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## China Civil Aviation Technical Standard Order

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This technical standard order is issued in accordance with *Technical Standard Order for Civil Aviation Materials, Parts and Airborne Equipment (CCAR37)*, a China Civil Aviation Regulation. China Civil Aviation Technical Standard Order is the mandatory regulation for the airworthiness certification of certain civil aircraft materials, parts and airborne equipment.

### Civil Aviation Jet Fuel Containing Synthesized Hydrocarbons

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#### **1. Purpose**

This China Civil Aviation Technical Standard Order (CTSO) is for manufacturers applying for civil aviation jet fuel containing synthesized hydrocarbons CTSO authorization (CTSOA). This CTSO prescribes the minimum performance standards that civil aviation jet fuel containing synthesized hydrocarbons must first meet for approval and identification with the applicable CTSO marking.

#### **2. Applicability**

This CTSO is applicable for new applications since CTSO goes into effect. Major design changes to civil aviation jet fuel containing synthesized hydrocarbons approved under this CTSO shall require a new authorization in accordance with CCAR-21.

Civil aviation jet fuel containing synthesized hydrocarbons is the jet fuel comprising conventional jet fuel blending with synthetic blending component or producing by co-processing.

### 3. Requirements

#### a. Process requirements

Civil aviation jet fuel containing synthesized hydrocarbons marked by this CTSO marking shall meet the process requirements of current product specifications which include GB 6537, ASTM D1655 and ASTM D7566, etc.

#### b. Performance requirements

Civil aviation jet fuel containing synthesized hydrocarbons and its synthetic blending component shall meet the performance requirements of GB 6537, ASTM D1655 and ASTM D7566, and the additional requirements specified in this CTSO. Components or performance requirements of additives in GB 6537 shall be according to CTSO-2C707. Additional requirements in this CTSO is as follows.

#### (1) Performance requirements for synthetic blending components

##### (i) Historically accepted synthetic blending components

These synthetic blending components shall meet the performance requirements of GB 6537 Annex B, Annex C or ASTM D7566 Annex A, and test some of fit for purpose properties in accordance with ASTM D4054. Fit for purpose properties include chemistry, bulk physical and performance properties, electrical properties, ground handling properties and safety.

Details of historically accepted synthetic blending components see

table 1.

(ii) Non-accepted synthetic blending components

Non-accepted synthetic blending component is produced by new process which not list in Section 3 b (1) 1) of this CTSO.

It shall meet the performance requirements (see table 2) and components requirements (see table 3) in the fast track qualification and approval process for new aviation turbine fuels of ASTM D4054.

Table 1 Performance Requirements for Historically Accepted Synthetic Blending Components

S/N	Synthetic Blending Components	Performance Requirements
1	Fisher-tropsch Hydroprocessed-synthesized Paraffinic Kerosine (FT-SPK)	GB 6537 Annex B or ASTM D7566 A1
2	Synthesized Paraffinic Kerosine from Hydroprocessed Esters and Fatty Acids (HEFA-SPK)	GB 6537 Annex C or ASTM D7566 A2
3	Synthesized Iso-paraffin (SIP)	ASTM D7566 A3
4	Synthesized Paraffinic Kerosine Plus Aromatics (SPK/A)	ASTM D7566 A4
5	Alcohol-to-jet Synthetic Paraffinic Kerosene (ATJ-SPK)	ASTM D7566 A5
6	Synthesized Catalytic Hydrothermolysis Jet (CHJ)	ASTM D7566 A6
7	Algae-based Hydrocarbon-Hydroprocessed Esters and Fatty Acids Synthetic Paraffinic Kerosene (HC-HEFA SPK)	ASTM D7566 A7

Table 2 Performance Requirements for Synthetic Blending Component Produced by New Process

Property	Target Value	Test Method
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COMPOSITION					
Acidity, total mg KOH/g	Max	0.015	GB/T 12574, ASTM D3242 and IP 354		
FLUIDITY					
Freezing point, °C	Max	-40	GB/T 2430, SH/T 0770, ASTM D2386, ASTM D5972, ASTM D7153, ASTM D7154, IP 16, IP 435, IP 528 and IP 529		
viscosity -40°C, mm <sup>2</sup> /s	Max	12.0	GB/T 30515, ASTM D445, ASTM D7042, ASTM D7945 and IP 71		
VOLATILITY					
Flash point, °C		38~66	GB/T 5208, GB/T 21789, GB/T 21929, ASTM D56, ASTM D3828, IP 170 and IP 523		
Density at 15°C, kg/m <sup>3</sup>		730~880	GB/T 1884, GB/T 1885, SH/T 0604, ASTM D1298, ASTM D4052, IP 160 and IP 365		
Distillation-both of the following distillation requirements shall be met: Initial boiling point, temperature (IBP), °C 10% recovered, temperature (T10), °C 30% recovered, temperature (T30), °C 50% recovered, temperature (T50), °C 70% recovered, temperature (T70), °C 90% recovered, temperature (T90), °C Final boiling point, temperature (FBP), °C Distillation residue, percent Distillation loss, percent T10-IBP, °C T50-T10, °C T90-T50, °C FBP-T90, °C		Distillation range	Simulated distillation	Distillation range: GB/T 6536, ASTM D86 and IP 123 Simulated distillation: S/T 0558, ASTM D2887 and IP 406	
			130~190		100~140
			150~200		130~160
			160~210		160~185
			170~225		180~210
			175~240		200~230
			180~265		225~260
			195~296		250~330
		Max	1.5		-
		Max	1.5		-
		Min	10		20
	Min	15	35		
	Min	25	35		
	Min	10	20		
COMBUSTION					
Derived Cetane Number,		35~60	NB/SH/T 0883 and ASTM D6890		
THERMAL STABILITY					

Thermal stability (2.5 h at control temperature)			GB/T 9169 and ASTM D3241 and IP 323
Temperature, °C	Min	325	
Filter pressure drop, mmHg	Max	25	
Tube rating, class	Less than	3 No peacock or abnormal color deposits	
nm avg over area of 2.5 mm <sup>2</sup>	Max	85	
Antioxidant, mg/L		17~24	-
FAME, mg/kg	Max	5	IP 585

Table 3 Composition Requirements for Synthetic Blending Component  
Produced by New Process

Property		Target Value	Test Method
Hydrocarbon Composition			
Paraffin-Distribution, mass %			
C8, C9, C10, C11, C12, C13, C14, C15 and C16		Report	-
Cycloparaffins, mass %	Max	30	-
Aromatics, mass %	Max	20	-
Aromatics-Distribution, mass %			
C8, C9, C10, C11, C12, C13, C14, C15 and C16		Report	-
Naphthalenes, mass %	Max	5.0 % of aromatic fraction	-
Tetalins and indans, mass%	Max	30 % of aromatic fraction	-
Carbon and hydrogen, mass %	Min	99.5	GB/T 0656 and ASTM D5291
Non-hydrocarbon Composition, mg/kg			
Nitrogen	Max	2	SH/T 0657, ASTM D4629 and IP 379
Water	Max	75	GB/T 11133, ASTM D6304 and IP 438
Sulphur	Max	15	GB/T 17040, SH/T 0689, ASTM D2622 and ASTM D5453
Metals, mg/kg Al, Ca, Co, Cr, Cu, Fe, K,	Max	0.1 per metal	NB/SH/T 0892 and ASTM D7111

Li, Mg, Mn, Mo, Na, Ni, P, Pb, Pd, Pt, Sn, Sr, Ti, V and Zn			
Cu, µg/kg	Max	20	SH/T 0102 and ASTM D6732
Halogens, mg/kg	Max	1	ASTM D7359
Trace Materials-organics, mg/kg Phenols, Anilines, Indoles, Quinolines, Tetrahydroquinolines, Pyridines, Carbazoles, Ketones, Cycloketones, Alcohols&Esters, Aldehydes, Ethers, Phthalates and Other		Report	-

(2) Performance requirements for civil aviation jet fuel containing synthesized hydrocarbons

(i) Blending ratio requirements

FT-SPK, HEFA-SPK, ATJ-SPK, SPK/A or CHJ can be blended with No. 3 Jet Fuel meeting GB 6537 or Jet A-1 meeting ASTM D1655, with up to 50 % by volume of the synthetic blending component.

SIP, HC-HEFA SPK, or non-accepted synthetic blending components marked by this CTSO can be blended with No. 3 Jet Fuel meeting GB 6537 or Jet A-1 meeting ASTM D1655, with up to 10 % by volume of the synthetic blending component.

(ii) Performance requirements of blended products

Synthetic blending components blended with No. 3 jet fuel shall use additives included in GB 6537. The blended product shall not only meet the requirements of GB 6537 table 1, but also have the aromatics volume content not less than 8.0%, the distillation slope T50-T10 not less than

15°C and T90-T10 not less than 40°C.

Synthetic blending components blended with Jet A-1 shall use additives included in ASTM D7566. The blended product shall meet the requirements of ASTM D7566-21 table 1 Jet A-1.

Civil aviation jet fuel containing FT-SPK、HEFA-SPK、SPK/A、SIP、ATJ-SPK、CHJ 或 HC-HEFA SPK synthesized hydrocarbons blending ration according to this CTSO b (2) (i), shall also test some of fit for purpose properties and nonmetallic materials compatibility in accordance with ASTM D4054. Fit for purpose properties include chemistry, bulk physical and performance properties, electrical properties, ground handling properties and safety, preliminary materials compatibility. Nonmetallic materials include adhesive, coating, sealing materials (sealant, o-ring, gasket) and film.

(iii) Feedstock of co-processing shall meet the requirements of ASTM D1655-21a Annex A1. In addition to meeting the performance requirements of ASTM D1655-21a table 1, co-processed product shall also meet the requirements of ASTM D1655-21a table A1.1.

c. Other requirements

If volume fraction of the synthetic blending component is beyond the limits of this CTSO b (2) 1), civil aviation jet fuel containing synthesized hydrocarbons and synthetic blending component shall be evaluated according to ASTM D4054.

d. Testing laboratory

All tests shall be conducted in laboratories approved by CAAC or under the supervision of CAAC.

e. Deviation

For using alternate or equivalent means of compliance to the criteria in this CTSO, the applicant must show that the product maintains an equivalent level of safety. The applicant must apply for a deviation under the provision of section 21.368 in CCAR-21.

#### **4. Marking**

a. The quality certificate and other applicable documents of civil aviation jet fuel containing synthesized hydrocarbons shall mark at least the following information:

- (1) Process and standard of synthetic blending components;
- (2) CTSO and CTSOA number;
- (3) Volume fraction of synthetic blending components;
- (4) Manufacturer designation and address;
- (5) Manufacture date, quantity and batch number.

b. Annex 1 and Annex 2 are examples of the refinery certificate quality of synthetic blending component and civil aviation jet fuel containing synthesized hydrocarbons.

#### **5. Documents Requirements**

The applicant shall submit the responsible documents as follows.



- a. Documents for CTSOA application according to CCAR-21;
- b. Standards or specifications;
- c. Description of feedstock;
- d. Description of manufacturing process;
- e. Safety data sheet for chemical products (SDS);
- f. Other documents required by CAAC.

## **6. Application Note**

After CTSOA authorization, the applicant shall obtain aircraft installation approval. If product standards have already listed in the type certificate data sheets (TCDS), supplemental type certificate (STC) or other design approval documents, the civil aviation jet fuel containing synthesized hydrocarbons is not essential for installation approval.

## **7. Referenced Documents**

- a. GB standards are available from:

Standard Press of China, No. 16, North Sanlihe Street, Fuxingmenwai, Beijing. Tel: 010-84271850.

- b. SH standards are available from:

China Petrochemical Press Co., Ltd., No. 58, Andingmenwai Street, Dongcheng District, Beijing. Tel: 010-84271850.

- c. ASTM standards are available from:

ASTM, 100 Barr Harbor Drive, West Conshohocken PA 19428-2959.

d. IP standards are available from:

Energy Institute, 61 New Cavendish Street, London, United Kingdom, W1G 7AR.

## Annex 1

## Fischer-Tropsch Synthetic Paraffinic Kerosene (FT-SPK)

## Refinery Certificate Quality (Example)

<b>Name of Synthetic blending Component:</b>				
Fischer Tropsch-Synthesized Paraffinic Standard: GB 6537-2018 Kerosene (FT-SPK)				
<b>CTSOA Number:</b>		<b>CTSO: CTOS-2C701</b>		
<b>Manufacturer designation:</b>		<b>Manufacturer address</b>		
<b>Product quantity and batch number:</b>		<b>Manufacture date:</b>		
Property		Limits	Results	Test Method
<b>Composition</b>				
Acidity, total mg KOH/g	Max	0.015		GB/T 12574
<b>Volatility</b>				
Distillation-both of the following requirements shall be met:				
<b>Distillation</b>				
10% recovered (T10), °C	Max	205		GB/T 6536
50% recovered (T50), °C		Report		
90% recovered (T90), °C		Report		
Final boiling point, °C	Max	300		
T90-T10, °C	Min	22		
Residue, vol %	Max	1.5		
Loss, vol %	Max	1.5		
<b>Simulated distillation</b>				
10% recovered (T10), °C	Max	205		SH/T 0558
50% recovered (T50), °C		Report		
90% recovered (T90), °C		Report		
Final boiling point, °C	Max	300		
Flash point, °C	Min	38		GB/T 21789
Density at 20°C, kg/m <sup>3</sup>		730~770		GB/T 1884 GB/T 1885
<b>Fluidity</b>				
Freezing point, °C	Max	-40		GB/T 2430
<b>Stability</b>				
Thermal stability (325°C, 2.5 h)				
Filter pressure drop, kPa	Max	3.3		GB/T 9169
Tube rating, class	Less	3		

	than	No peacock or abnormal color deposits		
<b>Hydrocarbon Composition, mass %</b>				
	<b>Cycloparaffins</b>	Max	15	
	<b>Aromatics</b>	Max	0.5	SH/T 0606
	<b>Paraffins</b>		Report	
	<b>Carbon and hydrogen</b>	Min	99.5	SH/T 0656
<b>Non-hydrocarbons, Composition mg/kg</b>				
	<b>Nitrogen</b>	Max	2	SH/T 0657
	<b>Water</b>	Max	75	GB/T 11133
	<b>Sulfur</b>	Max	15	SH/T 0689
	<b>Metals, mg/kg</b>			NB/SH/T 0892
	<b>Al, Ca, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Pd, Pt, Sn, Sr, Ti, V, Zn</b>	Max	0.1 for each metal	
	<b>Halogens, mg/kg</b>	Max	1	ASTM D7359
<b>Additives</b>				
	<b>Antioxidant, mg/L</b>		17~24	-
<b>Conclusion:</b>	<b>Tested by:</b>		<b>Approved by:</b>	
	<b>Reviewed by:</b>			

## Annex 2

## Civil Aviation Jet Fuel Containing Synthesized Hydrocarbons

## Certificate of Analysis (Example)

<b>Product Grade: No. 3 Jet Fuel containing synthesized hydrocarbons</b>		<b>Standard: GB 6537-2018</b>	
<b>Production Process and Blending Ratio of Synthesized Hydrocarbons</b>			
<b>CTSOA Number:</b>		<b>CTSO: CTSO-2C701</b>	
<b>Manufacturer designation:</b>		<b>Manufacturer address:</b>	
<b>Product quantity and batch number:</b>		<b>Manufacture date:</b>	
Property		Limits	Test Method
<b>Appearance</b>		Clear, bright and visually free from solid matter and undissolved water at ambient fuel temperature	Visual
<b>Color</b>		Report	GB/T 3555
<b>Composition</b>			
<b>Acidity, total mg KOH/g</b>	Max	0.015	GB/T 12574
<b>Aromatics, volume percent</b>		8.0~25.0	GB/T 11132
<b>Olefins, volume percent</b>	Max	5.0	SH/T 0689
<b>Sulfur, total mass percent</b>	Max	0.20	GB/T 1792
<b>Sulfur mercaptan, mass percent or Doctor test</b>	Max	0.0020 Pass	NB/SH/T 0174
<b>Fractionation components, volume percent</b>		Report	-
<b>Hydrotreating components, volume percent</b>		Report	-
<b>Hydrocracked components, volume percent</b>		Report	-
<b>Synthetic blending components, volume percent</b>		Report	-
<b>Co-processed synthetic blending components, volume percent</b>		Report	-
<b>Volatility</b>			
<b>Distillation range</b>			GB/T 6536
<b>Initial boiling point (IBP), °C</b>		Report	
<b>10% recovered (T10), °C</b>	Max	205	
<b>20% recovered (T20), °C</b>		Report	

<b>50% recovered (T50), °C</b>	Max	232		
<b>90% recovered (T90), °C</b>		Report		
<b>Final boiling point (FBP), °C</b>	Max	300		
<b>Residue, percent</b>	Max	1.5		
<b>Loss, percent</b>	Max	1.5		
<b>T50-T10, °C</b>	Min	15		
<b>T90-T10, °C</b>	Min	40		
<b>Flash point (closed cup), °C</b>	Min	38		GB/T 21789
<b>Density at 20°C, kg/m<sup>3</sup></b>		775~830		GB/T 1884 GB/T 1885
<b>Fluidity</b>				
<b>Freezing point, °C</b>	Max	-47		GB/T 2430
<b>Viscosity at -20°C, mm<sup>2</sup>/s</b>	Max	8.0		GB/T 265
<b>Combustion</b>				
<b>Neat heat of combustion, MJ/kg</b>	Min	42.8		GB/T 384
<b>Smoke point, mm</b>	Min	25.0		GB/T 382
<b>or when smoke point is no more than 20 mm,</b>				SH/T 0181
<b>Naphthalenes, volume percent</b>	Max	3.0		
<b>Corrosion</b>				
<b>Copper strip, 2 h at 100°C,</b>	Max	No.1		GB/T 5096
<b>Stability</b>				GB/T 9169
<b>Thermal stability (260°C, 2.5 h)</b>				
<b>Filter pressure drop, kPa</b>	Max	3.3 3		
<b>Tube rating</b>	Less than	No peacock or abnormal color deposits		
<b>Contaminants</b>				
<b>Existent gum, mg/100mL</b>	Max	7		GB/T 8019
<b>Particulate contamination, mg/L</b>	Max	1.0		SH/T 0093
<b>Conductivity</b>				
<b>Electrical conductivity, pS/m</b>		50~600		GB/T 6539
<b>Microseparometer, Rating</b>				SH/T 0616
<b>Without electrical conductivity additive</b>	Min	85		
<b>With electrical conductivity additive</b>	Min	70		
<b>Lubricity</b>				
<b>Wear scar diameter (WSD), mm</b>	Max	0.85		SH/T 0687
<b>Static dissipater additive</b>				
<b>First dose, mg/L</b>	Max	3.0		-

<b>Anti-wear additive, mg/L</b>	Max	20.0		-
<b>Antioxidant, mg/L</b>		17.0~24.0		-
<b>Conclusion:</b>	<b>Tested by:</b>	<b>Approved by:</b>		
	<b>Reviewed by:</b>			

*(The English version is for reference only. In case of any discrepancy or ambiguity of meaning between this English translation and the Chinese version, the latter shall prevail.)*