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## Airworthiness Certification of Civil Aero-chemicals In China

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### Abstract

Aero-chemicals are widely used in the field of manufacturing, maintaining and repairing aircrafts. With regard to safety, the aero-chemicals must not do harm to the aircraft. Airworthiness regulations, specifications, test methods, and certification are discussed in detail.

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### 1. Introduction

Safety is a fundamental concept generally ingrained in the human mind, especially in the field of civil aviation<sup>[1]</sup>. In the past three decades, the Chinese civil aviation market has had the fastest growth rate in the world, which also drives a strong momentum for growth in the civil aviation aero-chemicals market in China.

It is well-known to us that aero-chemicals are very important products, which are used in manufacturing, repairing and maintaining aircrafts, including: corrosion inhibiting compounds, de-icing fluids, cleaners, paint strippers, paints, sealing compounds, adhesives, deodorants, and so on. In order to ensure proper functioning of aircrafts, the aero-chemicals are essential; however, the aero-chemicals must not damage or destroy the aircrafts.

Only after passing the airworthiness certification and getting the license, the aero-chemicals can be used for aircrafts. More and more domestic and foreign aero-chemical manufacturers are applying for the CAAC license, 'Aviation Chemical Product Design & Manufacture Approval Letter'. There are three important items for getting the Approval Letter, which are as follows:

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- a) excellent quality management system
- b) product properties conforming to corresponding specifications
- c) excellent service

## **2. Airworthiness regulations and specifications about aero-chemicals**

### *2.1 Aero-chemicals airworthiness regulations*

According to the Airworthiness Requirements of CAAC, the materials including aero-chemical shall be demonstrated that they are not harmful to the aircrafts, and approved by the civil aviation administration of China (CAAC).

CCAR-53 is the airworthiness management regulation for civil aviation aero-chemicals. It was promulgated as of October 12th, 2004 and became effective as of January 1st, 2005. CCAR-53 is composed of seven sections: general, application and acceptance, checkup and decision, continuity and change, supervision and inspection, penalties, and supplementary articles.

All registered airplanes including their engines, propellers, airborne equipments, components and other materials, which are used and maintained, must use the approved aviation chemicals in accordance with CCAR-53.

### *2.2 Aero-chemicals airworthiness specifications and test methods*

#### *2.2.1 Aero-chemicals airworthiness specifications*

There are three major organizations or aircraft manufacturers in the world, namely, SAE, Boeing, and Airbus who have published many airworthiness specifications, such as SAE AMS 1424H, BOEING D6-17487, AIMS 09-00-002, and so on. These specifications provide technical requirements for aero-chemicals in detail. According to the requirements, it is imperative to test the aero-chemical effects on metallic surfaces, painted surfaces, and plastic materials.

##### *2.2.1.1 Effect on metallic surfaces*

The aero-chemicals containing acidic and alkaline materials can cause corrosion to aircraft skin, bolt, undercarriage, and other metals. So aluminum alloy, titanium alloy, and steel in the aircraft cannot be eroded by aero-chemicals during or after repairing and maintaining. The corresponding test methods about metallic surface are sandwich corrosion, total immersion corrosion, hydrogen embrittlement, low embrittling cadmium plate, stress-corrosion resistance, alloy steel surface corrosion, and effect on unpainted surfaces, which shall be performed per relevant airworthiness specifications.

##### *2.2.1.2 Effect on painted surfaces*

The aircraft skin is covered by paints, which could protect aircraft metallic surfaces against corrosion. So the aero-chemicals effect on painted surfaces shall neither decrease the paint film hardness nor shall it produce any streaking, discoloration, or blistering of the paint film.

##### *2.2.1.3 Effect on plastic materials*

Plastic materials are widely used in aircrafts, such as polymethyl methacrylate (PMMA), polycarbonate (PC), etc., thus the aero-chemicals can not destroy them. The corresponding test methods contain acrylic

### 2.2.2 Aero-chemicals compatibility test methods

To ensure safety of aero-chemicals, the compatibility tests shall be carried out according to the corresponding test method specifications, which are almost issued by American Society for Testing Material (ASTM). Table 1 shows the main test methods of aero-chemicals and corresponding specifications [2].

The Test Center of CAAC (TCCAAC), which is authorized by CAAC uniquely, is able to perform all of the test methods in Table 1 and give the corresponding test results authoritatively.

Table 1. Test methods of aero-chemicals

Test methods	Corresponding specifications
hydrogen embrittlement	ASTM F 519
sandwich corrosion	ASTM F 1110
total immersion corrosion	ASTM F 483
low embrittling cadmium plate	ASTM F 1111
stress-corrosion resistance	ASTM F 945
alloy steel surface corrosion	Boeing D6-17487
paint softening	ASTM F 502
acrylic crazing	ASTM F 484
polycarbonate crazing	ASTM F 484
elastomer degradation	ASTM D 471
tape adhesion	ASTM D 1000
effect on unpainted surfaces	ASTM F 485

## 3. Aero-chemicals airworthiness certification

### 3.1 Aero-chemicals airworthiness certification contents

In recent years, more and more applicants have applied for airworthiness certification of aero-chemicals. According to the requirements of CCAR-53, the documentations must be provided by applicants as following:

- a) organization
- b) documental system
- c) raw material supplier
- d) raw material inspection
- e) identify and traceability
- f) production process control
- g) calibration of the production and test equipment
- h) the management and control of failure goods
- i) recording archives' integrity and preservation
- j) staff training and accreditation
- k) test and inspection control
- l) transport, storage and packaging
- m) self-assessment procedures
- n) procedures that have been reported to agency
- o) after-sales service and guarantee<sup>[3]</sup>

If both the quality management system and service of applicant are conformed to the requirements of CCAR-53, the aero-chemicals produced by applicant shall be sent to TCCAAC to test the technical conformance per corresponding test procedures. If the test results meet the relevant requirements, CAAC will give the Aviation Chemical Product Design & Manufacture Approval Letter to the applicant. After that, for the sake of safety, the aero-chemicals getting the license will be audited for once by CAAC in two years.

### 3.1 Aero-chemicals airworthiness certification situations

Due to the high price and difficult transportation of overseas aero-chemicals, Chinese airlines cannot use all of the products on the aircraft maintenance manuals. In order to reduce maintenance costs, alternative aero-chemicals inevitable are needed. To meet the rapidly increasing requirements of civil aviation markets, domestic companies have researched and developed a lot of aero-chemicals conforming the airworthiness requirements stemming from 1980s. Figure 1(a) shows the number of manufacturers in different regions of China nowadays. In addition, there are some foreign companies, such as in USA, UK, France, and so on, which get the licenses and occupy some markets to a certain extent in China.

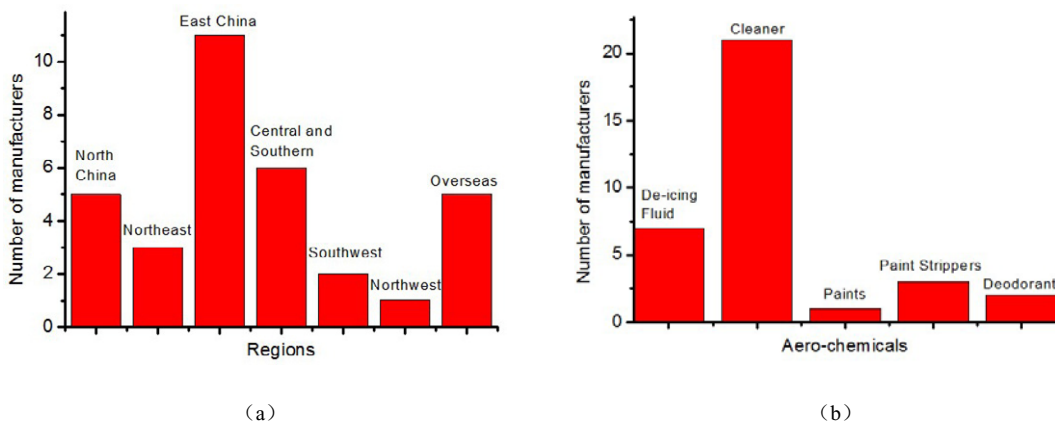


Figure 1 (a) Number of manufacturers in different regions of china (b) Number of manufacturers which producing aero-chemicals

From Figure 1 (a) we can see the aero-chemical manufactures are mainly located in the developed regions, such as North China and East China. Figure 1(b) is the number of manufacturers which produce different aero-chemicals. The results show that the numbers of manufacturer which produce de-icing fluid are the most. Whereas, only one manufacturer is able to produce paints due to the high technical requirements.

Based on the airworthiness certification, a lot of satisfied and inspired effects are acquired as following:

#### a) Ensuring safety

The quality of aero-chemicals is became better and better, and the manufacturers pay more attention to the products' quality, so the unsafe factors are diminished.

#### b) Providing good service in time

Before the airworthiness certification of aero-chemical in China, almost all of products are depended on foreign manufacturers. Due to the long distances and inconvenient communications, the foreign manufacturers are not able to give the good service for the aircrafts in time. However, under the technical

of aero-chemicals, which could be used for aircrafts. This advancement broke the monopoly of foreign companies.

c) Providing lower price of aero-chemicals

Nowadays, many aero-chemicals are made in China, which urges the same kind of aero-chemicals including foreign products and domestic products to give the lower price .

d) Accelerating national aviation industry development

More and more homemade aero-chemicals conforming to the requirements of CCAR-53 are produced. In addition, the corresponding designing ability and producing ability of domestic manufacturers are improved and strengthened.

#### 4. Conclusions

To ensure the civil aviation safety, aero-chemicals play an important role in the field of manufacturing, maintaining and repairing aircrafts. The quality of aero-chemicals is very significant and must meet the airworthiness certification requirements. Not only is the quality of aero-chemicals insured, but also accelerate the manufacturing ability of national aviation industry through airworthiness certification. In order to further improve the present results, we shall strengthen the intensity of airworthiness certification process, which can be further ensured the safety of civil aviation.

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