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Study on ground Evacuation test method of civil aircraft emergency lighting

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Abstract: The emergency evacuation ability of civil aircraft is an important index reflecting the safety of aircraft, and emergency lighting is an important factor reflecting its ability. Demonstration and verification of civil aircraft emergency lighting evacuation from the ground is an important prerequisite for the whole aircraft emergency evacuation, and also the only method to show the compliance of Article 812(E) of Part 25 of Civil aviation Regulations. For CCAR25.812 (e) clause to be read, study a civil aircraft that can carry out emergency lighting out of the ground test method, from the test scenario, test personnel and test environment, the evacuation route and so on various factor has carried on the detailed analysis and definition, emergency lighting for subsequent commercial out of the ground demonstration experiment provide a test method for reference.

Keywords: Emergency lighting; Evacuation; Test method for Chinese Library Classification Number: V216 Document Identification Code: A OSID

1. The introduction

With the rapid development of civil aviation industry, the state and civil aviation Administration pay more and more attention to aviation safety, and the probability of major safety accidents in the process of aircraft operation is also decreasing. However, with the increasing demand for aircraft in the global aviation market, the number of accidents is increasing year by year. In order to ensure the safety of crew and passengers, it is particularly important to improve the design of emergency evacuation capacity of civil aircraft. Emergency evacuation refers to the process in which passengers and crew members quickly evacuate to a safe position on the ground in a stable parking state after a survivable accident [1]. Civil aircraft emergency lighting evacuation test is an important prerequisite for the whole aircraft emergency evacuation test, and also a method to verify the compliance of CCAR25.812(E) clause [2].

As early as 1962, A. H. Hasbrook et al. [3] analyzed the important factors affecting the efficiency of civil aircraft emergency evacuation by summarizing the relevant data of civil aircraft emergency evacuation demonstration and verification test. Zhang Yugang and H. B. Du et al. conducted relevant computational research on the simulation model of civil aircraft emergency evacuation process [4-8]. There are relatively few experimental studies on emergency lighting evacuation at home and abroad. Li Zhanke et al. [9] conducted an experimental study on the influence of aisle width of large passenger aircraft on emergency evacuation time. Based on the requirements of aviation regulations, this paper studies a test method of civil aircraft emergency lighting evacuation from the ground that meets the requirements of regulations and can be implemented.

2. Clause Analysis

Section 812(E) of Part 25 of the Civil Aviation Regulations reads as follows:

CCAR25.812(E) : When all lighting sources above 1.2 m (4 ft) above the cockpit access floor are completely obscured, emergency exit access markers near the floor must be able to guide passengers to emergency evacuation. In the dark, emergency exit signs near the floor must ensure that each passenger:

(1) After leaving the seat, can visually identify the emergency evacuation path along the cockpit aisle floor leading to the nearest exit or the two exits before and after the seat;

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Each exit of the emergency evacuation route can be quickly identified only by reference to marks and visual features not higher than 1.2 m (4 ft) above the cockpit level floor.

As can be seen from the content of this clause, the main concern of this clause is whether the performance of the emergency evacuation passage marking can meet the requirements of this clause under specific circumstances. The following environments and requirements should be paid attention to:

(a) All lighting sources above 1.2 m in the cockpit should be shaded;

(b) The environment should be dark;

(c) The marking performance of emergency exit paths near the floor shall meet the requirements of the clause.

(d) Emergency exit passage marking, usually refers to FPEEPMS (Floor proximity Emergency Escape Path Marking System) and emergency lighting sources below 1.2 meters.

FPEEPMS do not need to rely on power supply to provide power, only the aircraft's own normal cabin lighting, daylight or cabin lighting into the cabin from the window during the day "recharge", when the cabin is dark, the stored energy in the form of light "discharge".

3. Test Methods

3.1 Test scenario definition

FPEEPMS can be charged to a certain extent by cabin lighting on civil aircraft, so special precautions are required to ensure that FPEEPMS are not affected by external lighting. At the same time, the harsh lighting conditions during the daily operation of the aircraft should be considered, so the test defines two test scenarios.

First flight scene during the day. Assuming that the plane is not powered overnight, the FPEEPMS will have released all the power. FPEEPMS should first be released in the dark for at least 16 hours in order to simulate the real situation. FPEEPMS were then activated using the lowest level of cabin lighting provided by normal cabin lighting. The time of activation should be appropriately limited to its minimum time to coincide with the time of preparing the aircraft for its first flight during the day. Thirty minutes is generally used as a reasonable minimum time for cabin preparation for the "first daytime flight". When the activation time is reached, the cabin lighting is turned off and subsequent tests are carried out.

Maximum night flight scenario. In this scenario, to simulate the most stringent test conditions for the test, the aircraft is assumed to be flying at night for the maximum time permitted by the performance characteristics of the aircraft. During the flight, the cabin is assumed to be in darkness or in a cabin lighting environment that allows passengers to sleep for a sufficient period of time. During this dark cabin, the FPEEPMS will release light energy. Then before landing, assuming an in-flight emergency, the cabin lighting fails to work and therefore the FPEEPMS cannot be reactivated. The FPEEPMS were activated with low light for 30 min at the time of the trial, and then the cabin was kept dark for 150 min before the trial began.

3.2 Test personnel

The selection of test personnel shall be universal and representative, and shall meet the following requirements:

1) The test personnel should be those who have not participated in the pre-evaluation of the emergency lighting system and the evacuation of the aircraft;

2) The test personnel shall not be flight crew, flight attendants and training personnel related to the operation, maintenance and training of the aircraft;

3) According to the two test scenarios, two groups of participants should be selected, with no less than 10 participants in each group, 6 males and 4 females in each group, and 2 of the 10 participants should be 50 years old or above;

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4) During the test, the two groups should be physically isolated to avoid that when the former group of test personnel fill in the test questionnaire, the latter group of test personnel know the test situation, which will affect the effectiveness of the test;

5) Before entering the aircraft cabin test area, the test personnel should wear the eye mask to adapt to the dark environment (or other forms to adapt to the dark environment) in advance, so as to avoid the test personnel to know the overall emergency lighting environment of the cabin in advance, which will affect the effectiveness of the test;

To make test personnel specific test content, can be related to test personnel training, the training content includes the description of the test environment, carried out in accordance with the commander of the password activities (including evacuation forward or backward to evacuate), when to keep his head or under the seat of the chair height, find correct report in a timely manner after the emergency exit, etc.

3.3 Test Environment

The test environment should be selected to represent the actual operating cabin environment of the aircraft. The environmental requirements are as follows:

It shall be carried out on a real aircraft or a physical prototype of exactly the same size and system equipment as the real aircraft;

2) Black cloth should be used to cover all light sources above 1.2 meters in the cabin of the aircraft to simulate the situation that the space above 1.2 meters is covered by smoke, and the light source cannot be perceived by evacuees. The light source covered by black cloth includes indicators, emergency lights, emergency signs, etc.;

In order to meet the requirements of darkness, the aircraft or real physical prototype should be in the dark night or aircraft hangar, and all relevant lighting lights in the hangar should be turned off to ensure that the illumination of the dark environment of the cabin where the test is conducted is less than or equal to 0.05lx. If the illumination requirements cannot be met, Black cloth should be used to cover the cabin porthole, cabin door observation window, cockpit door and other areas that may be exposed to the cabin from outside the aircraft;

3.4 Evacuation Route

The ground evacuation test of civil aircraft emergency lighting is to verify that the lighting equipment of the emergency evacuation corridor adjacent to the floor should enable passengers to visually identify the passage leading to the emergency exit and identify the emergency exit. Test personnel shall be under the guidance of the staff, to the selected seat to sit, and according to the commander issued a directive to the front of the cabin (course) or rear evacuations, in order to make the test can cover the whole cabin, and not caused by tester hesitate to forward or backward to evacuate test is invalid, can define each test personnel as early and the direction of evacuation, This is shown in Figure 1. The number of test personnel was defined as 10, and there were 5 test personnel on the left side and 5 on the right side of the aircraft heading, and the number of forward and backward evacuation personnel was also 5. It should be noted that the evacuation of each experimenter was done individually.

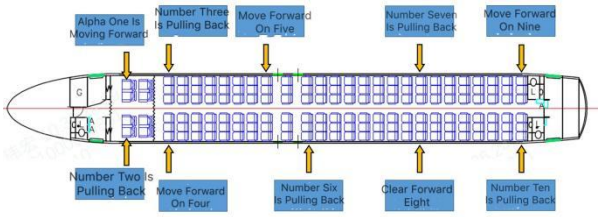

Figure 1 Seat position and evacuation direction of test personnel

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3.5 Test equipment

In order to ensure the normal development of the test, the following equipment shall be prepared for the test:

1) Real aircraft cabin or physical prototype of real aircraft with the exact same size and system equipment.

2) Intelligent illuminometer. Ensure that the cabin is in the dark environment before the test and the illuminance is less than or equal to 0.05lx;

3) Electronic stopwatch. The time between the start of evacuation and finding the emergency exit was recorded for each individual.

4) black cloth. For shielding all luminescent sources above 1.2 m of cabin floor height;

5) Night vision. Because the test is in a dark environment, it is necessary to use night vision device for visual enhancement, so as to facilitate the commander or civil aviation Administration certification personnel to witness the whole test process;

6) an eye mask. For the dark environment adaptation of test personnel;

7) Infrared camera. It is used to record the whole test process, so as to facilitate follow-up review of the test process for the test personnel or the bureau who have objections.

3.6 Test Procedure

3.6.1 Test procedures of the first flight scenario during daytime

The first daylight flight scenario was to allow the FPEEPMS system to sit in the cabin for 16 hours in the dark, releasing light energy from the FPEEPMS. After activation, use the lowest cabin lighting brightness for 30 minutes. The test procedure of this scene is shown in Table 1 below.

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Table 1 Test procedure of the first flight scenario during daytime

Step number	Steps describe
1.	Emergency floor luminous signs should be kept in the dark for 16 hours or more
2.	Turn on the cabin lighting to the lowest brightness, within 30 minutes of irradiation, to activate the emergency floor luminous sign
3.	Turn off all cabin lights and turn on cabin emergency lights
4.	Commanders and test witnesses wear night vision equipment to enter the cabin
5.	Before entering the cabin, individual test personnel put on the blindfold, the staff will guide the test personnel into the designated seat position in the cabin, and then close the cabin door
6.	When the experimenter was ready, the command officer issued the instruction: "Remove the blindfold and evacuate forward (or backward)."
7.	After the test personnel find the emergency exit according to FPEEPMS, indicate to the commander: "Find the exit".
8.	Repeat steps 5-7 for subjects 2-10
9.	At the end of the test, the tester filled in the questionnaire

3.6.2 Test procedure of maximum night flight scenario

In the maximum night flight test scenario, the FPEEPMS system should be illuminated for less than 30 minutes under the lowest lighting brightness of the cabin, and then the cabin should be kept in the dark environment for 150 minutes. The test steps of this scenario are shown in Table 2 below.

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Step number	Steps describe
1.	Turn on the cabin lighting to the lowest brightness, irradiation within 30 minutes
2.	Turn off all cabin lighting and allow the cabin to stand in the dark for 150 minutes
3.	Turn on emergency cabin lighting
4.	Commanders and test witnesses wear night vision equipment to enter the cabin
5.	Before entering the cabin, individual test personnel put on the blindfold, the staff will guide the test personnel into the designated seat position in the cabin, and then close the cabin door
6.	When the experimenter was ready, the command officer issued the instruction: "Remove the blindfold and evacuate forward (or backward)."
7.	After finding the emergency exit using the FPEEPMS system, the experimenter indicated to the observer: Exit found
8.	Repeat steps 5-7 for subjects 2-10
9.	At the end of the test, the tester filled in the questionnaire

Table 2 Test procedure of maximum night flight scenario

3.7 Test validity criteria

In any group of test personnel, at least 8 out of 10 test personnel meet the following behaviors, then the test is passed, indicating that the performance of FPEEPMS and emergency lighting below 1.2 meters meets the requirements of CCAR25.812(E), otherwise it is not passed:

1) Leave the passenger seat and enter the adjacent passageway immediately;

2) Moving in the direction of the exit without significant hesitation, delay or apparent confusion;

3) The outlet can be correctly identified by the floor fluorescent strip, and the method of identification can be explained to the test observer.

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4. Conclusion

Civil aircraft emergency lighting evacuation test is to demonstrate the compliance of clause CCAR25.812(E) through demonstration and verification. Through the analysis and understanding of the clause, this paper studies and summarizes a practical ground demonstration and verification test method, which has been specifically implemented and verified on a certain type of civil aircraft. It provides reference for demonstration and verification of civil aircraft emergency lighting evacuation from the ground.

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