



Number: CTSO-2C706

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Approved by: Xu Chaoqun

## China Civil Aviation Technical Standard Order

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This China Civil Aviation Technical Standard Order (CTSO) is issued according to Part 37 of the China Civil Aviation Regulations (CCAR-37). Each CTSO is a criterion which the concerned aeronautical materials, parts or appliances used on civil aircraft must comply with when it is presented for airworthiness certification.

### Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft

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#### **1. Purpose.**

This China Civil Aviation Technical Standard Order (CTSO) is for manufacturers applying for the fire resistant phosphate ester hydraulic fluid (hereinafter referred to as hydraulic fluid) CTSO authorization (CTSOA). This CTSO prescribes the minimum performance standards that hydraulic fluid 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 the hydraulic fluid approved under this CTSO shall require a new authorization in accordance with CCAR-21.

#### **3. Requirements**

##### **a. Composition**

The hydraulic fluid shall consist of a phosphate ester base to which

an additive package is blended.

All chemical ingredients contained in hydraulic fluid must comply with the legal and regulatory requirements of the countries related to environmental, toxicological and safety in which the products are manufactured and sold. Safety Data Sheet (SDS) or other appropriate documents shall be established.

b. Classification

The hydraulic fluid is classified as Type IV and Type V. Type IV fluid shall be divided into Class 1 and Class 2. Type V fluids shall be divided into Grade A and Grade B.

c. Performance

(1) Qualification Tests

For new hydraulic fluid, qualification tests including physical and chemical properties, application properties and bench test, shall be conducted according to the requirements of this CTSO or SAE AS1241D. The results shall be in accordance with Annex 1.

(i) Physical and Chemical Properties: appearance, color, viscosity (-54 °C, 38 °C, 99 °C and 127 °C), chemical contamination (chlorine, calcium, sodium, potassium and sulfur), water content, acid number, density (25 °C), electrical conductivity (20 °C), pour point, flash point (open cup), fire point, Autoignition temperature, coefficient of thermal expansion (25~99 °C), toxicity, anti-erosion additive content, foaming

characteristics, particulate contamination, etc.

(ii) Application Properties: exhaust manifold test, high pressure spray ignition test, wick ignition test, bulk modulus, hydrolytic stability, thermal stability, compatibility with materials (approved hydraulic fluids, solvents, paints and elastomers), high temperature effect on metals, four ball wear, etc.

(iii) Bench Tests: fluid performance test (pumping test), including hydraulic pump performance test, high temperature cycling test (500 hours), hydraulic fluid test and pump disassembly inspection etc., shall be done to analyze the performance changes of fluid and pump before and after cycling test and the erosion corrosion deposition of hydraulic components. Flow control valve life test (erosion resistance test), including the calibration, high temperature cycling test (200 hours), cycling test (300 hours) after addition of chlorine and hydraulic fluid test, shall be done to analyze the valve internal leakage and the erosion corrosion deposition of hydraulic components.

## (2) Quality Control Tests

After passing the qualification tests, the hydraulic fluid in each batch shall be tested for quality control, including viscosity (38 °C and 99 °C), chlorine chemical contamination content, density (25 °C), acid number, water content, autoignition temperature, flash point and particulate contamination. The results shall be in accordance with Annex 2.

d. Other Requirements

The hydraulic fluid shall also satisfy the other test items required by CAAC.

e. Testing Laboratory

Testing laboratories shall be approved by CAAC.

**4. Marking**

a. The quality certificate and other applicable documents of hydraulic fluid shall mark at least the following information:

(1) Product name, brand number and grade number;

(2) CTSO and CTSOA number;

(3) Name and address of the manufacturer;

(4) Batch number;

(5) Date of manufacture and expiration date;

b. Annex 3 is an example of the quality certificate for hydraulic fluid.

**5. Application Data Requirements**

The applicant shall furnish the related data to support design and production approval.

a. The documents required by the CTSOA in CCAR-21;

b. CTSO, standards or specifications;

c. Description of feedstock;

d. Technical documents relating production;

- e. Safety Data Sheet (SDS);
- f. Other data required by CAAC.

## **6. Application Note**

After obtaining CTSOA, the applicant shall also be approved for installation. The information of hydraulic fluid such as brand name and standard shall be filled in consumable material list (CML) or service bulletin (SB).

## **7. Referenced Documents**

- a. GB standards are available from:

Standard Press of China, No. 16, North Sanlihe Street, Fuxingmenwai, Beijing. Tel: 010-68523946.

- b. GJB standards are available from:

Military Standard Publication Department, COSTIND, No. 7, Jingshun Road, Dongwai, Beijing.

- c. SAE standards are available from:

Society of Automotive Engineers, Inc. 400 Commonwealth Drive, Warrendale, PA 15096-001, USA.

You may also order them online from [www.sae.org](http://www.sae.org).

- c. ASTM standards are available from:

American Society for Testing Materials, 100 Barr Harbor Drive, P. O. Box C700, West Conshohocken, PA 19428-2959.

You may also order them online from [www.astm.org](http://www.astm.org).

## Annex 1 Qualification Tests Requirements

### Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft Qualification Tests Requirements

Analysis Item		Standard Requirement			Test Methods
		Type IV Class 1	Type IV Class 2	Type V	
Viscosity, mm <sup>2</sup> /s	-54 °C	2000 max	3500 max	2600 max	ASTM D445 GB/T 265
	38 °C	9.0~12.5			
	99 °C	3.0~4.0			
	127 °C	——	——	1.5 min	
Chemical Contamination Content, mg/kg	Chlorine	50 max			SH/T 0929* ASTM D5185 ASTM D7536 ASTM D7751
	Calcium	10 max			
	Sodium	10 max			
	Potassium	10 max			
	Sulfur	150 max			
Water Content, wt%		0.20 max			ASTM D6304 GB/T 11133
Density, g/mL	25 °C	1.020 max	1.021~1.066	1.020 max	ASTM D4052* ASTM D1217 GB/T 1884 SH/T 0604
Acid Number, mg KOH/g		0.1 max			ASTM D974* ASTM D664 GB/T 4945 GB/T 7304
Electrical Conductivity, μS/cm	20 °C	0.2 min			ASTM D2624
Pour Point, °C		-62.0 max			ASTM D97 GB/T 3535
Flash Point (Open Cup), °C		160.0 min		154.0 min	ASTM D92 GB/T 3536
Fire Point, °C		177.0 min			ASTM D92 GB/T 3536
Autoignition Temperature, °C		399.0 min			ASTM D2155* ASTM E659 GB/T 21860
Exhaust Manifold Test		K <sub>m</sub> ≥10			SAE AS 1241 4.1.1

*English Translation Version for Reference Only*

CAAC

CTSO-2C706

<b>High Pressure Spray Ignition Test</b>		$K_n \geq 10$	SAE AS 1241 4.1.2
<b>Wick Ignition Test</b>		25 cycles min	SAE AS 1241 4.1.3
<b>Color</b>		Clear, blue to purple when viewed with white light passing through a fluid column of approximately 25 mm diameter.	
<b>Appearance</b>		Clear liquid, without layering or separation	
<b>Bulk Modulus, kPa</b>	38 °C	1447900 min	SAE AS 1241 4.2
<b>Coefficient of Thermal Expansion, mL/mL °C</b>	25~99 °C	$1.8 \times 10^{-3}$ max	ASTM D4052* ASTM D1217 GB/T 1884 SH/T 0604
<b>Toxicity</b>		Minimal irritant properties, low sensitization potential	SAE AS 1241 4.10
<b>Hydrolytic Stability</b> (the water of the fluid to 0.8 wt%±0.05 wt% by weight, 82°C±1°C, 168 hours)			
<b>Weight Change of The Metal, mg/cm<sup>2</sup></b>	Steel	±0.1 max	SAE AS 1241 4.3
	Cadmium plate	±0.4 max	
	Aluminum	±0.1 max	
	Magnesium	±0.2 max	
	Titanium	±0.1 max	
	Copper	±0.4 max	
	Silver	±0.2 max	
<b>Fluid Characteristic Changes</b>	Change in acid number, mg KOH/g	±0.3 max	
	Change in viscosity at 38 °C, cSt	±3.0 max	
	Change in viscosity at 99 °C, cSt	±1.0 max	
	The percent water content before and after test	Record	
<b>Thermal Stability</b> (121 °C±1 °C, 168 hours)			
<b>Weight Change of The Metal, mg/cm<sup>2</sup></b>	Steel	±0.3 max	SAE AS 1241 4.4
	Cadmium plate	±0.3 max	
	Aluminum	±0.2 max	

*English Translation Version for Reference Only*

CAAC

CTSO-2C706

	Magnesium	±0.5 max	
	Titanium	±0.6 max	
	Copper	±0.5 max	
	Silver	±0.3 max	
<b>Fluid Characteristic Changes</b>	Change in acid number, mg KOH/g	±0.1 max	
	Change in viscosity at 38 °C, cSt	±1.0 max	
	Change in viscosity at 99 °C, cSt	±0.3 max	
	The percent water content before and after test	Record	
<b>Compatibility with Other Materials</b>			SAE AS 1241 4.5
<b>Compatibility with Other Approved Hydraulic Fluids</b> (mix at ratios of 25/75, 50/50 and 75/25 by volume)	Stand for 48 hours	There shall be no separation, precipitation, cloudiness, or visible change throughout the entire test. The color of each mixture must lie within the spectrum from blue to purple. Color change is acceptable.	SAE AS 1241 4.5.1
	Put half the fluid at 121 °C±3 °C and put the other half at -54 °C±3 °C for 168h±2 hours. Allow the fluid to return to room temperature and observe for 2 days		
<b>Compatibility with Solvent</b> (mix at ratios of 25/75, 50/50 and 75/25 by volume with solvents)		There shall be no immediate separation, precipitation, cloudiness, or visual fluid change. There also shall be no precipitation, cloudiness, or reaction after the mixtures have been standing for 24 hours minimum. The color of each mixture may be only a dilution of the original hydraulic fluid color.	SAE AS 1241 4.5.2
<b>Compatibility with Paints</b> (Immerse the painted aluminum panels in fluid at room temperature for 30 days and pencil test)		Observe daily for evidence of softening or paint deterioration. No panels shall soften more than two grades in “pencil hardness”, Final “pencil hardness” shall be at least grade “B”	SAE AS 1241 4.5.3
<b>Compatibility with Elastomers</b>		Candidate fluids must meet all the fluid testing requirements of NAS 1613.	SAE AS 1241 4.5.4



*English Translation Version for Reference Only*

CAAC

CTSO-2C706

<b>High Temperature Effect on Metals</b>			SAE AS 1241 4.6
<b>Titanium</b>	Weight Change, mg/cm <sup>2</sup>	150 max	
	Hydrogen Input, ppm	850 max	
<b>Stainless Steel</b>	Weight Change, mg/cm <sup>2</sup>	15 max	
<b>Four Ball Wear Test , Scar Diameter, mm</b>	Load 4 kg	0.45 max	ASTM D4172 SH/T 0189
	Load 10 kg	0.50 max	
	Load 40 kg	0.55~0.85	
<b>Foaming Characteristics</b>			ASTM D892 GB/T 12579
<b>Foam After 5 minutes Blowing, mL</b>	24 °C	250 max	
	93 °C	150 max	
	After 93 °C, dropped to 24 °C	450 max	
<b>Time for Complete Foam Collapse, s</b>	24 °C	100 max	
	93 °C	50 max	
	After 93 °C, dropped to 24 °C	250 max	
<b>Anti-erosion Additive Content</b>		Record	
<b>Particulate Contamination</b>		Class 7 max	SAE AS 4059* ASTM D7647 ISO 11500 GB/T 37163 GJB 420
<b>Fluid Performance Test (Pumping Test)</b>			SAE AS 1241 4.8
<b>The change of hydraulic pump performance before and after cycling test</b>		Pre-test Acceptance test Procedure (ATP)	
<b>The change of hydraulic fluid Performance before and after cycling test</b>	Change in acid number, mg KOH/g	±0.10 max	
	Change in viscosity at 38 °C, cSt	6.0 min	
	Change in viscosity at 99 °C, cSt	2.0 min	
	Four Ball Wear	Record	
<b>The erosion corrosion deposition of hydraulic components</b>		The system and system components shall not show adverse effects, including but not limited to: unusual wear on pump components, evidence	

**English Translation Version for Reference Only**

CAAC

CTSO-2C706

		of erosion and evidence of unusual deposits.	
<b>Flow Control Valve Life (Erosion Resistance Test)</b>			SAE AS 1241 4.9
<b>The valve internal leakage during testing</b>	The increase for final 300 hours , mL/min	200 max	
	The change in leakage in the final 50 hours, mL/min/h	0.5 max	
<b>The erosion corrosion deposition of hydraulic components</b>		The system and system components shall not show adverse effects, including but not limited to: unusual wear on pump components, evidence of erosion and evidence of unusual deposits.	
<p>Note: In case of dispute, the test method with an asterisk shall be a referee method.</p>			

## Annex 2 Quality Control Tests Requirements

### Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft Quality Control Tests Requirements

Analysis Item		Standard Requirement			Test Methods
		Type IV Class 1	Type IV Class 2	Type V	
Viscosity, mm <sup>2</sup> /s	38 °C	9.0~12.5			ASTM D445 GB/T 265
	99 °C	3.0~4.0			
Chlorine Chemical Contamination Content, mg/kg		50 max			SH/T 0929* ASTM D5185 ASTM D7536 ASTM D7751
Density, g/mL	25 °C	1.020 max	1.021~1.066	1.020 max	ASTM D4052* ASTM D1217 GB/T 1884 SH/T 0604
Acid Number, mg KOH/g		0.1 max			ASTM D974* ASTM D664 GB/T 4945 GB/T 7304
Water Content, wt%		0.20 max			ASTM D6304 GB/T 11133
Autoignition Temperature, °C		399 min			ASTM D2155* ASTM E659 GB/T 21860
Flash Point (Open Cup), °C		160 min		154 min	ASTM D92 GB/T 3536
Particulate Contamination		Class 7 max			SAE AS 4059* ASTM D7647 ISO 11500 GB/T 37163 GJB 420
Note: In case of dispute, the test method with an asterisk shall be a referee method.					

**Annex 3 Quality Certificate**

**Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft**

**Quality Certificate (Example)**

<b>Product name, brand number and grade number:</b>						
<b>CTSOA number:</b>			<b>CTSO: 2C706</b>			
<b>Designation and address of manufacturer:</b>						
<b>Batch number:</b>						
<b>Manufacture date:</b>			<b>Expiration date:</b>			
Analysis Item		Standard Requirement			Results	Test Methods
		Type IV Class 1	Type IV Class 2	Type V		
Viscosity, mm <sup>2</sup> /s	38 °C	9.0~12.5				ASTM D445, GB/T 265
	99 °C	3.0~4.0				
Chlorine Chemical Contamination content, mg/kg,		50 max				SH/T 0929* ASTM D7536, ASTM D7751
Density (25 °C), g/mL		1.020 max	1.021~1. 066	1.020 max		ASTM D4052*, ASTM D1217 GB/T 1884, SH/T 0604
Acid Number, mg KOH/g		0.1 max				ASTM D974*, ASTM D664 GB/T 4945, GB/T 7304
Water Content, wt%		0.2 max				ASTM D6304, GB/T 11133
Autoignition Temperature, °C		399 min				ASTM D2155* ASTM E659, GB/T 21860
Flash Point (Open Cup), °C		160 min		154 min		ASTM D92, GB/T 3536
Particulate Contamination		Class 7 max				SAE AS 4059*, ASTM D7647 ISO 11500, GB/T 37163, GJB 420

*English Translation Version for Reference Only*

CAAC

CTSO-2C706

Note: In case of dispute, the test method with an asterisk shall be a referee method.		
<b>Conclusion:</b>	<b>Tested by:</b>  <b>Reviewed by:</b>	<b>Approved by:</b>

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