



第十二次空中航行会议

2012年11月19日至30日，蒙特利尔

议程项目 2: 机场运行 — 提高机场的效绩

2.2: 基于性能的导航（PBN）— 以安全和效率改进机场效绩的实际途径

日本的飞行运行安全评估（FOSA）程序

（由日本提交）

摘要

按照国家空中交通管理（ATM）未来概念——空中交通系统创新协作行动方案（CARATS），日本已开始采用需要特殊授权的所需导航性能进近（RNP AR），而这要求进行飞行运行安全评估（FOSA）。本文件介绍了日本的飞行运行安全评估程序，作为国家国内规则的一个例子。

行动：请会议视情分享RNP AR部署的现状，以及相关的飞行运行安全评估文件和执行情况。

1. 引言

1.1 基于性能导航（PBN）手册（Doc 9613 号文件）规定，在采用所需导航性能（RNP）需要特殊授权的进近（RNP AR）时，需要进行飞行运行安全评估（FOSA）。但是，在公共领域中，关于这一方法的指导材料却微乎其微。

1.2 2011 年 3 月/4 月，举行了仪表飞程序专家组（IFPP）全体工作组第八次会议，并完成了飞行运行安全评估指导材料的起草工作。这一草案基于欧洲空中航行安全组织（EUROCONTROL）的文件，现在正当其时，拟由国际民航组织决定将这一材料置于何处。

2. 讨论

2.1 日本 ATM 未来概念，即空中交通系统创新协作行动方案（CARATS），规定将采用 RNP AR 作为首要的近期实施内容之一。2012 年 1 月，日本民航局（JCAB）在大馆能代机场采用了 RNP AR，这一机场位于山区。一家航空公司报告，通过在大馆能代机场采用 RNP AR，每一航班的进近飞行航迹比现行的 ILS 盘旋进近程序缩短约 50 公里。此外，最低高度从 944 英尺改善到 351 英尺，

着陆最低能见度从 2,400 米降低至 1,400 米。自那以后，日本民航局在日本的四个其他机场（高知、新北九州、函馆和羽田）也部署了 RNP AR，并计划在 RNP AR 预期会带来运行收益的其他机场继续部署这一程序。

2.2 在大馆能代机场采用 RNP AR 的筹备阶段，日本民航局在国际民航组织的指导出台之前即制定了飞行运行安全评估程序，不言而喻，这是至关重要的。为此，日本民航局于 2009 年与挪威船级社（DNV）签订了合同，研究在日本机场采用飞行运行安全评估的事宜。挪威船级社所开展的工作包括举办了飞行运行安全评估研讨会（2009 年 11 月）、第一期安全讲习班（2009 年 11 月）、第二期安全讲习班（2010 年 2 月），以及与参加了特罗姆瑟机场和/或巴斯蒂亚机场飞行运行安全评估的欧洲组织/航空公司举行会议（2010 年 2 月），并制定了相关文件。

2.3 继挪威船级社的研究后，日本民航局于 2011 年 10 月制定了一份国家文件：“RNP AR 进近的飞行运行安全评估（FOSA）程序”，如附录所示。这一程序基于欧洲空中航行安全组织的“RNP AR APCH 飞行运行安全评估（FOSA）指导材料”、国际民航组织的安全管理手册（Doc 9859 号文件），以及上述 2.2 分段所述与挪威船级社的学习经验。

2.4 日本民航局意识到，欧洲空中航行安全组织规定了飞行运行安全评估的深度，以及随着经验的积累而简化或完全取消飞行运行安全评估的可能性。但是，日本民航局在这一问题上采取了保守的态度，制定了规则，要求为每个 RNP AR 都进行飞行运行安全评估。日本民航局期待着与成员国就 RNP AR 的部署，以及相关的飞行运行安全评估文件与实施情况交流信息。

3. 结论

3.1 请会议视情分享 RNP AR 部署的现状，以及相关的飞行运行安全评估文件和执行情况。

APPENDIX

Procedures of Flight Operational Safety Assessment (FOSA) for
RNP AR Approach

Ver. 1.0

Civil Aviation Bureau, Japan (JCAB)

Chapter 1: GENERAL

1.1 Objectives

Based on the standards and recommended practices in ICAO Annex 11 and the guidance in Performance-based Navigation (PBN) Manual (Doc 9613), this document establishes a procedure to conduct a Flight Operational Safety Assessment (FOSA) for the introduction, amendment, and post-implementation monitoring of RNP Authorization Required Approach (RNP AR APCH).

1.2 Application

In accordance with the procedures herein, FOSA shall be conducted for each RNP AR APCH which is established or amended. If the system definition clarified in 2.1.4 is changed, FOSA shall be conducted except when the change has no effect on the documented safety assessment.

1.3 Definitions

RNP Authorization Required Approach (RNP AR APCH): An approach procedure which could necessitate navigation accuracy, navigation performance, and navigation functional requirement (including on-board performance monitoring and alerting) that fulfilled the minimum lateral navigation error of ± 0.1 NM for 95 per cent of the flight time, and which would require stakeholders to conduct a FOSA.

Safety: The state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management.

Hazard: Any contributor (event or action) which could induce an accident or an incident.

Safety Risk: The harm that arises as a consequence of hazard, which is expressed in terms of predicted probability and the severity, taking as reference the worst foreseeable situation.

Safety Risk Management: A series of activities that encompass the identification of hazards, the analysis of the safety risks of the consequences of hazards, the assessment of the safety risk tolerability, and the mitigation of safety risks to a level as low as reasonably practicable.

Chapter 2: FRAMEWORK OF FOSA

2.1 FOSA Session

2.1.1 A FOSA session is held to assess the safety of operation of the proposed RNP AR APCH.

2.1.2 A FOSA session conducts a safety risk management.

2.1.3 The attendees of a FOSA session are the eligible personnel for a safety risk management of the RNP AR APCH, who are in charge of respective fields of duty in the related organizations (JCAB and aircraft operators) that join the FOSA task force described in 2.2.3.

2.1.4 A FOSA session is held after clarifying the following system definition with due consideration for the airport and the flight path of the proposed RNP AR APCH procedure, the aircraft operator and their aircraft wishing to obtain approval to fly the RNP AR APCH, the scheduled starting date of operation, and so forth.

- (a) The proposed procedure design and details of the proposed navigation database;
- (b) Aircraft information;
- (c) Proposed Minimum Equipment List;
- (d) Operating procedures required for flight crew/ dispatcher/ aircraft operator;

- (e) Knowledge and training required for flight crew/ dispatcher;
- (f) Airport and airspace environment;
- (g) Navigation infrastructure;
- (h) ATC facilities, procedures and training with respect to RNP AR APCH;
- (i) Monitoring program (post-implementation assessment).

2.1.5 A facilitator who maintains neutrality presides at the safety risk management in the FOSA session.

2.1.6 The attendees of a FOSA session make maximum efforts to collect safety related information through the use of previous safety assessments and so forth.

2.1.7 The safety risk management in the FOSA session is repeated through any form of qualitative and/or quantitative assessments until all hazards are mitigated to tolerable levels.

2.1.8 The outcome of the safety risk management in the FOSA session shall be documented.

2.2 FOSA Task Force

2.2.1 A FOSA task force is set up to develop well-prepared environment for the safety risk management of an RNP AR APCH in the FOSA session.

2.2.2 A FOSA task force organizes the information listed in 2.1.4 to clarify the system definition of the proposed RNP AR APCH.

2.2.3 The following divisions and offices of JCAB whose personnel are in charge of flight standards, airworthiness, scheduled introduction of RNP AR APCH, air traffic control, procedure design of RNP AR APCH, airspace safety assessment, flight plan/ aeronautical information, flight validation, and air navigation services engineering are the members of the FOSA task force where aircraft operators wishing for the approval of the RNP AR APCH will join. In case that the airport where RNP AR APCH is introduced has some special situation, the divisions and offices of JCAB in charge of the special factor will be consulted about the participation to the FOSA task force.

- (a) Flight Standards Division
- (b) Air Transport Safety Unit
- (c) Airworthiness Division
- (d) Air Navigation Services Planning Division
- (e) Air Traffic Control Division
- (f) Flight Procedures and Airspace Program Office
- (g) Operations and Flight Inspection Division
- (h) Flight Inspector
- (i) Air Navigation Services Engineering Division
- (j) Aircraft Operator
- (k) Other

2.2.4 A FOSA task force fully briefs about the system definition of the proposed RNP AR APCH to attendees of the FOSA session in advance.

2.2.5 A FOSA task force receives a safety assessment document which is recorded the outcome of the safety risk assessment at the FOSA session.

2.3 FOSA Clerical Staff

2.3.1 FOSA clerical staff is put to deal with any clerical works to conduct a FOSA. FOSA clerical staff consists of Flight Standards Division and Flight Procedures and Airspace Program Office.

2.3.2 FOSA clerical staff engages in the following matters.

- (a) Collecting and preparing materials related to a FOSA
- (b) Calling a FOSA task force and a FOSA session
- (c) Being a facilitator of a FOSA session (in a non-judgmental attitude)
- (d) Drafting a report of the outcome of a FOSA, and controlling a safety assessment document
- (e) Controlling hazard checklists to be utilized in 3.4.3

Chapter 3: SAFETY RISK MANAGEMENT

3.1 Steps of Safety Risk Management

A safety risk management in a FOSA session is conducted through the following steps depicted in the figure below.

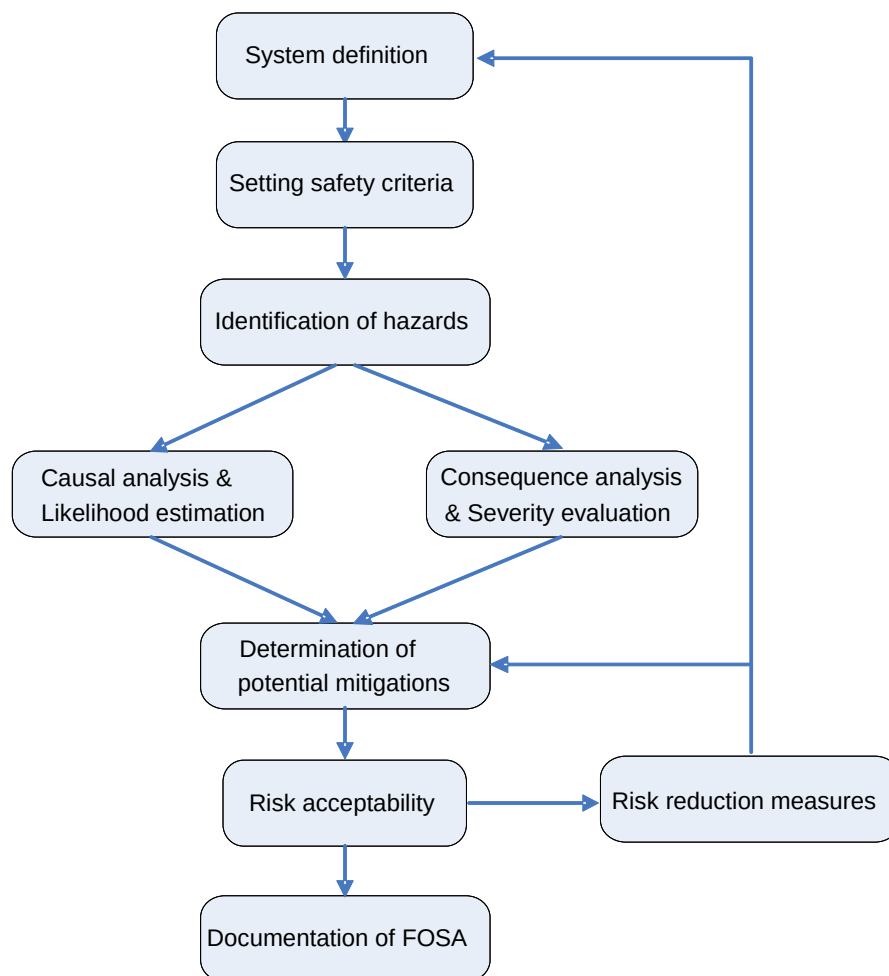


Figure 1: Steps in the safety risk management of FOSA

3.2 System Definition

In order to clarify the operational environment and the operational procedures of a proposed RNP AR APCH as well as the advantageous effect brought by the RNP AR APCH and so forth, items listed in 2.1.4 shall be confirmed in a FOSA session.

3.3 Setting Safety Criteria

With the exception that there is any special reason to do so, a FOSA session uses the methodology to judge the tolerability of risks by the severity of occurrence and the possibility of occurrence as described in the ICAO's Safety Management Manual (Doc 9859) for the safety risk assessment.

3.4 Identification of Hazards

3.4.1 Considering the operational environment and the operational procedures of a proposed RNP AR APCH and so forth described in 3.2 as prerequisites, as well as considering any operational situations beyond the normal operations of aircraft such as contingencies, further considering multiple contributors for human errors, a FOSA session shall identify any potential hazards to induce accidents and/or serious incidents.

3.4.2 The following items shall be covered in the hazard identification.

- (a) Navigation system of the aircraft
- (b) Aircraft performance
- (c) Flight crew operations
- (d) Aircraft failures
- (e) ATC operations
- (f) Flight procedure design
- (g) Route spacing
- (h) Obstacle clearance
- (i) Navigation database
- (j) CNS infrastructure

3.4.3 A FOSA session uses the example of hazards and the method of identifying hazards described in the following documents for the hazard identification. A FOSA session also uses the checklist of hazards identified in the previous FOSA.

- (a) ICAO: Performance-based Navigation (PBN) Manual (Doc 9613)
- (b) EUROCONTROL: Guidance Material on Flight Operational Safety Assessment (FOSA) for RNP AR APCH

3.5 Consequence Analysis and Severity Evaluation

A FOSA session analyses the possible consequence of the identified hazard in 3.4 above, taking as reference the worst foreseeable situation, and evaluates the degree of damage by using the following five-point safety risk severity table.

[Note] When evaluating the worst possible consequences, the potential mitigations (safety risk mitigations which already exist) need to be considered. More than one potential mitigation may exist. The aircraft equipment like a head-up display to increase situational awareness of flight crew, the alerting function for the flight course deviation, the training of flight crew and air traffic controllers for contingencies, the actual vertical separation between the aircraft and obstacles and so forth, need to be considered as potential mitigations for RNP AR APCH.

Level	Severity of Occurrence	Meaning
A	Catastrophic	– Aircraft destroyed – Multiple deaths
B	Hazardous	– A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely

		– Serious injury – Major equipment damage
C	Major	– A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of increase in workload, or as a result of conditions impairing their efficiency – Serious incident – Injury to persons
D	Minor	– Nuisance – Operating limitations – Use of emergency procedures – Minor incident
E	Negligible	– Little consequences

[Note] The severity is classified with consideration for the scale of damage on human lives and/or properties, and operational sustainability.

Figure 2: Safety risk severity table

3.6 Causal Analysis and Likelihood Estimation

A FOSA session estimates the probability that the worst foreseeable consequence of each hazard evaluated in 3.5 will occur by using the following five-point table.

Level	Probability of Occurrence	Meaning
5	Frequent	Likely to occur many times (has occurred frequently)
4	Occasional	Likely to occur sometimes (has occurred infrequently)
3	Remote	Unlikely to occur, but possible (has occurred rarely)
2	Improbable	Very unlikely to occur (not known to have occurred)
1	Extremely improbable	Almost inconceivable that the event will occur

[Note] The probability is classified with consideration for the history of occurrence of identical or similar event.

Figure 3: Safety risk probability table

3.7 Determination of Potential Mitigations and Assessment of Risk Acceptability

A FOSA session determines potential mitigations on each hazard. Based on these mitigations, a FOSA session assesses whether the safety risk of each hazard is acceptable or not comprehensively by applying the severity of occurrence identified in 3.5 and the probability of occurrence identified in 3.6 to the following five-by-five matrix.

Risk probability	Risk severity				
	Catastrophic	Hazardous	Major	Minor	Negligible
Frequent	Unacceptable	Unacceptable	Unacceptable	ALARP	ALARP

Occasional	Unacceptable	Unacceptable	ALARP	ALARP	ALARP
Remote	Unacceptable	ALARP	ALARP	ALARP	Acceptable
Improbable	ALARP	ALARP	ALARP	Acceptable	Acceptable
Extremely improbable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

[Note] The acronym ALARP expresses that the level of a safety risk is between acceptable and unacceptable, which means that the safety risk should be reduced to a level that is “As Low As Reasonably Practicable”. If the safety risk of the hazard falls under this category, the effect and the cost resulted from the risk mitigations should be examined, and also the technical possibility should be considered, then after mitigating the risk as low as reasonably practicable, the inevitable risk is to be accepted.

Figure 4: Safety risk assessment matrix

3.8 Risk Reduction Measures

3.8.1 A FOSA session considers solutions for unacceptable risks either through the elimination of the hazard or through the mitigation to reduce the risk of the hazard to an acceptable level.

3.8.2 A FOSA session pays attention to the higher risks (with greater severity and higher possibility) which should be mitigated with greater urgency.

3.8.3 A FOSA session gives a preference to the mitigation which has the biggest effect and is the easiest to carry out when multiple measures are envisaged.

3.8.4 A FOSA session combines advantage of multiple mitigations when a single measure cannot reduce the safety risk sufficiently.

3.8.5 A FOSA session considers the degree of risk reduction by the selected mitigation and the residual risk after the risk reduction.

3.9 Documentation of FOSA

3.9.1 A FOSA session draws up a safety assessment document on the process of the safety risk management and the outcome of the risk assessment.

[Note] Not only recording the outcome of the risk assessment, i.e. the acceptability of the risk, but also the background to reach the outcome shall be recorded in the safety assessment document. The steps of safety risk management described in 3.1 (system definition, setting safety criteria, identification of hazards, consequence analysis and severity evaluation, causal analysis and likelihood estimation, determination of potential mitigations, assessment of risk acceptability, risk reduction measures) shall be all recorded in the safety assessment document.

3.9.2 A FOSA session uses Form 1 to record the identified hazards and the outcome of risk assessment on each hazard in the safety assessment document.

3.9.3 A FOSA session uses Form 2 to record the process of safety risk management on each hazard respectively in the safety assessment document. All hazards identified in the FOSA session are recorded whatever minor things may be.

Chapter 4: HANDLING OF THE OUTCOME OF FOSA

4.1 Documentation Management

A safety assessment document is reported to the FOSA task force. The document is controlled by FOSA clerical staff.

4.2 Execution of Safety Risk Mitigations

The divisions and offices of JCAB participated in the FOSA task force shall carry out the necessitated risk reduction measures described in the safety assessment document.

[Note] In accordance with annex 8, chapter 7, ‘miscellaneous provisions’ of “Rules of Operational Approval and Examination Procedures for Area Navigation (RNAV)” dated 7 June 2007, aircraft operators are obliged to carry out the risk reduction measures described in a FOSA document.

Chapter 5: POST-IMPLEMENTATION ASSESSMENT

5.1 Safety Monitoring after Implementation of RNP AR APCH

5.1.1 Safety monitoring of RNP AR APCH shall be conducted after starting the actual operation in order to verify the effectiveness of risk mitigations.

5.1.2 Safety monitoring of implemented RNP AR APCH is conducted through the daily duty of the stakeholders listed in 2.2.3, and the collected data shall be reported to the FOSA clerical staff.

5.1.3 FOSA clerical staff uses Form 3 to organize reported hazard-related information.

5.1.4 FOSA clerical staff organizes the report based on article 111-4 of Civil Aeronautics Law and the report obliged by Rules of Operational Approval and Examination Procedures for Area Navigation (RNAV) if those reports are related to RNP AR APCH.

5.2 Safety Assessment after Implementation of RNP AR APCH

5.2.1 Based on the data collected through 5.1.2, 5.1.3 and 5.1.4, and the flight track data analysed through regular sampling, FOSA clerical staff reviews the actual operational conditions of implemented RNP AR APCH.

5.2.2 Post-implementation assessment is conducted at the point when one year having passed since the operational start of the established or amended RNP AR APCH, in principle. However, it might be conducted earlier when FOSA clerical staff recognizes the need to do so, based on the review described in 5.2.1 above.

5.2.3 If the post-implementation assessment identifies influential or likely influential events on the safe operation of RNP AR APCH, countermeasures shall be considered and carried out. In this case, a FOSA session is held to conduct a safety risk management.

5.2.4 A safety assessment document is revised if the post-implementation assessment brings new mitigations and so forth, and necessitates the update of the document.

Supplementary Provision:

Procedures established herein will be effective on 5th October 2011.

Form 1 List of Identified Hazards and Outcome of Safety Risk Assessment on each Hazard

Outcome of Safety Risk Assessment on each Hazard and Mitigations

List of Hazards					
No.	Code	Identified Hazard	Outcome of Assessment		Mitigation / Residual Risk
(1)	*1	*2	*3	*3	*4
(2)					
(3)					
(4)					
(5)					
e.g.	RJTT23-101	Error in navigation database	3B	ALARP	7

Risk Tolerability Matrix

Risk probability		Risk severity				
		Catastrophic	Hazardous	Major	Minor	Negligible
		A	B	C	D	E
Frequent	5	(5A) Unacceptable	(5B) Unacceptable	(5C) Unacceptable	(5D) ALARP	(5E) ALARP
Occasional	4	(4A) Unacceptable	(4B) Unacceptable	(4C) ALARP	(4D) ALARP	(4E) ALARP
Remote	3	(3A) Unacceptable	(3B) ALARP	(3C) ALARP	(3D) ALARP	(3E) Acceptable
Improbable	2	(2A) ALARP	(2B) ALARP	(2C) ALARP	(2D) Acceptable	(2E) Acceptable
Extremely improbable	1	(1A) Acceptable	(1B) Acceptable	(1C) Acceptable	(1D) Acceptable	(1E) Acceptable

*1 Put alphanumeric code (airport name, name of approach procedure, serial number, etc.) as a reference for the identified hazard in the safety risk management. It should be used for ease of reference. e.g.: RJTT23-101

*2 Put the title of identified hazard.

*3 Put acceptability of the hazard. In addition, put the number-alphabet combination code in the five-by-five matrix above and colour the column in red, yellow or green appropriately.

*4 Put risk reduction measures and/or residual risks, which make the hazard currently acceptable but may need to increase safety in the future, may need technical development, or may need to monitor after introduction. Mitigations and residual risks would be more than one, so the details are described separately as needed. e.g.: Number mitigations/residual risks serially, and put the number only in the table.

Form 2 Process of Safety Risk Management on each Hazard

Hazard (1)	*1						
Code	Class	Key Word	Acceptability	5 x 5	Severity	Probability	mitigation
*2	*3	*4	*5	*6	*7	*8	*9
1. Occurrence	*10						
2. Cause	*11						
3. Potential Mitigation	*12						
4. Worst Consequence	*13						
5. Severity	*14						
6. Probability	*15						
7. Assessment Process	*16						
8. Mitigation	*17						
9. Residual Risk	*18						
10. Remarks	*19						

*1 Put the title of identified hazard. The same title put in the Form 1.

*2 Put alphanumeric code (airport name, name of approach procedure, serial number, etc.) as a reference for the identified hazard in the safety risk management. It should be used for ease of reference. e.g.: RJTT23-101

*3 Put the code of relevant area for the grouping of identified hazards. e.g.: For the hazard related to air traffic control, put "ATC" in the column.

*4 Put key words to subdivide hazards.

*5 Put the outcome of risk assessment as "Unacceptable", "ALARP" or "Acceptable". Colour the column in red, yellow or green as needed.

*6 Put the number-alphabet combination code in the five-by-five safety risk assessment matrix.

*7 Put the degree of severity in the five point safety risk severity table.

*8 Put the degree of probability in the five point safety risk probability table.

*9 Put the need of mitigations either 'necessary' or 'unnecessary'.

*10 Put the situation of the occurrence of the hazard.

*11 Put the cause of the occurrence of the hazard.

*12 Put the mitigations which already exist. In addition, put the assumed operational procedures, ATC procedures, etc.

*13 Put the worst consequence possibly happen even after considering all the potential mitigations.

*14 Put the reason why that severity is chosen from the five-point safety risk severity table.

*15 Put the reason why that probability is chosen from the five-point safety risk probability table.

*16 Put the repeated process of safety risk management. The hazard assessed as unacceptable in the first risk assessment may be assessed as ALARP in the next risk assessment by applying additional mitigations.

*17 Put the required mitigation to make the hazard acceptable.

*18 Put the residual risks associated with the hazard, which are currently acceptable but may need technical development or post-implementation monitoring in order to increase safety in the future.

*19 Put any information to keep in mind.

Form 3 RNP AR APCH Hazard Information Log

Item	Content
Date & Time of Occurrence	YY MM DD hh mm (JST)
Site of Occurrence	(Airport, Name of RNP AR APCH, Altitude, etc.)
Name of AO Flight No. Type of A/C Reg. No.	
Detail of Hazard	
Cause	
Other	