

## THE PROCEDURES DESIGN OF HAZARDS MANAGEMENT AND CONTROL FOR AIR TRAFFIC MANAGEMENT<sup>1</sup>

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**Abstract** From the point of hazards, oriented to feasible implementation of hazards management and control, to the principle of closed-loop control, dynamic control and hierarchical control, this paper describes the procedures of hazards management and control in detail which contain the following seven stages: identification and collection of hazards, whether to set up a risk management group, risk assessment of hazards, establishment of pre-control schemes, implementation of pre-control schemes, continuous monitoring of schemes implementation and the effect evaluation of schemes implementation. The process of risk assessment of hazards which is the critical stage is also introduced so as to provide some useful suggestions to the implementation of hazards management and control for air traffic bureaus.

**Key words** air traffic management (ATM), hazards, risk assessment, management and control procedures

### 1 Introduction

At present the ICAO is widely promoting the construct of safety Management System (SMS) in all its members. Civil Aviation of China has made great progress in safety management fields not only in theory but also in practice. However, most of them focus on the risk assessment of the whole system which has poor location for early warning. In high-risk aviation industry, it is always the small obscure sources which called hazards here that cause significant accidents or disasters. So it's very necessary to make deep studies on hazards. Most notably, there are big difficulties in the implementation of hazards management and control which caused by the disordered procedures.

There are a few researches in which the procedures of risk management are described, but not about air traffic management. The procedure of risk management in Microsoft Corporation which is cycling executed includes risk assessment, the supports of decision implementation, carrying out controls and the effects evaluation<sup>[1]</sup>. And that of East-china Communication Network Company in Shanghai Civil Aviation contains preliminary risk analysis, comparing safety assessment, the proposing and tracking of risk mitigation measures<sup>[2]</sup>. Then, a power generation enterprise called Datang bloc formed a closed-loop model to manage and control the major hazard installations with the composition of registering, assessing to the table, quantizing risk, grade monitoring, continuous improvement and risk reduce<sup>[3]</sup>. Overall, the risk management processes are covered by risk assessment and risk control with cycling model.

Our project put forward an operation process of security risk management for a certain Air Traffic Management (all abbreviated as ATM) Bureau which is divided into two braches, that is whether or not to set up a risk management group. And both braches have the same five stages: risk identification, risk assessment, scheme establishment, scheme implementation and effect evaluation of schemes<sup>[4]</sup>. However, this process didn't reflect the principle of hierarchical control and dividing into two parts is unnecessary, what's worse, the risk assessment method is subjective and seems ungrounded. To make up its shortcomings, based on repeat practice, in the view of hazards and oriented to implementation, this paper will describe the procedures of hazards management and control in detail and introduce the processes of risk assessment of hazards.

### 2 Definition of ATM Hazards

There is no consensus on the definition of hazards. Sun Bin hold that hazards were all the facilities which may cause fire, explosion, toxic leak, radioactive materials leak, building collapses or other major personal injury and property loss. To some extent, they are man-made systems with observability and controllability<sup>[5]</sup>. Chen Ting etc described hazards as the origin and development of risk, that is the critical states in which the risks are unacceptable for people in three forms of energy storage material, beam energy facilities and staff using energy<sup>[6]</sup>. And Ping Fan thought hazards are the root states which may cause injury or illness, property damage, the work environment damage or combination of these

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circumstances <sup>[7]</sup>. This definition is found most widely cited when access to a large number of documents. Based on the researches mentioned above, in light of the Instruction of Safety Management System for ATM in Civil Aviation(for trial), we define ATM hazards as “states which may cause injury or illness, property damage, the work environment damage or combination of these circumstances in ATM operation including the correlative airport and airlines operation .”

Hazards are the most basic elements and units leading to accidents or its symptoms in ATM. And every hazard has many attributes. Only in specific scenes that are in certain time or certain places will risks happen. Accordingly, the accident chains will be disconnected from the bottom as long as the scenes of hazards are in control. Thus, research on hazards is basic to safety and risk management and also is critical to control incidents so as to improve the level of safety and risk management ultimately.

### 3 Principles of Hazards Management and Control

#### 3.1 Closed-loop Control Principle

In the procedures of hazards management and control, some new hazards may be brought out when pre-control schemes are carried out. So make close watch to new situations to keep the system tightness. And the procedures are not single ones. The effect evaluation must be completed once the schemes implementation is finished. If the control fails, the problems should be found timely and appropriate measures must be taken quickly to ensure the effectiveness of the schemes. It seems going to the former stages. This is called the principle of closed-loop for control.

#### 3.2 Dynamic Control Principle

Hazards are dynamic with multiple attributes. Different hazards are in different scenarios and have different factors when they happen. Even one hazard appears difference at different times and different places. Hence, the corresponding sub-factors of hazards must be chosen reasonably before its risk assessment. The factors can be divided to four aspects which called the first indexes, such as people, machines, circumstances and management, and every aspect contain different sub-factors which named the second indexes. This selection process is dynamic. As long as catching efficient sub-factors sensitively and exploring the law of their change, then adjusting the schemes continuously according to new situation, making dynamic control to hazards can lead to good results.

#### 3.3 Hierarchical Control Principle

The risk level of hazards is in different plane. So different types of schemes have to be taken. Hazard risk must be graded before its risk assessment. We can assess the risk of hazards from their possibility and severity. The possibility index has five grades: unlikely occur, rare occur, less occur, may occur and frequently occur. The severity index also has five grades: negligible, slight, serious, dangerous and disastrous. Then the risk assessment matrix as table 1 showing forms. In the table, the red area manifests the risk here is unacceptable, risk management must start up immediately. The yellow area demonstrates the risk is intolerable and need make decisions to reduce the risk. The blue zone illustrates the risk is tolerable and only take some reform schemes can eliminate the risk. The green zone displays the risk is acceptable and it's better to be closely monitored.

**Table 1 Risk Assessment Matrix**

Severity \ Possibility	Grade 1 :	Grade2 :	Grade3 :	Grade 4 :	Grade 5 :	
	Negligible	Slight	Serious	Dangerous	Disastrous	
Grade : Frequently Occur						
Grade 4 : May Occur						
Grade 3 : Less Occur						
Grade 2 : Rare Occur						
Grade 1 : Unlikely Occur						

### 4 Procedures of Hazards Management and Control

The procedures of hazards management and control contains the following seven stages:

identification and collection of hazards, whether to set up a risk management group, risk assessment of hazards, pre-control schemes making, implementation of pre-control schemes, continuous monitoring of schemes implementation and the effect evaluation of schemes implementation. The safety management department is mainly responsible for this task and all the staff in ATM sectors are involved as shown in Figure 1.

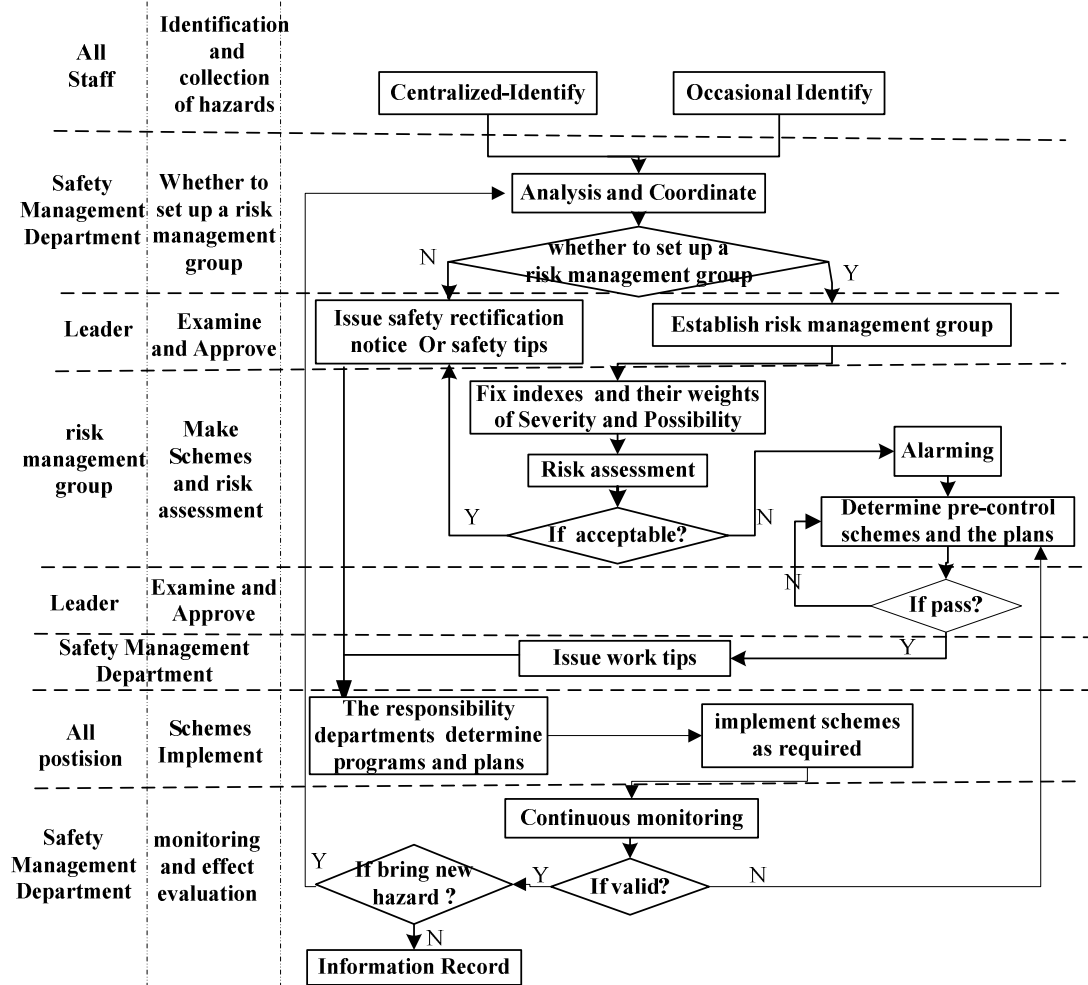


Figure 1 Flow Chart of Hazards Management and Control

#### 4.1 Identification and Collection of Hazards

Identification and collection of hazards are the basic stage in the procedures. There are many sources to collect hazards such as identified from the accidents, incidents or other unsafe symptoms happened before, collected from questionnaire surveys or interviews to the professionals, concluded from comprehensive security assessment or audit, gotten from voluntary reporting system or mandatory report, from data of ATM daily monitoring. Most of the risks can be monitored through these channels. As to the process of collection, both centralized-identifying and occasional identifying can cover more details comprehensively by all staff. In the activities of initiative risk assessment or investigation into incident, there are many problems for safety officers to analyze and classify. These jobs called centralized-identifying. On the contrary, information analyses collecting hazards from all kinds of daily reports or other production information through information management systems is called occasional identifying. Hazards identification can be presented in the form of “Identifying Forms” with the contents such as hazards mumble, name, category, involved staff and equipments, descriptions of possible risks and identifying time and so on.

#### 4.2 Whether to Set up a Risk Management Group

As to the hazards submitted, after collated, analyzed, classified and abstracted, the safety management department should put them into the hazards database in accordance with hazards names and code rules. Following, they have to decide whether or not a risk management group is necessary referring to some standards. If so, they also have to work out the members and their specific job under some principles. The suggestions should be handed in to leader who in charge of security to examine and approve then finally decides whether to set up a risk management group. If the hazards don't have

influences on more than two post operation and don't have threat to other type of jobs, risk management group is not necessary and issue safety rectifications notice or safety tips can eliminate or alleviate the risk. Otherwise, set up risk management group.

#### 4.3 Risk Assessment of Hazards

Once suggestion of setting up a risk management group gets through, the safety management department has to organize the established risk management group to do the job of risk assessment and pre-control scheme implementation. Before assessing the risk, members of the group should separately choose the possibility and severity indexes then fix what they should be through discussion. Afterwards all members give the weights independently of the first indexes and the second indexes. Next, integrated using the method of analytic hierarchy process and multi-level fuzzy comprehensive evaluation which had made in some software, combined with the risk assessment matrix, the level of hazards risk can be determined. The detailed risk assessment process is shown in Figure 2. If the risk is in the acceptable area, it also has to issue safety rectifications notice or safety tips to alleviate the risk. Once finding the risk level exceeds the standard, alarm immediately to take heavy attention of relevant departments and personnel. At the same time, the risk management group has to work out per-control schemes and the thorough implementation plans effectively.

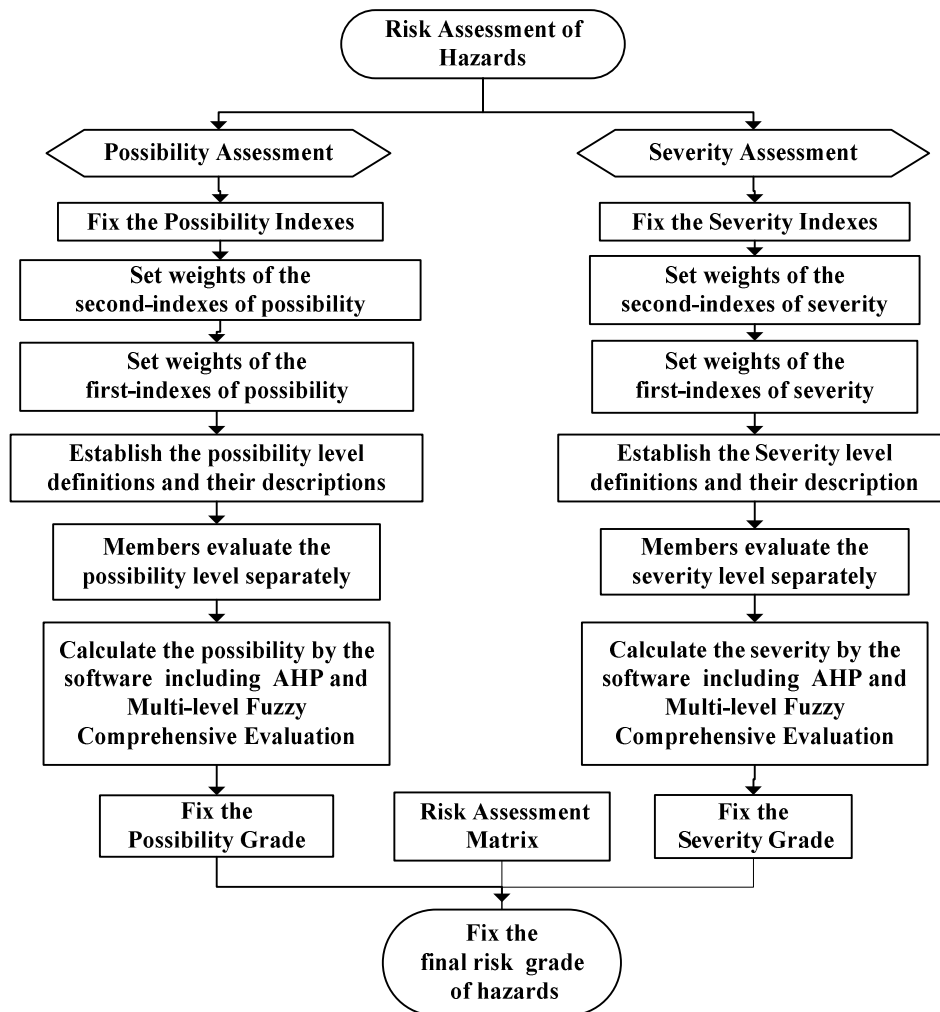


Figure 2 Flow Chart of Risk Assessment of Hazards

#### 4.4 Establishment of pre-control schemes

Risk-control scheme is generally recommended by the front-line staff firstly, then established by the leader of risk management group, finally determined by the leader who is in charge of security after examine and approve. Pre-control scheme can be considered from four aspects: First, take measures to reduce the possibility of the risk occurrence; second, reduce the damage degree of risk occurrence; third, transfer all or part of the risks to the areas that is relatively less important or do not generate loss directly; fourth, take measures to avoid risks. In addition, the establishments of pre-control schemes also have to consider capital investment, staff input, effectiveness of the scheme, the negative impact and residual risks.

#### **4.5 Implementation of pre-control schemes**

Pre-control scheme is handed in to leader for examine and approve. If the leader does not approve it, the safety management department should modify it according to the suggestion until passing the approval. Once it's approved, the relevant departments at all levels should strictly implement the control scheme, which is the implementation of pre-control schemes. And the safety management department need to establish the specific implementation plans further, including establishing risk-control objectives, dividing risk-control responsibilities, predicting the starting time and ending time, departments in charge, and monitoring staff and so on.

#### **4.6 Continuous monitoring of schemes implementation**

Leaders in different department must supervise and inspect the implementation progress of control scheme towards hazards according to safety instructions, give necessary suggestions to the work and record the status of the schemes implementation.

#### **4.7 Effect evaluation of schemes implementation**

In different stages of scheme implementation, safety management department should spot check the effect of the implementation scheme. If risk get relieved, risk degree of hazards can be decreased to the level of tolerance, the implementation units involved should submit the safety improvement report timely. Then the safety management department verifies it and evaluates its control effect according to relevant criteria. If the effect of risk control is not obvious, it is the responsibility of the risk management group to modify the pre-control schemes. As to the hazards controlled effectively, we should further analysis whether the implementation of control schemes has caused new risks or not. If new risks generated, we also regard it as a new hazard and conduct a new round of risk management, on the contrary, the work of risk management is completed and all the information should be preserved for reference subsequently.

### **5 Conclusions**

At present researches on safety and risk management mostly focus on predicting the whole risk level of the system which has poor location for early-warning. From the point of hazards, sources of risk can be found exhaustively and early-warning can achieve accurate location. Then targeting to the hazards, conducting management and control can reduce the operational risks level from the root.

This paper describes the procedures of hazards management and control. It researches on how to management and control the micro-sources of risks. The procedures of hazards management and control contains the following seven stages: identification and collection of hazards, whether to set up a risk management group, risk assessment of hazards, pre-control schemes making, implementation of pre-control schemes, continuous monitoring of schemes implementation and the effect evaluation of schemes implementation. All these seven stages form a closed loop. These procedures also follow the principle of closed-loop control, dynamic control and hierarchical control. The flow chart of hazards management and control can help us understand the procedures better. It demonstrates the tasks of different roles clearly. Risk assessment of hazards is the critical stage. The flow chart of risk assessment of hazards also displays a doable method which we will further introduce it other chances and make deep researches. Although the flow chart seems a little complex, it's really a result of a long period of practice. It can provide feasible operating suggestions for related ATM bureaus. It's worthy to research on other aspects of hazards in ATM, such as the analysis of hazards, the design of hazards indexes, risk assessment of hazards and so on which are also our next study orientation.

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