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## An Approach of AHP for Human Factors Analysis in the Aircraft Icing Accident

CHEN Lijuan<sup>a</sup>, CHANG Shinan<sup>b</sup> a\*

<sup>ab</sup> School of Aeronautics Science and Engineering Beihang University, Xuanyuan Road 37# of Beijing, 100191, P.R.China

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### Abstract

The reasons that icing of aircraft leads to an accident are diverse. Ensuring the aircraft to take off clearly is the important factor of giving support to flying safety. Human factor is one of the important factors which have caused the accidents. In this paper, because of the complexity and uncertainty of human factors, we introduce Analytical Hierarchy Process (AHP) to create weight model of human factors by analyzing and deciding importance of all kinds of human factors. Based on this basis, further study on assessment of human factors in aircraft icing accidents is developed, and the arrangement in importance order of human factors in aircraft icing has been given according to the given weight distribution of human factors. This paper provides reliable basis for equipment improvement and personnel management.

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### 1. Introduction

In winter, the ice, snow or frost will be found on the surface of aircraft and they will destroy the well aerodynamic characteristics of the surface of aircraft, which is injurious to flight safety. The aircraft which has been contaminated by the ice, snow or frost is not airworthy and must be treated with de-icing and anti-icing. The FAA's records of freezing between 2004 and 2005 show that if the icing thickness of the leading edge of aircraft wings, the rate of climb will decrease by 500 ft/min and the cruising speed will decrease by 40 km/h<sup>[1]</sup>. For some models, the safe flight pre-stall warmer will even likely be out of order.

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\* Corresponding author. Tel.: 18901260825; fax: 010-82338008  
E-mail address: [leftbank52@126.com](mailto:leftbank52@126.com).

Therefore the icing of aircraft is the important factor of flying safety. In 2003, the research on the 26 accidents and the unsafe occurrences relating to icing indicates that 15 of them happened in the flying course (approaching and landing included), 10 of them happened because of incomplete de-icing or icing before taking off, and 1 of them has not been introduced in details<sup>[11]</sup>. In general, the period of the aircraft icing could be divided into two forms: ground maintaining period and icing during flight. However the final causes why the aircraft ices or the aircraft takes off with icing on surface are intricate, because they are affected by two forms together and can't be attributed to one form. For example, the accident took place when one Douglas DC-9-140 was taking off in the American state of Colorado on Nov. 15, 1987 and that claimed hundreds of lives. On 10 Mar. 2003, one Fokker F28-1000 crashed and was cut into three on Ontario, Canada when it was taking off and there were 69 passengers of whom 24 were killed. The two accidents were credited to the aircraft icing and both causes of 2 aircrafts' icing included 2 forms: the secondary de-icing before the aircraft (ground maintaining period) took off was neglected and the captain didn't turn on the ice removing system<sup>[6]</sup>. So we can know that the reasons that the aircraft freezes are diverse and commonly have to do with operators. But because the human error has characteristics of uncertainty and difficulty of being quantized, the reasons which are included haven't been analyzed concretely.

The AHP is a kind of method by which the complex problem that is difficult to be quantized is converted into a series of simple problems that is easy to be quantized by downward depth profile analysis. This method is very commonly applied to the analyzing and evaluating problems of complex system<sup>[2]</sup>. Based on consulting the relevant literature, taking advantage of characteristics of AHP, which is suitable to Multi-Criteria and multiple-objective decision analysis into complex problems, this paper analyzed the human factors of the aircraft icing and on this analysis base that made clear the included factors and interrelation of these factors, then gave the weights of all kinds. Consequently, we can pointedly pay enough attention to the human factors which might happen in future to avoid the future tragedies.

## 2. ANALYTICAL HIERARCHY PROCESS

### 2.1. The concept and the principle of AHP

AHP, which is a kind of method of multi-objective decision and combines qualitative and quantitative analysis, was firstly created by American scholar Saaty<sup>[7]</sup>. The fundamental theory of AHP is that the complex problem was decomposed into composing factors, which are grouped hierarchically according to their administrative affiliation.

The establishment of judgment matrix is the key of application of AHP. The characteristic feature of AHP in human factors analysis (HFA) is quantitative analysis of the qualitative problem and mathematic modeling of reviewers' Exercise Priority. So not much quantitative data is needed by AHP, but all the related factors and their interrelation must be define, which is a matter that the final answer is correct or not.

### 2.2. The analysis and basic steps of AHP

(1) Identify the problem. Identify the scope of problem and the relations between the factors. This step is not only the basic of approach for AHP but also the key point of entire process. The correctness of the logical relations among factors directly relates to the reliability of final result.

(2) Establish the layer structure and matrix  $A$  it is the sticking point of this step to clear and definite the factors involved in each layer. According to the important degree of each factor that belongs to the above

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