a possible reduction in logistics costs of 85 % over the supply chain demonstrated in DEMO-SPK. However, a cost ratio of 1.3 was determined in the case of multiblend JET A-1 to fossil jet fuels, assuming the year-round supply and using Leipzig / Halle airport as an example. This would favor an industrial-scale introduction in the future. However, as long as there are cost reservations with respect to renewable jet fuels, further measures are needed to introduce the use of multiblend JET A-1 on a larger scale due to the fierce international competition in air transport.

How can the aviation industry offset its obligations in emissions trading?

Another important aspect for the market implementation of sustainable aviation fuels (SAF) is the intersection between the mass balance system for sustainability certification and documentation, on the one hand, and the inclusion of renewable jet fuels in the European Emissions Trading Scheme, on the other. Certification and credits based on the current legal approach are associated with high administrative and operational costs, which leads to limited use of credit allowances for renewable jet fuels and thus further reduces incentives for the use of SAF. Against this backdrop, DEMO-SPK has therefore developed various approaches for improving credit allowances in European emissions trading (so-called "track and trace" or mass balancing, and "book

and claim" or the certificate solution) and has confirmed their basic functionality. In a further step, the developed procedures and approaches will be verified in practice beyond the experience gained in DEMO-SPK, thus identifying further measures for their future operationalization.

What other recommendations for action have emerged from DEMO-SPK?

The pilot project has identified not only numerous suggestions for operational project management, but also the concrete need for clarification, which is important for a successful implementation on the broader market. These include (i) the expansion of ASTM D7566 to include simultaneous production of multiblend JET A-1, (ii) a simplified REACH registration for renewable jet fuels and (iii) the amendment of the Energy Tax Act using the so-called similarity principle as per Article 2 (4) of the Energy Tax Act.

In addition, specific recommendations were derived for the international institutions (ASTM, JIG, ETS etc.) and addressed to them for consideration when further developing the respective specifications and guidelines. DEMO-SPK thus goes beyond the actual project and makes recommendations to internationally facilitate the operational coverage of renewable jets fuels as part of multiblend jet fuel and thus to enable market implementation.

Notwithstanding the successful investigations conducted as part of the DEMO-SPK MFS model project, the fact remains that, in addition to the above-mentioned recommendations for broad market implementation of renewable jet fuels, a massive expansion of production capacities and infrastructures (e.g., for the production of multiblend JET A-1) are required. Only then will it be possible to achieve the positive effects identified and verified by DEMO-SPK in relation to reducing potential pollutant emissions and greenhouse gases.

Table of Contents

List of Abbreviations

ASTM *formerly American Society for Testing and Materials*
ATJ *Alcohol-to-Jet*
BMVI *Federal Ministry of Transport and Digital Infrastructure*
CoO *Certificate of Origin*
CORSIA *Carbon Offsetting and Reduction Scheme for International Aviation*
EC *European Commission*
EECS *European Energy Certificate System*
EPA *Environment Protection Agency*
EU ETS *European Union Emissions Trading Scheme*
FT *Fischer-Tropsch*
GHG *greenhouse gas*
HEFA *Hydrotreated Esters and Fatty Acid*
IATA *International Air Transport Association*
ICAO *International Civil Aviation Organization*
IFQP *IATA Fuel Quality Pool*
iLUC *Indirect Land Use Change*
ISCC *International Sustainability and Carbon Certification*
JIG *Joint Inspection Group*
LUC *Land Use Change*
MFS *Mobility and Fuels Strategy*
OEM *Original Equipment Manufacturer*
PTL *Power-to-Liquid*
RED *Renewable Energy Directive*
RFS *Renewable Fuel Standard*
RIN *Renewable Identification Number*
RSB *Renewable Sustainable Biomaterials*
SAF *Sustainable Aviation Fuel*
SIP *Synthesized Iso Paraffins*
SPK *Synthetic Paraffinic Kerosene*


Bio-Jet A-1

1 Introduction – Current Information Gaps regarding SPK Handling

The introduction of jet engines into the market came about as new propulsion systems for aircraft in the late 1950s required a uniform, specified aviation fuel type, which had to be produced and distributed globally in order to match the growing fuel demand of international air traffic. The aviation turbine fuel grades JET A and JET A-1 were developed to meet the energy demand of the innovative jet engines with a maximum of reliability and operational safety, especially with regard to cold temperature properties and high flash points (i.e., a reduced fire hazard).

The airlines are required by their national airworthiness authorities to operate only with jet fuel that meets the fuel properties specified by the aircraft and engine original equipment manufacturers (OEMs). To meet this requirement, a framework of industry norms and "best (industry) practice" was established control jet fuel properties and quality on a global scale. However, this means there is neither an intergovernmental authority regulating or defining jet fuel properties, nor a governmental body supervising and monitoring the quality of jet fuel on a global scale. Besides the framework of industry norms and "best (industry) practice", a system to frequently inspect refineries, fuel transport companies, tank farms and aircraft refuelling services was set up on a voluntary basis via JIG, the Joint Inspection Group. Such a regulatory framework is particularly necessary to ensure that aviation fuel supply and fuel handling is carried out in accordance with uniform and globally recognized standards. Later, the International Air Transport Association (IATA), the association of commercial airlines providing scheduled services for passengers and cargo, commenced with an intra-sectoral voluntary inspection group (IFQP – IATA Fuel Quality Pool), which has endorsed the JIG regulation as a cornerstone of their voluntary contribution to improving aviation fuel storage and handling.

As far as jet fuel specification issues are concerned, ASTM (formerly American Society for Testing and Materials) and the British Ministry of Defence have taken the leading role within a self-organized and non-governmental jet fuel specification forum for all industry members including engine and aircraft OEMs, oil companies, airlines and further fuel supply chain industry members.

While ASTM sets the specification for jet fuels without regulating operational issues, JIG and IATA define standards for the operational handling of jet fuel. At present, there is neither an interaction between these two leading institutions nor a direct communication from ASTM through JIG / IATA to fuel operators and airlines.

Since the 1990s, ASTM and the UK's Ministry of Defence have been involved in the specification of new synthetic jet fuel feedstock/synthetic kerosenes. One of the new fuel types introduced into the market was South African jet fuel derived from coal and converted to a SPK through Fischer-Tropsch (FT) processing. Since 1998, ASTM has been involved in creating various new jet fuel specifications, commencing with bio-based SPK derived from woody and cultivated biomass (FT-SPK), followed by Hydrotreated Esters and Fatty Acids SPK (HEFA SPK) and more (according to ASTM D7566 and its Annexes).

The new production processes generate different synthetic kerosene types; all of them differ in their composition and properties from petroleum-based aviation fuels. As these non-fossil jet fuels themselves do not entirely fulfil the conventional JET A / JET A-1 specification (ASTM D1655), they must be blended with conventional hydrocarbons or conventional jet fuel prior to release for aviation purposes. Hence, their use is still limited to a blend with fossil jet fuel. When produced and blended according to the applicable specifications (ASTM D7566 and ASTM D1655), these blends are so-called "Drop-in" jet fuels or "Drop-in" fuel blends. This means that such a blend can be commingled with conventional jet fuel and be fully compatible with existing fuel supply infrastructure as well as aircraft fuel systems and engines. These "Drop-in" jet fuels did not cause

any technical problems for the industry, as the final blend completely fulfilled the ASTM D1655 specification for conventional jet fuels. However, the commercialization of these non-fossil fuels and the commencement of their large-scale production is still hindered, especially due to high production costs and lack of sustainable feedstock. Under the prevailing conditions, where Sustainable Aviation Fuels are hardly integrated in day-to-day fuel handling processes, Sustainable Aviation Fuels have been handled outside the regulatory framework for airport tank farms and aircraft refuelling companies.

So far, the first steps into commercialization have been successfully achieved. However, under the prevailing conditions, it is necessary to teach, train and support stakeholders along the entire supply chain in handling Sustainable Aviation Fuel, e.g., in terms of blending procedures, sustainability documentation or accounting against greenhouse gas (GHG) regulation systems like the European Union Emissions Trading Scheme (EU ETS) or Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

The commercialization of Sustainable Aviation Fuels will require all participants along the jet fuel supply chain not only to handle a new type of jet fuel and jet fuel blends but also to implement and provide accurate bookkeeping of Sustainable Aviation Fuels at any time. This will especially be required for accounting purposes or to demonstrate fulfilment of any mandate or quota set by national governments.

Due to these circumstances, there is a need for a harmonization of regulations. Hence, there is a need to break down the ASTM D7566 specification in line with ASTM D1655 from the fuel properties level to operational and accounting standards such as JIG 1530 and further on to practical handling and administrative procedures. The latter may be adopted by the supply chain participants into their operation manuals. Such a widespread transfer of information is critical for allowing the operational quality level of fossil JET A/JET A-1, which has been continuously improved over decades to be achieved for the newly introduced Sustainable Aviation Fuels as non-fossil jet fuel types.

2 Drop-in SAF and Ready-for-Use SAF

There is a requirement to differentiate between Drop-in SPK and Ready-for-Use SPK, as each type requires different handling.[1]

2.1 Drop-in SPK

Today, a Drop-in SPK is commonly regarded as a restricted fuel that can be used in combination with conventional JET A/JET A-1 as a blend. Effectively, it can also be the other way around, when the fuel properties of the fossil jet fuel are relevant and limiting factors for the actual blend. They determine the maximum blending ratio of a binary blend besides ASTM specification limits, which limit a blend to a maximum SPK ratio of 50 % (FT, HEFA, ATJ), 10 % Synthesized Iso Paraffins (SIP) and also as an anticipated blending ratio for synthetic "green" diesel by volume.

Recommendations:

(1) **Effective Blending Ratio [IFQP, JIG]** As a matter of fact, depending on the parameters and properties of the fossil jet fuel batch used as a blending-component, the maximum effective blending ratio may be below the approved ASTM certification limits.

Restrictions to lower than the maximum permitted blending limits due to composition and fuel property parameters should be communicated in all publications and shall be printed on all forms and templates associated with blending and certification procedures.

(2) **Blending Procedures [IFQP, JIG]** Concerning the variety of Sustainable Aviation Fuel types (FT-SPK, HEFA SPK, SIP, SPK/A, ATJ-SPK) that have already been created by ASTM (as of December 2018), there is presently no regulation in place that deals with the handling of multiple blended SPKs (i.e., how to handle a blend of more than one SPK type with a fossil jet fuel batch). The safest way to avoid any off-specification (off-spec) fuel situation would be to produce binary blends of an SPK and fossil JET A/JET A-1 (as the case may be) in the beginning and to blend such binary blends to a "multiblend" jet fuel in a subsequent secondary procedure.

However, such a procedure requires a number of storage tanks and will most likely be both costly and time consuming.

In a more likely scenario, a blender blends such SPKs in one storage unit and determines the fuel properties of the SPK blend. Based on such figures, the maximum blending ratio with a dedicated batch of JET A/JET A-1 can be calculated. It may be considered to deduct a safety margin from such determined maximum blending ratios in order to avoid any risk from a multiblend jet fuel batch that does not fulfil the ASTM D7566 and ASTM D1655 specification requirements and may cause a safety issue when used for aircraft refuelling purposes.

(3) **Proposed Blending Ratios for Drop-in fuels [JIG]** Assuming that industry safety standards are not weakened, it should be considered to commence the production of Drop-in fuel blends only in given ratios. Such given ratios may be far below the maximum blending ratios observed and will not release any operator from accurate testing of fuel properties, but will generate a global database of the behaviour of fuel properties depending on the blending ratios in order to promote the further development and use of Sustainable Aviation Fuels. In addition, such given ratios will possibly ease

[1] The following recommendations and explanations, which are explained here for SPKs, can also apply to other synthetic aviation fuels, such as Synthesized Iso Paraffins.

the handling of Sustainable Aviation Fuels in general as well as tank farm operations due to revolving parameters (i.e., HEFA blend ratio and FT blend ratio 5 %, 10 % or 15 % and ATJ 5 % or 10 % and SIP blend ratio 5 %).

Multiblend jet fuels shall be approved for operation, provided the JET A / A-1 composition has been checked and recorded prior to blending and thereafter SPK components have been blended under observation of the final multiblend specification requirements to be achieved (i.e., 70 % JET A-1 topped with 15 % HEFA + 10 % ATJ + 5 % SIP).

With reference to Recommendation (2), a provision has to be established on how multiblends shall be produced. While blending of SPKs with JET A / A-1 is in progress, the operator of such blending has to ensure that the commingled products remain within the ATM D1655 specification limits at all times.

(4) **Amended Declaration of Conformity [JIG]** The Declaration of Conformity should be amended, declaring that the fuel batch properties conform to the specification of jet fuel as per ASTM D1655 and that each SPK type used for the multiblend production has fulfilled ASTM D7566 specification prior to blending.

In case the SPK's have been commingled and blended thereafter with JET A-1, the Declaration of Conformity shall also include the commingled SPKs jointly fulfilling ASTM D7566.

(5) **Blend Certificate of Origin [IFQP, JIG]** If not otherwise regulated, any binary blended or multiblended jet fuel shall be delivered to an Airport Fuel Depot only upon certification of the blended jet fuel batch (prior to reaching the airport or depot boundary).

The blends shall be delivered with a Certificate of Origin issued by the blending facility that lists all SPKs and their ratio in the final blend as well as the ratio of fossil jet fuel in such a blend. The format of such a "Blend Certificate of Origin" shall be provided as a template. Any kind of blending on the premises of an airport or Airport Fuel Depot shall be avoided as the operator of an airport depot shall in no way be the (technical) blender of jet fuel (i.e., the actual blending procedure shall in no way be conducted in an Airport Fuel Depot).

Nevertheless, the operator of an Airport Fuel Depot may be entitled to commingled storage upon reaching evidence that a blend conforms to all applicable specifications as well as the Indemnification Agreement Consortium or any other applicable document in place ruling the responsibilities and warranties to be provided when operating an Airport Fuel Depot.

(6) **Handling of Additives [IFQP, JIG]** As per ASTM D1655 specification, fossil jet fuel should receive additives in order to fulfil all specification requirements. SPK or SPKs commingled shall be added to such a jet fuel until the blend reaches one or more specification limits. Thereafter no additional additives may be added to the binary blend / multiblend for its use in an aircraft. A couple of years ago, a case was reported in which, for reasons unknown, the fuelling of a series of flights from the UK to the Mediterranean had been conducted with a SPK JET A-1 blend whose conductivity parameter fell below the specification limit during storage.

As a consequence, any jet fuel should be declared to be off-spec if the quantity in a tank does not meet the specification requirements. Any activity to regain specification conformity should not be allowed or must be subject to clear advisory rules which need to be specified and provided to all operators.

2.2 Ready-for-Use SPK

Presently, new synthetic fuel types are in the ASTM certification process. Such fuels contain aromatics. Based on such conditions, additives can be added to the SPK and the final fuel composition will match ASTM D1655 specifications without additional blending. Being specification-compliant, such SAF can be declared as JET A / JET A-1 (in line with the defined freezing point) in principle without the need for any upfront blending with JET A / JET A-1. These purely synthetic jet fuels will henceforth be referred to as "Ready-for-Use SPK". For safety reasons, ASTM may also require a blending of such fuels until their reliability in daily airline operation has been unanimously accepted.

Recommendations:

(7) **Typology for Ready-for-Use SPKs [IFQP, JIG]** It should be considered to establish a differentiation of fossil JET A-1 and non-fossil JET A-1. The ASTM specification does not cover all characteristics of a jet fuel. Hence, matching the specification does not necessarily mean that all parameters of the fuel types are similar. An amendment of the common brand names JET A and JET A-1 by a suffix "S" should be considered as a means of marking this fuel as being purely synthetic.

(8) **Synthetic fuel as JET A / JET A-1 blending component [JIG]** Drop-in SPKs may be blended with JET A / JET A-1. Presently there is a common understanding that the JET A / JET A-1 used as a base for blending shall be an ASTM D1655 conform fossil jet fuel. With respect to Ready-for-Use SPK, it needs to be clarified whether this provision (ASTM D1655) also applies, if the base fuel for blending is a purely synthetic jet fuel.

(9) **Unlimited commingling [JIG]** Following ASTM D1655 and ASTM D7566, Ready-for-Use SPKs meeting both specifications can be commingled without restrictions. A fuel tank may contain shipments of Drop-in SPK blends (containing the Drop-in components and Ready-for-Use SPK as blending component) as well as various Ready-for-Use SPKs commingled. The Drop-in SPKs may be blended with fossil JET A-1 and additional shipments of various Ready-for-Use SPKs may also be commingled with the blend as described above. If such composite fuel causes no further operational control mechanism other than the checklists already in place and well respected, no further operational rules are necessary. Such statement should be added to the JIG Guidelines.

If additional operational handling requirements have been detected, the JIG Guidelines shall be amended accordingly. It is recommended to promote immediate alert if any depot operator detects any kind of deviation from expected behaviour or observes any off-spec situation associated with the storage of SPK jet fuels.

3 Agreement Adaptions for SPK-Usage

3.1 Amendment of Indemnification Agreement Consortium and Airport Fuel Depot Shareholder Agreement with regard to Sustainable Aviation Fuels

The Airport Fuel Depot Shareholder Agreement and the Indemnification Agreement Consortium have to be amended with regard to Sustainable Aviation Fuels.

At present, the Airport Fuel Depot Shareholder Agreement contains the provisions for a Joint Venture Company of shareholders holding a license to sell jet fuel and AVGAS 100LL on the airport premises to their customers. It also contains specific provisions on how throughputters may use the Airport Fuel Depot against paying a throughput fee. They also have to obtain their license from the airport authority and have to prove insurance protection by an into-plane insurance covering damages to the amount of $2 billion USD. The Indemnification Agreement Consortium ("Tarbox Agreement") rules liabilities in relation to commingled storage of jet fuel as well as liabilities with regard to jet fuel handling and aircraft refuelling as the case may be.

Currently, the specific contracts are based on supply, storage and sale of fossil JET A / JET A-1 as per ASTM D1655 specification and do not refer to any type of Sustainable Aviation Fuel (whether being a blended SPK or supplied as Ready-for-Use SPK) yet. Sustainable Aviation Fuels will be subject to accounting towards the emission compensation duties of an airline. Consequently, fuel suppliers have not only to monitor total jet fuel quantities in the depot but also to provide sufficient records about the supply and utilization of Sustainable Aviation Fuels to (airport) authorities, fuel suppliers and airlines. Fuel depot operators have to be mandated and obliged to establish a reporting system out of their inventory management to provide reliable data for the portion of Sustainable Aviation Fuel they manage in the depot and data on the allocation of Sustainable Aviation Fuels sold to customers / airlines. This will be necessary, since the commingled storage of Sustainable Aviation Fuels and conventional (fossil) jet fuels in a common fuel depot does not allow the actual fuel molecules to be kept separate (as they have been delivered to the airport fuel depot) and any airline/customer will receive an equally commingled volume of aviation fuel.

Recommendations:

(10) **Upgrade of inventory management systems [JIG]** The JIG Guidelines shall be amended accordingly and shall have a provision that (Airport) Fuel Depot Operators have to follow up receipt, storage and distribution of SPK blends and Ready-for-Use SPKs in their inventory management system.

(11) **Supervision of maximum blending ratios [IFQP, JIG]** As a duty of the Airport Fuel Depot Operator, observance of maximum blending ratios as per ASTM D7566 provision shall become mandatory as well as providing a proof of specification conformity for all Sustainable Aviation Fuel blends and deliveries of Ready-for-Use SPK.

(12) **Second stock level in inventory management systems [IFQP, JIG]** In addition to the existing volume-related monitoring of jet fuel quantities, the inventory management shall contain a second stock of jet fuel ownership for the portion of Sustainable Aviation Fuel delivered. The utilization of Sustainable Aviation Fuels shall be based on documented agreements between shareholders or throughputters with their customers dealing with a percentage of Sustainable Aviation Fuel in every refuelling operation for that customer. Alternatively, a preferred allocation of such virtual inventory to aircraft refuelling may be executed in a manner that such virtual inventory shall be delivered first to the defined customer until his ordered quantity of Sustainable Aviation Fuel has been consumed. As

such refuelling data movements are related to a virtual consumption only, there is no need to follow-up maximum blending ratios as specified in ASTM D7566.

(13) **Controlled access to inventory data [EC, IATA, JIG]** Upon request of any authority or airline receiving Sustainable Aviation Fuel, the Airport Fuel Depot Operator shall grant access to his fuel inventory data and shall provide the data required for accounting purposes in GHG regulation systems. In addition, shareholders and throughputters shall advise the Airport Fuel Depot Operator about authorized receivers of their client base. Therefore, a continuously updated list of authorized receivers shall be maintained in a way that the Airport Fuel Depot Operator is aware about coming requests for information and is entitled to provide such information without any undue delay.

(14) **Amending of existing contracts [JIG]** The Shareholders Agreement and the Throughput Agreement of such Airport Fuel Depot should be amended accordingly. The Management Agreement with the operating company of the Airport Fuel Depot should also be amended. It should contain additional provisions requesting the mandatory functions of the fuel inventory management system (unless property of the Joint Venture Company) as well as the obligation to keep the inventory data of Sustainable Aviation Fuel always updated and to provide relevant information to all parties authorized to receive such information.

(15) **Contractual handling of SAF quantities [JIG]** The Shareholders Agreement and the Throughput Agreement shall be enlarged by a provision that entitles each user of the facilities to deliver Sustainable Aviation Fuel. It shall further limit any virtual allocation of a user's inventory to his customers to the quantity of Sustainable Aviation Fuel stored on his behalf. The associated fuel supply agreements shall contain appropriate Sustainable Aviation Fuel conditions. For any missing quantity of Sustainable Aviation Fuel, only conventional (fossil) jet fuel will be supplied. Shareholders and throughputters may elect to virtually borrow and lend Sustainable Aviation Fuel quantities of their virtual inventories among each other. In this respect, the principles for transfer of ownership in the depot as currently practised should be continued.

(16) **Virtual versus physical consumption of SAF [JIG]** While the physical distribution of Sustainable Aviation Fuels in commingled storage cannot be monitored, the virtual consumption shall follow the dedicated directives of the owners of such Sustainable Aviation Fuels with regard to their customers. The operator shall report any incapacity or delay in observing these directives immediately to the owner(s) of Sustainable Aviation Fuel in a written format.

(17) **Clearing of virtual inventories [JIG]** A shareholder / throughputter holding Sustainable Aviation Fuel (i.e., virtual quantities) without having taking-off customers and without movements/trades of his virtual Sustainable Aviation Fuel quantities, should be obliged to either sell the virtual quantity to any airline customer or shareholder / throughputter or declare the virtual quantity as conventional (fossil) jet fuel (i.e., "downgrading" it) upon expiration of a defined period of time.

This recommendation may be justified as follows: Oversupply of Sustainable Aviation Fuel will be held as inventory in the second stock level of the Airport Fuel Depot while, after expiration of the defined period, the physical volumes have already been supplied through the fuel system. Hence, a widespread of aircraft physically received volumes / molecules from the Sustainable Aviation Fuel volumes (i.e., from blended or neat SPKs). Holding this inventory will delay the reporting of consumed fuel quantities to the owner of the Sustainable Aviation Fuel, which means that no CO_2 certificate can be issued until the Sustainable Aviation Fuel has been "virtually" consumed.

Assuming that the molecules have already been supplied through a hydrant system or bowser being refuelled leads to the question of who legally consumed the fuel and if such "virtual" consumption legally qualifies for receipt of CO_2 certificates. Although these circumstances may be unlikely, for reasons of adequate fuel inventory management, this situation has to be described and relevant management procedures have to be developed. It is more likely that a customer receives less Sustainable Aviation Fuel than ordered due to the fact that any seller of Sustainable Aviation Fuel is motivated to avoid an oversupply of such fuels due to the situation described above.

However, as missing quantities of Sustainable Aviation Fuel can be substituted any time by fossil JET A / JET A-1, such situation will not lead to operational shortages if the supplier also holds fossil JET A / JET A-1 in his depot or if he is able to borrow substitute quantities until his depot inventory will be refilled. The lack of Sustainable Aviation Fuel will more or less be a legal issue between supplier and customer for non-fulfilment of contractual obligations and the need for the customer to buy CO_2 certificates from the market.

(18) **Depot utilization rights to be extended to SAF [JIG]** The industry standard of Airport Fuel Depot Shareholder Agreements contains a provision to regulate the right of shareholders (and throughputters as the case may be) to hold inventories in the magnitude of their market share of jet fuel supplies at that airport. This provision needs to be amended, as the demand of Sustainable Aviation Fuel and their storage in an Airport Fuel Depot shall also be limited to the market share of the actual Sustainable Aviation Fuel supplier. Otherwise a situation may occur in which suppliers use the Airport Fuel Depot as a storage and trading institution by selling their Sustainable Aviation Fuel inside the depot to other suppliers who have to fulfil contractual agreements with their customers for a certain quantity or percentage of Sustainable Aviation Fuel as part of their total fuel demand at an airport. Using the Airport Fuel Depot as a trading institution does not comply with the Shareholder Agreement. It may furthermore cause disagreements with tax authorities (tax supervision) and / or the airport authority for non-observance of license conditions.

3.2 Amendment of Free Into-Plane Supply Agreements for SPK blends

"Free Into-plane Supply Agreements" means an agreement for jet fuel supply to a customer at a defined airport for a defined period of time. The agreement itself does not constitute any legal obligation to buy a predefined quantity of jet fuel, but is considered that any jet fuel demand of a customer serving such airport shall be part of the agreement, if a share of the effective demand or the volume up to a fixed quantity has been awarded to the supplier. The agreement obliges the fuel supplier to hold sufficient inventory at the airport to meet his customer's fuel demands. Furthermore, aircraft refuelling operations have to be provided at no extra charge through his staff or any qualified service provider acting on his behalf.

Up until now, such industry standard agreements refer to JET A / JET A-1 according to ASTM D1655 without any provision for Sustainable Aviation Fuel. According to the ICAO rule that international commercial air traffic is exempted from jet fuel taxation while domestic air traffic is not exempted (including technical flights upon completion of maintenance, engine test runs and repositioning flights of an aircraft to its next commercial departure airport) consumption of jet fuel is normally tax-free as the Airport Fuel Depot is under tax supervision.

Such contracts have to be operationally fulfilled by the Airport Fuel Depot Operator and the into-plane service companies serving an airport. Therefore, contractual provisions in the supply agreement shall be negotiated

in a way that depot operators and into-plane service companies can manage the contractual provisions of a supply agreement.

Recommendations:

(19) **Harmonized contractual provisions for SAF [IATA, JIG]** A set of contractual provisions concerning Sustainable Aviation Fuel should be collected from international fuel suppliers. In addition, an industry working group consisting of jet fuel suppliers, fuel depot operators and airlines shall be established to finalize a proposed wording reflecting the most common (or most anticipated) industry practices with respect to the sale and purchase of Sustainable Aviation Fuels (SPK blends or Ready-for-Use SPK). Such proposals should be assessed and discussed. Additionally, provisions for Airport Fuel Depot Operators on the handling of jet fuel supply contracts containing provisions for the supply of Sustainable Aviation Fuels should be prepared.

Finally, a non-binding understanding between fuel suppliers and Airport Fuel Depot Operators should be elaborated in order to support an easy jet fuel inventory management and reporting systems.

(20) **Reporting instructions for SAF throughput [EC, IATA, JIG]** The Airport Fuel Depot Operator should receive industry-wide accepted reporting instructions on the documentation and reporting of Sustainable Aviation Fuels eligible for CO_2 certificates or offsets in GHG regulation systems.

3.3 Amendment of Ex-Refinery Supply Agreements for SPK Blends

Airlines buying jet fuel on an ex-refinery basis should commit themselves to buying a defined quantity of jet fuel over a defined period of time with scheduled shipments / transports of the agreed upon quantity to an airport or airports of their choice. The nature of an ex-refinery agreement calls for transports to be arranged and paid for by the airline itself, acting as the buyer of such jet fuel quantities.

Assuming these principles reflect the industry practice for ex-refinery contracts, the issue of CO_2 certification is unproblematic as there will be a direct transfer of ownership to the end consumer.

The supplier / distributor of Sustainable Aviation Fuel will be entitled to submit the adequate number of CO_2 certificates to the buying airline who can use the certificates for CO_2 compensation in a GHG regulation system. As long as the airline is not reselling the Sustainable Aviation Fuels in whole or in part to other stakeholders, ex-refinery purchased jet fuel remains to be handled under tax exemption. Under such conditions, the Sustainable Aviation Fuel can be delivered to an Airport Fuel Depot as JET A / JET A-1 containing a SPK blend without further action of the depot operator as the certificate(s) for such jet fuel have already been issued and handed over to the end consumer.

Recommendations:

(21) **SAF ex-refinery provision [JIG]** Ex-refinery sold Sustainable Aviation Fuel (Drop-in SPK) has to be blended (if no Ready for Use SPKs are considered) outside the Airport Fuel Depot and only Sustainable Aviation Fuel blends (Drop-in SPK blends) fulfilling both ASTM D7566 and ASTM D1655 are qualified to be stored in such depots.

(22) **Trading of fuel blends [IATA, JIG]** Airlines may elect to sell any Sustainable Aviation Fuel blend prior to reaching any Airport Fuel Depot. The handling of CO_2 certificates is not an issue of the Airport Fuel Depot Operator and such cases have to be settled bilaterally between seller and buyer.

(23) **Counting of virtual inventory movements [IATA, JIG]** Assuming that all Airport Fuel Depots are obliged to follow-up “virtual” Sustainable Aviation Fuel blend consumption, a regulation should be established to ensure that the Sustainable Aviation Fuel (component) is always consumed first by airlines following the ex-refinery supply scheme (i.e., self-supplying airlines) – knowing that such consumption is only virtual and does not comply with the physical distribution of molecules.

(24) **Limitation of transfer of ownership [JIG]** Once such “virtual” consumption has been recorded in the second level fuel inventory management, such Sustainable Aviation Fuel quantity can no longer be transferred to any other shareholder / throughputter as it has “virtually” left the depot for consumption.

4 Mandatory Handling Requirements to ensure Specification Conformity

4.1 Source of SPK Manufacturing (ASTM D4054 – Evaluation of new Turbine Fuels)

Assuming that SPK is produced in a dedicated facility, such a “SPK refinery” should issue a regular Certificate of Origin for the SPK produced, regardless of whether the SPK is a Drop-In fuel or Ready-for-Use fuel. In order to have such SPK accepted in a GHG regulation system, additional feedstock and processing related documents have to be added to the Certificate of Origin. To ensure accountability regarding Sustainable Aviation Fuels, a feedstock-related (i.e., origin related) Proof of Sustainability is required. The corresponding supply chain of a SPK shall be certified according to a recognized sustainability certification scheme like ISCC or RSB as the case may be. These two certification schemes have been accredited (amongst others) in the European Union and are considered to reflect a preferred standard in guaranteeing sustainable feedstock production and supply.

Recommendations:

(25) **Technical responsibility of JIG [JIG]** Most likely, JIG will not have any direct impact or influence on the sustainability certification. However, JIG shall remain technically responsible for all documents that need to be supplied by the supplier of Sustainable Aviation Fuels (certificates, forms, declarations etc.) for CO_2 accounting purposes in any GHG regulation system. No shipment of Sustainable Aviation Fuel (blended SPK or Ready-for-Use SPK) should be accepted by any Airport Fuel Depot Operator without such documents.

(26) **Traceability of sustainability criteria [EC, JIG]** A synthetic fuel type shall be accepted, if it is qualified to the requirements of testing fuels according to ASTM D4054 and produced to ASTM D7566 (ASTM D4054 characterizes the approval procedure that a manufacturer of a Sustainable Aviation Fuel has to complete in order to qualify the fuel to be incorporated into ASTM D7566). A Certificate of Origin shall be issued by the producing facility. For accounting purposes of Sustainable Aviation Fuel, the producer of the SPK should be obliged to submit a certificate which contains data of the feedstock batch(es) that have been utilized for SPK production. The producer shall additionally submit the mandatory sustainability certification documents referring to the relevant feedstocks, farmlands and / or re-use of residues, waste and other feedstocks / raw materials in a sustainability certification scheme according to EU RED, US EPA or any other standard scheme applicable for the producer of Sustainable Aviation Fuel.

(27) **Documentation requirements [EC, IATA, JIG]** A record should be issued and maintained that lists all documents required for the fuel to be officially recognized as Sustainable Aviation Fuel at an Airport Fuel Depot and to meet (!) all relevant technical and sustainability requirements as well as requirements related to accounting in GHG regulation systems. This list shall refer to the EU ETS (in combination with the EU RED) and US EPA as reference provisions for two major sustainability regulations.

(28) **Extended storage of documents [JIG]** The operator of the Airport Fuel Depot shall be obliged to store and secure such documents for audits of accredited emissions trading verifiers, tax authorities or any other governmental bodies having jurisdiction with regard to sustainability documentation and accounting of Sustainable Aviation Fuel (by an airline uplifting Sustainable Aviation Fuel at the corresponding airports).

4.2 Feedstock / Raw Material Certification (ISCC, RSB etc.)

Sustainable Aviation Fuel can be derived from biomass feedstocks as well as from biomass residues, bio-based gases, waste and from conversion of electrical power, hydrogen and CO_2. Depending on the pathway chosen, the accounting for effective CO_2 reduction through utilization of non-fossil sources requires a Proof of Sustainability as a prerequisite for their acceptance and accountability in GHG regulation systems. Even though it is not the task of JIG to determine the basic framework for such acceptance, it shall be the intermediary institution delivering background information to Airport Fuel Depot Operators. This is to foster the understanding of the methodology and intention of research and market development for Sustainable Aviation Fuels to the necessary extent for depot operations, fuel handling and sustainability documentation.

Recommendations:

(29) **Background information about SAF feedstocks etc. [EC, JIG]** Inspectors and inspection teams for bio-refinery operations, transport procedures as well as Airport Fuel Depot operations and aircraft refuelling "into-plane" services require a basic knowledge of Sustainable Aviation Fuel feedstocks and production processes. Otherwise, an increasing quality gap will emerge, with a potential of negative impacts on the jet fuel quality as the backbone of safe aircraft flight operations. The safety record of the petroleum industry to produce and deliver a globally specified high quality fuel may deteriorate, if new stakeholders enter the jet fuel market, who may have a different safety and fuel quality attitude / experience compared to conventional oil companies that produced and handled conventional jet fuels for decades. A supervising inspection unit should be established that pays sufficient attention to new producers of Sustainable Aviation Fuel by overseeing their day to day production as well as quality measurement systems and to act accordingly in case of any doubt regarding fuel quality and safety standards.

(30) **Collaboration with certification systems [EC, IATA, JIG]** An alignment of JIG and the sustainability certification systems like ISCC and RSB (even if they compete with each other) should be pursued in order to draft a joint working paper that constitutes to the first step towards an acknowledgement of accepting different standards in the industry as a Proof of Sustainability for Sustainable Aviation Fuel. This paper shall be submitted to oil companies, aircraft refuelling companies and Airport Fuel Depot Operators as a consolidated working paper. This working paper released by JIG shall be endorsed by IATA. As an alternative to a joint-working paper, IATA can establish sustainability requirements for Sustainable Aviation Fuel against which the respective certification systems are benchmarked and the appropriate ones are eligible for the use of Sustainable Aviation Fuel.

(31) **Harmonized global standards [IATA, JIG]** We recommend that JIG and IATA jointly approach ICAO to establish a legal framework for global acceptance of Sustainable Aviation Fuels as an element of CO_2 reduction, if one of the ISCC or RSB sustainability standards has been used for the issuance of a Proof of Sustainability for feedstock utilization.

(We are fully aware that this recommendation enlarges the role of JIG, but as oil companies take their first steps towards the future blending of SPKs, we believe it is in JIG's best interest to cover all aspects of SPKs, instead of installing a second quality control body in the aviation industry to deal with quality and safety issues. CO_2 accounting of Sustainable Aviation Fuels requires the involvement of governments and UN institutions such as ICAO.)

While the petroleum industry and airlines have refused to involve governments in their business and have organized themselves without a legal framework, the upcoming change from conventional

(fossil) jet fuel to Sustainable Aviation Fuels (derived from various feedstocks) needs a binding resolution of the ICAO to accept Sustainable Aviation Fuels as a beneficial option for emissions reduction. Thereafter, all participants along the supply chain should be enabled to act in accordance with an effective system for CO_2 accounting in a GHG regulation system such as a "Track & Trace" or a "Book & Claim" concept.

4.3 Feedstock Processing, Refining and Documentation of Sustainable Aviation Fuel

Various feedstocks are available for the production of Sustainable Aviation Fuel. While conventional jet fuels are refined from crude oil, natural gas liquid condensates, heavy oil, shale oil and/or oil sands, Sustainable Aviation Fuel can be produced on the basis of different biogenic materials such as specific energy crops, algae, and certain organic waste materials or – in so-called "Power-to-Liquid" (PTL) processes – electricity from renewable energy sources, water and carbon dioxide. Different production pathways exist to process these raw materials into kerosene fractions.

Each production pathway requires its unique facility design for production. The production processes lead to a fragmentation of the output stream into different specified products. Pathways leading to synthetic fuels are basically suitable for the aviation industry.

Only processing methods that have been approved by ASTM (and the British Defence Standard, as the case may be) shall be applied for the production of Sustainable Aviation Fuel. Production units shall operate according to JIG standards and observance of these standards must be inspected and controlled frequently.

Recommendations:

(32) **Change of Inspection business model [EC, ICAO, JIG]** While the current inspections are voluntary actions of oil companies who wish to ensure a globally harmonized supply chain quality within their industry, the upcoming market entry of small companies without the financial background to participate in such a global inspection arrangement of domestic and international inspections (as set by the oil companies) may be considered as a reason to change the business model of the existing inspection scheme:

a. **Future Inspection Standards [EC, IFQP, ICAO, JIG]** Inspections shall become a mandatory issue of ICAO's General Assembly. The member states shall be obliged to set up rules and regulations to be observed by any producer of jet fuel, regardless if it is conventional or synthetic jet fuel. If recommended by industry members, EC / ICAO may consider delegating the execution of inspections to non-governmental bodies, but shall nevertheless supervise the performance of these inspections as needed.

b. **Delegation of inspections to industry institutions [EC, ICAO, JIG]** Government inspection duties may be delegated to JIG as an industry body. JIG shall charge their clients for the execution of inspections. The fees collected shall be used to pay its own inspection staff or to compensate companies for delegating their engineers to participate in inspections.

c. **Notification of deficiencies [EC, JIG]** Severe deviations from JIG recommendations shall not only be recorded but shall also be registered and forwarded to the respective government for further action.

d. **Ultimate restrictions [EC, JIG]** Producers / refiners who fail to act according to the quality and safety regulations may be punished by the competent airworthiness authority of the respective state. Companies which fail to act according to the regulations shall be suspended from producing jet fuel until they prove their adherence to all applicable rules and regulations.

(33) **Review of current procedures [JIG]** With regard to Sustainable Aviation Fuel quality control procedures, JIG shall review the current practice of a voluntary quality control system (which was established among oil companies at a time when no other companies were able to supply jet fuel). As long as industry members share the burden of defining standards and execution of inspections, the voluntary set-up may have been the easiest way to ensure and maintain an appropriate quality level to supply the aviation industry.

However, with new stakeholders entering the market this well-established system will be confronted with new challenges. From a consumer's perspective, there is no doubt that operational safety in the jet fuel supply chain as well as in aircraft operations will have to remain essential.

(34) **Publishing of Inspection Reports [EC, IATA, JIG]** Inspection reports shall be generated and published by JIG in a global register that is accessible to all airlines and airport authorities granting permission to sell jet fuel on their premises. Airports may decide to recall issued licenses in case the licensee does not comply with JIG standards. This provision shall also apply to producers (and possibly all supply chain elements) of Sustainable Aviation Fuel who fail to deliver adequate sustainability certification and documentation for the feedstocks used for production. Only a strict observance of such requirements will foster globally accepted standards – whether dealing with product quality, safety and sustainability.

(35) **Extended collaboration [IATA, JIG]** A collaboration of JIG and IATA IFQP is strongly recommended to ensure that all IATA Member Airlines unanimously follow the recommendation not to buy any Sustainable Aviation Fuel if such production is not controlled by frequent inspections.

(36) **Qualification requirements for inspectors [IATA, JIG]** It is recommended that IATA IFQP Members shall pass the same tests for qualification as a JIG inspector. IFQP Member Airlines participating and executing inspections shall receive the same refund as JIG members for their contributions.

(37) **Collaboration between JIG and sustainability certification systems [EC, JIG]** While the sustainability certification deals, among other things, with environmental impacts of feedstocks production, refining and fuel logistics, JIG should seek a collaboration with sustainability certification institutions (such as ISCC or RSB). It is essential to develop an adequate competence level with regard to the detection of any unexpected behaviour of feedstocks and processing units and to establish a global data collection in order to detect recurring deficiencies prior to any major incident.

(38) **Limitation of storage periods for feedstocks [EC, JIG]** As feedstocks may deteriorate over time and, as a consequence, may cause complications during processing, the storage period of biomass feedstock prior to conversion into distillation products shall be monitored and the joint working group of JIG and corresponding sustainability certification institutions shall consider recommendations with respect to maximum storage periods for raw materials.

4.4 Blending Site / Amended Certificate of Origin

As long as a seller of jet fuel holds an airport license to sell and has entered into a throughput agreement with an Airport Fuel Depot and an Aircraft Refuelling Company, he can be a seller of a SPK blend without being the

producer. He also might elect to take responsibility as a producer if he blends Sustainable Aviation Fuel with JET A/JET A-1 at a tank farm of his choice. Under this condition, the already existing Certificates of Origin (for Sustainable Aviation Fuel and JET A/JET A-1), which had been issued prior to blending, have to be superseded by a new Certificate for the blended jet fuel.

Recommendations:

(39) **Declaration of operating standards [IFQP, JIG]** A seller of blended SPK shall confirm that the tank farm used for blending complies with JIG requirements (i.e., JIG 2) and is operated in accordance with all applicable regulations.

(40) **CoO content [IFQP, JIG]** The new Certificate of Origin should expressly list the documents and document numbers of all blending components' Certificates of Origin. Such certificates shall be attached to the Blend Certificate as attachments.

(41) **Attachments to the CoO [IFQP, JIG]** With regard to specification conformity, the test results of the new batch of blended SPK shall be attached to the Certificate of Origin.

(42) **Measuring requirements [IFQP, JIG]** The blended batch should list all SPK and JET A/JET A-1 components and indicate their actual quantities (related to volume) in the batch exactly to three decimal places. For each shipment, the percentage of all components shall be applicable to determine the content of each component in a shipment. All quantities shall be expressed in volumes at 15 degrees centigrade. The composition of a shipment shall be copied into the depot's fuel inventory management system – in the second level of determination of the blending components.

4.5 Handling of SPK Blends

If not otherwise stated herein or required by law, all SPK blends shall be handled as JET A/JET A-1 and all rules and recommendations for the handling of jet fuel shall also apply to Sustainable Aviation Fuel (SPK blends and neat SPKs).

Recommendations:

(43) **Safety data sheet [JIG]** The safety data sheet for JET A/JET A-1 shall be amended and include Sustainable Aviation Fuels as an equivalent jet fuel option. As the characteristics of SPK blends is almost identical to fossil JET A/JET A-1, there is no need for further declaration, additional safety instructions or HSE-requirements besides the already existing regulations for fossil jet fuel. We refer to our recommendation to consider a suffix for neat SPKs that fulfils the ASTM D7566 specification and will be sold as JET A/JET A-1.

(44) **Observation of irregularities when using SPK-blends [IFQP, JIG]** High blending ratios of Drop-in SPKs require fossil jet fuel with a high aromatics content in order to meet the specification requirements for the blend. As observed during Lufthansa's long-term testing period of renewable jet fuel in 2011, the filter element in the bowser supplying a 50/50 blend of HEFA NexBtL from Neste with JET A-1 was heavily deteriorated over time. The reason for such deterioration remained unclear. As this effect may not be visible or attributable with low blending ratios, it is recommended to pay attention to the content of the fossil jet fuel used for blending. All kinds of filtration equipment in the depot as well as in the bowsers and hydrant dispensers should frequently be controlled to identify any unexpected deterioration in due time.

4.6 Transport Documentation for blended SPK

Documents for transport and storage of Sustainable Aviation Fuels shall be carried with their physical transport. As the number of documents to be attached to each shipment will increase, the receiving depots shall be aware of the duty handle and store all documents for tax exemption reasons and CO_2 accounting purposes.

Recommendations:

(45) **Electronic data transfer [JIG]** If not already practised, the documents for each shipment of Sustainable Aviation Fuel shall be scanned and forwarded in an electronic format to the receiver of the shipment while the physical shipment is on its way to the receiver. Such electronic formats shall include the name / number of the vessel / barge or train and the truck plate number of each truck commissioned to serve an Airport Fuel Depot. For pipeline supplies, the name of the pipeline and the batch number shall be addressed electronically. Such documents can be stored electronically at the Airport Fuel Depot as the tax exempted storage facility from where the jet fuel will be distributed directly to the customers' aircraft. Over time, transport-related documents should no longer be attached to a physical shipment but shall be made available to all stakeholders of such a supply chain in an electronic format to be agreed upon.

(46) **Ownership reservation [JIG]** If Sustainable Aviation Fuel components of a blended jet fuel shipment are attributable to a dedicated customer (airline), such information shall be provided in addition to the standard documents for transport. The receiving Airport Fuel Depot shall register such a priority in its inventory management system (second level) and any jet fuel quantities supplied to that customer shall be counted against the reserved sustainable SPK quantity of the seller holding his "sustainable" inventory in the second level of the depot's inventory management system.

4.7 Transport Documentation for JET A-1 from Ready-for-Use SPK

As the Ready-for-Use SPK is being sold as JET A / JET A-1 there is no deviation from standard transport procedures and documents with the exception that the entire shipment quantity shall be accounted as Sustainable Aviation Fuel in the second level of the depot's inventory management system. Any dedicated customer for such shipment (if existing) shall be named as the preferred customer in the documents. This information shall be registered by the Airport Fuel Depot Operator.

Recommendations:

(47) **Transparency about depot utilization [IFQP, JIG]** It will be necessary to install a "Customer Service Protocol" by each Airport Fuel Depot shareholder / throughputter for the services to be provided by the Fuel Depot Operator (presently, this information is handed out to Aircraft Refuelling Companies but not necessarily to Fuel Depot Operators). The format shall be standardized and each shareholder / throughputter shall list all fuel contracts with his customers, the percentage of supply awarded to him and any contract details dealing with a percentage or defined quantity of Sustainable Aviation Fuel supply to his customers holding a contract for Sustainable Aviation Fuel supply in a defined quantity. The same list may be handed out to Aircraft Refuelling Companies.

4.8 Commingled Storage

SPK blends and Ready-for-Use SPKs fulfilling the ASTM D1655 specification requirements are traded as JET A / JET A-1. Consequently, all shareholders and throughputters of an Airport Fuel Depot have the right to utilize the depot for distributing these Sustainable Aviation Fuels to their customers.

Recommendations:

(48) **Amendment of J / V Agreements [JIG]** The Shareholder Agreement and any Throughput Agreement shall be revised and the provisions for commingled storage of jet fuel from various sources and production pathways shall be updated. A provision shall be added which requires blending of Drop-in SPKs prior to delivery to the depot and that any blending inside the depot shall be forbidden and seen as breach of contract.

5 Mandatory Administrative Procedures

Airlines conducting flights that are subject to a GHG regulation system may either offset their CO2-emissions by acquiring emission certificates (such as EU ETS Emission Allowances) from the market (including utilization of emissions granted for free) or may reduce their CO_2-emission balance through the purchase and utilization of Sustainable Aviation Fuel due to their positive GHG emission balance. However, existing accounting methodologies in GHG regulation systems are insufficient for the accounting of Sustainable Aviation Fuel in a seamless, practical manner and represent a barrier to their market entry – e.g., in the EU ETS.

The EU ETS originally required that only the actual consumer of Sustainable Aviation Fuel would be eligible for its accounting. This requirement can only be met to a limited extent or not at all at large commercial airports, where pipeline-systems and / or jointly-operated tank farms are used, as there is continuous mixing of fuels from different sources. Using common infrastructure, a separation of synthetic and fossil fuel molecules and dedicated aircraft refuelling with Sustainable Aviation Fuel cannot be implemented in a practical way as each withdrawal from the airport tank farm will henceforth contain a Sustainable Aviation Fuel component. In addition, an EU RED-compliant Proof of Sustainability must be submitted along the entire supply chain to the consuming airline, without which Sustainable Aviation Fuel cannot be accounted in the EU ETS. The existing fuel supply infrastructure allows these prerequisites to be fulfilled only to a limited extent, if at all, as there is no provision for the physical traceability of individual fuel batches and their mixing with other fuel batches at the airport tank farm is ultimately unavoidable. As a more flexible option, the owner of Sustainable Aviation Fuel can account “his” Sustainable Aviation Fuel on the basis of fuel purchase records without having consumed it completely physically. Here the airport tank farm represents the “balance limit”. But even this procedure, which has not been harmonized across different states participating in the EU ETS, has not yet been operationalized in a practical way, nor does it represent an accounting mechanism that regards the entire EU ETS as its system boundary / balance limit. Even this accounting approach basically requires a separate fuel logistic for Sustainable Aviation Fuel to the airport tank farm to create a traceable Chain-of-Custody in order to ensure the accountability of these fuels in the EU ETS. These logistical circumstances are technically not necessary and are disadvantageous from an ecological, economic and operational point of view.

Analogous to the EU ETS, for CORSIA a proven and operationalized concept for the accounting of Sustainable Aviation Fuel does not yet exist, which potentially inhibits the market entry of Sustainable Aviation Fuel and their large-scale use. Regulatory requirements for the certification and accounting of Sustainable Aviation Fuel differ at national and / or regional level. In contrast, the fuel uplift of airlines takes place in their entire route network (i.e., globally). With regard to this heterogeneous supply situation, it is not guaranteed that globally uplifted Sustainable Aviation Fuel will be accountable in the domestic market in accordance with the respective certification schemes and accounting procedures.

In order to be able to use Sustainable Aviation Fuel adequately and seamlessly in future in the EU ETS or globally in commercial air traffic, it is necessary to establish suitable concepts to account for Sustainable Aviation Fuel in GHG regulation systems like the EU ETS or CORSIA. If an airline chooses to reduce their emissions by using Sustainable Aviation Fuel, in terms of accounting purposes, the two options (a) “Track & Trace” and (b) “Book & Claim” allow for the effective accounting of such fuels in a GHG regulation system. The basic principles and mandatory requirements of both options will be described in more detail in the following and subsequent two sub-sections:

a. “Track & Trace” (Mass Balance Accounting)

Based on a fuel purchasing contract for Sustainable Aviation Fuel (either as a Drop-in SPK blended with fossil JET A / JET A-1 or by buying Ready-for-Use SPK) the physical storage and transport of this jet fuel has to be monitored from its production site up to the point where the product is uplifted into an aircraft. From then on, it shall be deemed as consumed. Evidence of such consumption has to be provided to both the consuming aircraft operator and the seller of Sustainable Aviation Fuel. The seller may afterwards issue a certain number of CO_2 certificates which allow for an emission reduction in the amount of CO_2 saved by using sustainable instead of conventional jet fuel.

As part of the Sustainable Aviation Fuel purchase agreement, the purchasing airline – as the assumed consumer of such jet fuel – is entitled to receive the CO_2 certificates issued by the seller. Thereafter the airline may decide to use these CO_2 certificates for a reduction of its CO_2 compensation requirements and thus to avoid a purchase of emission certificates commensurate with its consumption of Sustainable Aviation Fuel. Alternatively, the airline can still sell such CO_2 certificates to other parties wishing to purchase them.

b. “Book & Claim”

An alternative option for airlines to account for the purchase and use of Sustainable Aviation Fuel is Book & Claim. The key characteristic of accounting Sustainable Aviation Fuel within a Book & Claim approach is the separation of physical fuel and its sustainability characteristics, which are transferred to tradable certificates (so called “Guarantees of Origin”) at a specific point in the supply chain. For a certain quantity of Sustainable Aviation Fuel fed into the fuel supply system, the producer / supplier receives a value-equivalent quantity of Guarantees of Origin (the number of Guarantees of Origin must be equivalent to the amount of Sustainable Aviation Fuel actually produced / fed into the fuel supply system). Based on a valid and binding purchase agreement, these Guarantees of Origins may then be transferred / awarded to the airline as the buyer. The airline can then use the Guarantees of Origins to account for the use of Sustainable Aviation Fuel and the associated reduction in emissions in a GHG regulation system. By redeeming an acquired Guarantee of Origin, an aircraft operator is able to (virtually) declare a certain quantity of jet fuel used to Sustainable Aviation Fuel, regardless of its true origin. They prove to the competent authority that an equivalent quantity of Sustainable Aviation Fuel, meeting the corresponding sustainability criteria, was fed into the fuel supply system and thus burned in an aircraft, if the supply system represents a closed system (at the EU ETS system level, the latter is ensured by tax supervisions). Compared to fossil JET A / JET A-1, the end consumer pays a higher market price for Sustainable Aviation Fuel and receives an amount of Guarantees of Origin in proportion to the Sustainable Aviation Fuel quantity purchased to compensate for the additional price. Alternatively, the Sustainable Aviation Fuel can be sold at the market price of fossil jet fuel, whereby the producer/supplier covers its increased manufacturing costs from the separate sale of the Guarantees of Origin. If the airline has chosen a preferred price for the Sustainable Aviation Fuel which excludes the right to receive the corresponding amount of Guarantees of Origins for the amount of Sustainable Aviation Fuel purchased under such agreement, the fuel producer may also sell the Guarantees of Origins to any third party.

5.1 Implications for "Track & Trace" (Mass Balance Accounting)

Under the tax exemption regulation agreed upon in ICAO, the tax-free jet fuel has to be separated from all other taxable fuels and such separation, storage and transport has to be proven by the producer and by all participants in the supply chain until the fuel has reached the Airport Fuel Depot. As the storage of jet fuels will be commingled, the Aircraft Refuelling Companies will take jet fuel and deliver the tax-free product to airlines for fuelling purposes. The volumes delivered to the aircraft of an airline will be reported to the Airport Fuel Depot operator on a daily basis. Quantities leaving the depot must match with the quantities delivered to aircraft with a daily balance of zero. Under these conditions, jet fuel temporarily stored in bowers or in the hydrant system are deemed to belong to the inventory of the depot, despite the fact that the quantities have physically left the storage tanks (known as "dead stock" in the case of a permanently filled hydrant system).

Following the principles of tax-exempted jet fuel and its supervision through the respective tax authority (customs authority), the authority in charge could also trace back the supply chain of Sustainable Aviation Fuel from its production in a refinery or blending site to the consumption in an aircraft and could verify the number of CO_2 certificates as well as the amount of CO_2-savings represented by these certificates by deducting the volume of consumed jet fuel from the volume of jet fuel produced. The remaining balance of fuel shall correspond to the data in the inventory management system of the Airport Fuel Depot operator and his associated Aircraft Refuelling Companies, which also hold inventory in their fuel trucks.

Like tax-exempted conventional jet fuel, all movements, interim and final storage in an Airport Fuel Depot of Sustainable Aviation Fuel need to be constantly monitored and controlled prior to consumption of the fuel.

While this monitoring may be executed easily in the European Union with the Excise Movement and Control System (EMCS), a supra-national, standardized electronic system used for excise tax supervision, i.e. for monitoring national and international aviation fuel movements in EU member states, it may be completely different in other world regions without such a monitoring and control system. However, if an airline intends to count their Sustainable Aviation Fuel consumption towards their obligation to acquire CO_2 certificates, it will most likely call for certificates covering those airports where the airline has entered into Sustainable Aviation Fuel purchasing agreements and where Sustainable Aviation Fuel has been used for aircraft refuelling accordingly.

Besides the aspect of different regulatory frameworks and legal systems with their individual provisions for renewable feedstocks, accounting methods and requirements, the way of issuing certificates has to be accepted by the tax authority of the airline's country of jurisdiction (State of Registry). In the absence of a monitoring system covering fuel movements, a reliable monitoring procedure will be mandatory in order to track and control the production of Sustainable Aviation Fuel from "Well-to-Wing".

Recommendations:

(49) **Airport Fuel Depot as central source of information [EC, JIG] JIG** shall consider the Airport Fuel Depot as the central gathering point of information regarding the receipt of Sustainable Aviation Fuel and its distribution to dedicated airlines based on their Sustainable Aviation Fuel purchasing agreements. The Airport Fuel Depot will collect all transport and interim storage-related information from production / blending of Sustainable Aviation Fuel to the storage in the tanks of the depot as "the downstream". This also applies to the attribution of Sustainable Aviation Fuel quantities to selected aircraft refuelling operations performed by Aircraft Refuelling Companies and their meter readings of jet fuel supplied to such airlines ("wingstream").

(50) **Updating of fuel handling software in depots [IFQP, JIG]** Assuming that the physical molecules of Sustainable Aviation Fuel can neither be traced in a commingled storage, nor in any wingstream supply from the tanks of the depot to the fuel inlet valve in an aircraft wing, it will become essential that the attribution of Sustainable Aviation Fuel volumes to an airline is done on a bookkeeping basis in the depot. Effectively, it should be done electronically in the depot's fuel inventory management system, which is for tax-exemption reasons already approved and frequently inspected by the corresponding tax authority (customs authority). Under these conditions, JIG shall develop worldwide principles and rules for virtual inventory bookkeeping software for Sustainable Aviation Fuel, allowing not only for the quantity of stored and withdrawn fuels to be balanced, but also for their individual sustainability and emission reduction properties to be recorded, documented and checked during inspections.

(51) **Second inventory stock level [JIG]** JIG shall consider establishing a second level of volume inventory management. Presently, jet fuel counts volumes delivered into the depot on behalf of a shareholder / throughputter and their inventory are hold as virtual stocks in the inventory management systems (virtual / bookkeeping-based allocation). All outgoing quantities used for aircraft refuelling will be reported by the Aircraft Refuelling Companies stating the date of refuelling, airline, flight number and fuelled quantity, including the name of the seller of fuel (holding a supply agreement with such airline).

Based on the fuel supply messages received from the Aircraft Refuelling Companies, the operator adjusts the inventory stock level for each shareholder / supplier in the depot and reports updated inventory data. Simultaneously, the Aircraft Refuelling Company reports all refuelling details affecting the supply contracts of a depot shareholder / throughputter to the seller in charge for billing to airlines and comparison with the data supplied by the depot for replenishment of inventory. Such single level inventory management cannot follow up supply of Sustainable Aviation Fuel as there will be no separation from other jet fuel nor any meter readings that can prove physical quantities. Therefore, the attribution of Sustainable Aviation Fuel to individual aircraft refuelling operations can only be executed "virtually" in the depot's fuel inventory management system.

(52) **Fuel accounting modalities in a second stock level [JIG]** The second stock level of the fuel inventory management system shall split the stored volume of each shareholder / throughputter into conventional (fossil) jet fuel (as before) and Sustainable Aviation Fuels. Based on the specification of SPKs, the Sustainable Aviation Fuel volume has to be split into different SPKs if these SPKs have different CO_2-accounting values / emission factors (even though feedstock types can be identical)! While the fuel intake and consumption in the first level is based on meter readings, the intake and consumption in the second level can only be defined from delivery documents (e.g., a Certificate of Origin as proposed) and from the provisions of the fuel purchasing agreement / fuelling agreement between seller (shareholder / throughputter) and buyer (airline)!

The consolidated fuel movements between first and second stock level of the fuel inventory management system have to be identical. Based on physical movements (downstream and wingstream, first level) the movements of the second stock level are reflecting the same magnitude of volume movements but only related to the sustainable and conventional jet fuel quantities on a virtual consumption pattern, i.e. preferred consumption of Sustainable Aviation Fuel as requested in supply agreements between airlines and supplier.

5.2 Basic Requirements for the Implementation of a Book & Claim Concept

A Book & Claim concept as described above has yet to be implemented at either the European or international levels. The following recommendations should therefore be regarded as implementation approaches for such a concept.

Recommendations:

(53) **Book & Claim concept collaboration [EC, IATA, ICAO, JIG]** The implementation of an EU-wide Book & Claim concept as well as the development of instructions for its handling in day-to-day operations requires interactions between the European Commission, JIG and further institutions. Therefore, a working group consisting of the European Commission, JIG, IATA, ICAO and sustainability certification institutions such as ISCC and RSB should be initiated together with operational representatives (e.g., fuel distributors like pipeline operators and fuel depot operators) as well as representatives of the EU and US EPA for recognition of accounting principles for other sustainability standards and vice versa.

The implementation of a Book & Claim concept on a global scale is conceivable and reasonable. It requires provisions on how to acknowledge different standards (e.g., EU RED versus US EPA) outside their principal jurisdiction. Otherwise, aircraft operators can only uplift Sustainable Aviation Fuel that meets the accounting rules in their home country (State of Registry), meaning that they will probably only uplift Sustainable Aviation Fuel at domestic aerodromes / hubs and any uplift offshore would not qualify for the issuance of (domestic) Book & Claim certificates. For that reason, initiating a working group is strongly recommended.

(54) **New registry for sustainable fuels [EC, JIG]** There is no standard accounting in a Book & Claim concept. The Proofs of Sustainability of the feedstock (respectively the sustainable production of the SPK) will determine how and to what extent a Sustainable Aviation Fuel qualifies for the issuance of Guarantees of Origin. It should be considered this can be registered and how a registry can be made available to tax authorities or other bodies supervising the issuance of Guarantees of Origin.

(55) **Proof of Sustainability as the source of information [EC, IATA, ICAO, JIG]** Issuing a Guarantee of Origin requires a Proof of Sustainability for the feedstocks used to produce a specific Sustainable Aviation Fuel batch. The corresponding sustainability documentation must be available along the entire supply chain until the final production of Sustainable Aviation Fuel. In addition, in order to ensure a closed chain of custody from the feedstock production to the final use of Sustainable Aviation Fuel in an aircraft, it must be ensured that the supply chain is certified according to recognised sustainability certification systems until the point where a Guarantee of Origin is issued on the basis of a Proof of Sustainability.

(56) **Content of Guarantee of Origins [EC, JIG]** In order to minimize implementation efforts, a Guarantee of Origin for Sustainable Aviation Fuel shall be designed in accordance with the EU RED design of Guarantees of Origin for renewable energy. Therefore, it should include information about the energy source (raw material from which the Sustainable Aviation Fuel was produced and the production processes), the date of issue, the issuing country, the unique identification number of the relevant Proofs of Sustainability, a unique identification number as well as information on the production site (name, location, type) and its date of commissioning as minimum information.

JIG shall ensure that this information can be made available by jet fuel producers (or blending companies) to allow for issuing Guarantees of Origin that contain all relevant information.

(57) **Adoption of sustainability abbreviations [EC, JIG]** Guarantee of Origin and Proof of Sustainability are common terms with regard to Book & Claim concepts and sustainability documentation. A widespread use of Sustainable Aviation Fuel results in increased contact of jet fuel suppliers with topics of sustainability documentation. Therefore, these terms as well as further related terminology are to be adopted as definitions in JIG regulations in order to familiarize jet fuel suppliers with terminologies of sustainability documentation and to avoid misunderstandings in communication (e.g., between jet fuel suppliers and other stakeholders such as companies for sustainability certification or authorities for emissions trading).

(58) **Refinery / Blending site as the central location of certificate-issuing [JIG]** A Guarantee of Origin must be issued as long as the pure synthetic content of a binary blend or multiblend is still known or can be taken from appropriate documents like a Refinery Certificate of Quality. The further Sustainable Aviation Fuel is transported along the supply chain, the more commingling with other fuel batches occurs and the more difficult it will be to determine the synthetic proportion on the basis of (transport-related) fuel documents. Guarantees of Origin should therefore be issued as early as possible after blending. Therefore, JIG should consider the refineries / blending sites as the point in the supply chain, where the Guarantees of Origin are issued as soon as two prerequisites are fulfilled: (1) The Sustainable Aviation Fuel is blended with conventional jet fuel to such an extent that the JET A / JET A-1 specification is met and (2) after leaving the production site, it can be ensured that the fuel is in fact used for the application in an aircraft.

(59) **Supervision of issuing Guarantees of Origin [EC, IATA, ICAO, JIG]** A Book & Claim concept requires that no unintentional multiple counting of Sustainable Aviation Fuel occurs, i.e., that Guarantees of Origin are not improperly issued without a corresponding sustainable fuel being produced and brought to the market for its use in an aircraft. For this purpose, the issue of Guarantees of Origin at the production / blending site must be supervised regularly, e.g., as part of audits. For this task, auditors of pre-existing sustainability certification systems (e.g., ISCC or RSB) or tax inspectors are eligible. The working group mentioned in (53) shall prepare a proposal as to which authority or institution should be entrusted with this task.

(60) **Implementation strategy for a Book & Claim concept in aviation [EC, JIG]** Book & Claim concepts are already employed in other industries, such as the energy industry, for the marketing of renewable energy and bio-methane. For implementing a Book & Claim concept for Sustainable Aviation Fuel, synergies with existing systems should be utilized, i.e. adapting software and using certificates (e.g., Guarantees of Origin). The working group according to Recommendation No. (53) should carry out a strong orientation and adaptation of the already established Book & Claim concepts and for this purpose contact the relevant stakeholders to jointly work out an implementation strategy of a Book & Claim concept for Sustainable Aviation Fuel. Representatives from the scientific community should also be consulted on this.

When implementing a Book & Claim concept, the following essential elements and aspects should be considered.

a. A core element of a Book & Claim concept is a Central Registry operated by an independent Issuing Body. In the European Energy Certificate System (EECS) the German Environment Agency (UBA) is the Issuing Body in Germany for the issuance, transfer and validation of EECS Guarantees of Origin, as well as for the account management of account holders (electricity producers, traders and suppliers). A comparable registry for bio-methane fed into the natural gas grid is operated by the German Energy Agency (dena). The working group mentioned in

No. (53) is to work out the implementation of a central registry and the handling for all stakeholders in the corresponding supply chain (i.e., fuel producers, fuel suppliers and airlines) as well as emission trading authorities and customs authorities. It should also be examined whether such a register could be incorporated into existing registers (such as the European Union registry) and to what extent existing registry architectures could be incorporated.

b. In the EECS, the Issuing Body issues a Guarantee of Origin at the request of the system operator and records it in the system operator's account provided a valid registration for the system has been submitted and the system operator has an account to which this system is assigned. In a Book & Claim system for Sustainable Aviation Fuel, the issuance of Guarantees of Origin should be designed analogously. Hence, production facilities or blending sites for Sustainable Aviation Fuel must be registered by the Issuing Body. Such a requirement, as well as the processes and framework conditions for the issuance of Guarantees of Origin, need to be elaborated and recorded in proper regulations.

c. In a Book & Claim concept for Sustainable Aviation Fuel, account holders (especially jet fuel producers and airlines) will have various obligations. Major obligations are (1) conducting regular account checking for receipts, (2) checking of received Guarantees of Origin for their correctness and (3) taking all necessary measures to prevent unauthorized accessing of their account by third parties or to notify the Issuing Body of any discrepancies or errors in the data stored (analogous to the EECS). The resulting obligations shall be included in JIG regulations.

   Furthermore, guidelines and instructions concerning the account management in the Central Registry and management of Guarantees of Origin for Sustainable Aviation Fuel should be developed by JIG in cooperation with future Issuing Bodies or a superordinate association of Issuing Bodies.

5.3 Further Requirements for the Accounting in the EU ETS

Irrespective of the possible implementation of a Track & Trace or a Book & Claim concept, there is further need for action to guarantee seamless account for Sustainable Aviation Fuel in GHG regulation systems like the EU ETS (and CORSIA in the future).

Recommendations:

(61) **Enlarged scope of work for IFQP and JIG [IFQP, JIG]** For the handling of Sustainable Aviation Fuel in the EU ETS (or other GHG regulation systems such as CORSIA), the provision of sustainability evidence will become more important for all stakeholders along the supply infrastructure. Hence, the nature of JIG's more technical approach will change over time to include sustainability requirements, in order to handle Sustainable Aviation Fuel properly. JIG shall establish an internal body to deal with such upcoming issues.

(62) **Designation of a competent body [EC, IATA, ICAO, JIG]** The matter of verification and accounting of Sustainable Aviation Fuel concerns various stakeholders, such as national and supranational bodies, sustainability certification organisations, emission verifiers, fuel producers, airlines, authorities for emissions trading, customs authorities and others. So far there is no institution or authority that is unambiguously responsible for the task of developing a feasible accounting system (neither on a

European, nor a global scale). In this context, a competent institution or authority must be determined as responsible for the future development of verification and accounting systems for Sustainable Aviation Fuels.

(63) **Additional Guidelines for current EU ETS accounting methodology [JIG]** As long as the current EU ETS accounting methodology remains unchanged, JIG shall develop guidelines for fuel suppliers to meet the requirements of the European Commission regarding the use of a purchase record-based accounting system. For fuel suppliers, these guidelines should contain the following criteria:

a. **[JIG]** Where aircraft operators rely on evidence from the fuel supplier(s) (concerning Proofs of Sustainability and further sustainability documentation), fuel suppliers must, upon request, make evidence available for each shipment of Sustainable Aviation Fuel on meeting the relevant sustainability criteria to the EU ETS verifier and the competent authority (e.g., national emissions trading authorities).

b. **[JIG]** Fuel suppliers must provide evidence that the total amount of Sustainable Aviation Fuel sold does not exceed the amount of Sustainable Aviation Fuel purchased, while meeting the appropriate sustainability criteria.

c. **[JIG]** Where several fuel suppliers share facilities such as storage tanks for the Sustainable Aviation Fuel, those suppliers shall set up an appropriate system of joint record keeping. The system for accounting of Sustainable Aviation Fuel shall be set up in a transparent way, ensuring that no double counting of Sustainable Aviation Fuel can occur.

d. **[JIG]** In order to minimize the administrative burden on all participants of such a system, the supplier (or, where appropriate, the suppliers sharing the facilities) should ensure that the records are verified at least once per year by an accredited verifier. This shall apply a reasonable level of assurance and a materiality threshold appropriate to the volume of Sustainable Aviation Fuel sold to EU ETS aircraft operators.

In order to meet this requirement, JIG should either train its own engineers / personnel to conduct the verification of joint record keeping systems as accredited verifiers or engage a cooperation with accredited EU ETS verifiers to delegate this task to them.

At this point it should be mentioned again that it is strongly recommended that the current accounting methodology and expansion of system boundaries at least according to the scope of EU ETS and CORSIA be enhanced.

(64) **Enhanced Airport Fuel Depot software [JIG]** In the EU ETS, the aircraft operator is obliged to report emissions only to the competent (national) authority. This also applies to the verification of the emission report within verification activities of an EU ETS verifier. Here it must be possible to check whether other aircraft operators who physically consumed Sustainable Aviation Fuel (because they were supplied by an Airport Fuel Depot which contains Sustainable Aviation Fuel, but did not pay for it) have also accounted it. The processes and procedures required for this verification have not yet been operationalized and harmonized throughout the system. On the software side, too, systems for the storage of jet fuels are not yet designed for the accounting procedure on the purchase record basis.

As long as the current EU ETS accounting methodology remains unchanged, these circumstances must be verifiable for an EU ETS verifier. If more flights from different airports are to be operated

with Sustainable Aviation Fuel and these fuels shall be accounted in the EU ETS, an automated software solution must be established to carry reliably all required sustainability, fuel purchase and fuel delivery data. Automated data comparison between the consumption data of an airline with the supply data of a jet fuel supplier to that airline is already state-of-the-art in commercial fuel transaction processes. A similar procedure for the allocation of sustainability certificates to fuel batches produced will become essential for cost-effective data handling under EU ETS or future CORSIA conditions.

5.4 Cross Border Acceptance of SPK containing Non-Petroleum Feedstocks certified according to an Offshore Sustainability Certification System; imported and used within the Scope of the EU ETS Regulatory Framework

Despite the fact that global aviation-related CO_2 emissions are increasing and the substitution of fossil aviation fuels through Sustainable Aviation Fuel has been verbally promoted by the aviation industry and institutions as the best way to effectively reduce climate impacts, only marginal progress has been achieved with regard to the use of Sustainable Aviation Fuel.

In addition, a cross-sectoral carbon offsetting through the purchase of CO_2 certificates from other (non-aviation) sectors – as recommended by CORSIA – has not yet been proven to be effective and sustainable.

The USA and the EU are the dominant aviation industry and air transport markets. In both markets, the use of Sustainable Aviation Fuel and their accounting in a GHG regulation system, as set by the European Commission and the US Government, follow different rules and procedures. These differences limit the use of Sustainable Aviation Fuel to airlines which intend to uplift Sustainable Aviation Fuel at aerodromes throughout their entire (i.e., predominantly supranational and global) route network, since a credit for Sustainable Aviation Fuel can only be received if the eligible sustainability criteria of the regulatory framework applicable to their State of Registry.

For example, this means a European airline with a State of Registry in Europe can only call for CO_2 certificates if the Sustainable Aviation Fuel purchased and used meets the sustainability criteria of the EU Renewable Energy Directive (RED). If the airline wishes to buy and uplift Sustainable Aviation Fuel in the USA, such fuel will be marketed only under the jurisdiction of the Environment Protection Agency (EPA) of the US Government, while the applicable fuels directive dealing with Sustainable Aviation Fuel and other eco-friendly fuels will apply for granting Renewable Identification Numbers (RINs) in the USA only.

Meanwhile, a US-based airline buying and uplifting Sustainable Aviation Fuel in Europe cannot qualify for RINs in the USA because the European fuel quantities uplifted cannot be used for subsidies in the USA, as long as the European Sustainable Aviation Fuel does not meet the EPA Renewable Fuel Standard (RFS), which is currently RFS2.

As of today, regarding CORSIA, the ICAO did not specify the conditions Sustainable Aviation Fuel has to meet to be counted as an option to reduce CO_2 and to simultaneously reduce the airlines' acquisition of CO_2 certificates from the market or pay the respective fees to any government authority exercising jurisdiction over the airline concerned.

The parties with the right of jurisdiction on a national, European or global level with regards to GHG regulation systems have, so far, neither included adequate procedures on how to manage the emission reductions by the use of Sustainable Aviation Fuel, nor harmonized the regulations for acceptance of sustainability standards as a prerequisite for granting certificates or subsidies supporting the purchase of Sustainable Aviation Fuel by airlines.

Recommendations:

(65) **Global harmonization of sustainability certification [EC, IATA, ICAO]** The competent bodies for CORSIA and EU RED (and potentially all other national regulatory bodies exercising jurisdiction) should call for proposals from the industry or call their working groups in order to integrate the use of Sustainable Aviation Fuel as an option for airlines to reduce their CO_2 emissions. IATA, as the voice of the airline industry, should actively participate in this issue and possibly present their solution to the European Commission as well as ICAO.

Regarding sustainability certification, one of the issues between the US and the EU framework is the discrepancy between the Renewable Fuel Standard 2 and the EU Renewable Energy Directive.

While the RFS2 calls for feedstock production on agricultural land that has been in use on or before 19 December 2007, the EU RED intends to avoid land use change (LUC) from farmland for food to farmland for energy crop production. In Africa, unused land can be converted into farmland without affecting food security. However, such newly established farmland would not qualify for any feedstock export or refinery product export to the USA, as the farmland was established after 19 December 2007. On the other hand, change of unused land into farmland will be ruled by the EU RED despite the fact that the European Commission has refused to set a negative emissions reduction factor on indirect land use change (iLUC, change of unused land for energy crop production) as a direct penalty for energy crop farming regardless of the suitability and eligibility of such land for food crops.

(66) **Resolve biomass feedstock discrimination and foster sustainability certification for biomass feedstocks [EC, ICAO]** A cooperation with accredited sustainability certification systems should be pursued to resolve this dispute. According to aireg published studies, there is sufficient land available which is not in agricultural use but is suitable for certification. In developing countries, such land use change is on hold due to the high investments necessary for land cultivation and the development of infrastructure (roads, bridges, power lines, water pipelines and infrastructure for feedstock production, storage and transportation) which does not pay off, due to lack of capital for such investments and even more due to consumers who cannot buy food products because of a lack in income. The EPA requirements with regard to existing farmland shall be limited to US territory only. LUC shall be possible and supported, if such change does not affect domestic food security (which is the case in the European Union) or if such change affects unused land that is suitable for certification without any proven negative impact such as the anticipated iLUC consequences.

(67) **Global acceptance of standards [EC, ICAO]** Sustainability standards should be accepted globally or, if there is evidence that a biomass-based Sustainable Aviation Fuel production will harm food security, such standards should be improved.

(68) **Setting of new standards for non-biomass pathways [EC, IATA, ICAO]** Standards should also be set for non-biomass related pathways for Sustainable Aviation Fuel, e.g., for the use of municipal and industrial waste as well as the use of electrical power for conversion processes in order to achieve a level playing field for all types of Sustainable Aviation Fuel, regardless of their origins and production pathways.

(69) **Resolve storage segregation of feedstocks for EU-RED or EPA-RFS2 standards [EC, ICAO]** Consequently, Sustainable Aviation Fuel producers shall be released from separating feedstocks fulfilling the EPA RFS2 standard and those ones fulfilling the EU RED standard. With regard to waste reuse,

energy production from waste shall be accepted as an alternative to waste separation and the reuse of certain materials separated for the recycling economy.

(70) **Create a level playing field for Sustainable Aviation Fuel in comparison to other renewable pathways [EC, ICAO]** In line with international agreements on GHG reduction requirements, the promotion of Sustainable Aviation Fuel production should be supported in the same way as all other renewable energy pathways (solar, wind, etc.) have been supported until their technologies had reached a scaled production level. So far, there is a lack of support for Sustainable Aviation Fuel, even though each ton of Sustainable Aviation Fuel used will contribute to the substitution of fossil energy resources. DEMO-SPK, the German demonstration and research project, has contributed to promoting the use of Sustainable Aviation Fuel in day to day airline operations. For the sake of our environment, we strongly recommend the closure of all remaining technology, quality assurance, specification, certification, safety and operation related gaps that (conceivably) prevent airlines from covering their fuel demand using renewable and sustainable energy sources.

Research and Demonstration Project on the Use of Renewable Kerosene at Airport Leipzig / Halle (DEMO-SPK)

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