CHAPTER 4

Civil Aviation Department

Administration of the air traffic control and related services

Audit Commission
Hong Kong
30 October 2014

This audit review was carried out under a set of guidelines tabled in the Provisional Legislative Council by the Chairman of the Public Accounts Committee on 11 February 1998. The guidelines were agreed between the Public Accounts Committee and the Director of Audit and accepted by the Government of the Hong Kong Special Administrative Region.

Report No. 63 of the Director of Audit contains 10 Chapters which are available on our website at http://www.aud.gov.hk

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Executive Summary

1. The Civil Aviation Department (CAD) is committed to a safe, efficient and sustainable air transport system. The Air Traffic Management Division (ATMD) of the CAD is responsible for the provision of air traffic control (ATC) services for aircraft arriving/departing the Hong Kong International Airport (HKIA) and aircraft overflying within the Hong Kong Flight Information Region. From 1998-99 (the commencement of the HKIA's operation at Chek Lap Kok) to 2013-14, the air traffic handled by the CAD had increased by 113% for HKIA traffic and 217% for overflying traffic. The Air Traffic Engineering Services Division (AESD) of the CAD is responsible for the planning, provision and maintenance of ATC facilities, including the ATC system and radar systems. The CAD has about 580 staff working in its ATMD and AESD. For 2014-15, their estimated expenditure totalled $668 million. The Audit Commission (Audit) has recently conducted a review of the CAD's administration of the ATC and related services, and in particular the implementation progress of the Air Traffic Management System (ATMS) contract, with a view to identifying issues that warrant attention and the key challenges ahead.

Management of the new ATC system project

2. In 2007, the CAD obtained funding of $1,565 million to replace its ATC system. According to the Finance Committee paper, the existing ATC system would be approaching the end of its usable life by 2012 and the new ATC system was targeted for commissioning in December 2012. The CAD implemented the new ATC system project through eight major contracts. While seven of the eight contracts were substantially completed within their scheduled times, there was delay in implementing the ATMS contract. To-date, the ATMS contract had two contract variations totalling $89 million. The Factory Acceptance Tests of the ATMS contract initially scheduled for completion in July 2012 were accepted in June 2013, on the condition that the then 127 outstanding deficiencies/observations would be followed up during the Site Acceptance Tests of the ATMS contract. Since then, a significant number of comments were submitted by users during user's training

and testing sessions. As at June 2014, there were still 76 outstanding deficiencies/observations and 420 comments from users to be followed up. The Site Acceptance Tests of the ATMS contract only commenced in mid-August 2014. As a result, the new ATC system was not yet in operation as at October 2014 and the latest estimate was that the new system would only be ready for operation in 2015. Meanwhile, the existing ATC system was operating above its planned capacity, with frequency of surveillance data display problems increasing since 2011 (paras. 2.1, 2.3, 2.4, 2.12 to 2.15, 2.17 to 2.19 and 2.20).

Management of the precision runway monitor project

3. In June 1996, the CAD obtained funding approval from the Finance Committee to procure a precision runway monitor (PRM) radar. The Finance Committee was informed that the PRM radar was required for independent mixed mode of operation of the two runways of the HKIA with a view to maximising the utilisation of their capacity. The PRM radar costing $101.4 million was commissioned in 2000. Audit found that before funding approval was sought, the CAD had been made aware of the constraints in adopting independent mixed mode of operation by two consultancy studies in 1990 and 1994, (i.e. the International Civil Aviation Organization's requirements on independent mixed mode of operation could not be met due to terrain obstructions, south and northeast of the HKIA). However, the CAD proceeded with the PRM project in the belief that there might be advancement in technology to permit simultaneous independent operations and the PRM radar could then support independent mixed mode of operation. In the event, the expected changes in technology did not happen. As a result, the PRM radar was only put into use for purposes other than supporting the independent mixed mode of operation of the HKIA's runways. Such other uses also turned out to be supplemental and were discontinued after some 20 months to 4 years. The PRM radar has been put into standby mode since 2005 (paras. 3.2, 3.3, 3.6(c), 3.9(a) and 3.13).

Administration of ATC service related charges

4. Under the Government's "user pays" principle, the full cost of providing ATC services is to be recovered through the ATC service charges for aircraft using the HKIA and en-route navigation charges for aircraft using the Hong Kong airspace only. Since the setting of the en-route navigation charge at $4.8 per nautical mile flown in 2000, the CAD completed four reviews of the charge level. However,

Audit found that after implementing the en-route navigation charge level as recommended in each fees and charges review, the CAD had not reviewed the implementation results to ensure that the charge level is conducive to achieving full-cost recovery. Audit also found that the amount of overdue en-route navigation charges had increased since 2009-10. There is a need to implement measures (such as security deposit) to provide coverage against revenue loss in default cases (paras. 4.3, 4.6 to 4.8, 4.10 and 4.13).

Administration of the mandatory occurrence reporting scheme

5. Safety has always been a top priority in the civil aviation industry. To improve the level of flight safety, the CAD has monitored hazardous or potentially hazardous incidents through a mandatory occurrence reporting (MOR) scheme. MOR cases are required to be reported within four days of occurrence. The CAD uses a database to capture information from receipt of reports to closure of the cases. Audit has found that there is a need to strengthen the management of the MOR database to ensure that it can provide accurate and up-to-date information to support MOR case management and trend analysis of significant aviation safety issues. Audit has also found that there is room for improving the timeliness of reporting MOR cases, and closer monitoring of the progress of long outstanding MOR cases (paras. 1.9, 1.12, 5.3(a), 5.7, 5.10, 5.11 and 5.21).

Way forward

6. From time to time, the CAD has to undertake major procurement projects to upgrade/replace its ATC equipment in order to provide safe, reliable, effective and efficient ATC services. The problems identified in the projects for procuring the new ATC system and the PRM radar indicate the need for conducting post-completion reviews to draw lessons for the benefit of future similar projects (para. 6.6).

Audit recommendations

7. **Audit recommendations are made in the respective sections of this Audit Report. Only the key ones are highlighted in this Executive Summary. Audit has *recommended* that the Director-General of Civil Aviation should:**

(a) **in conjunction with the ATMS contractor, expedite action in rectifying the outstanding deficiencies/observations in the ATMS and closely monitor the remaining contract work to minimise further project delay (para. 2.23(a));**

(b) **continue the efforts to deal with the issues of operating the existing ATC system until the new ATC system is available (para. 2.23(c));**

(c) **strengthen project appraisal to ensure that all uncertainties/risks impacting on project viability are fully evaluated in a cost-benefit analysis before making procurement decisions (para. 3.16(a));**

(d) **conduct a review after implementing the en-route navigation charge level recommended in each fees and charges review to ensure that the charge level is conducive to achieving full-cost recovery (para. 4.17(a));**

(e) **take effective measures to prevent the loss of revenue in default en-route navigation charge cases (para. 4.17(c));**

(f) **strengthen the management of the MOR database to ensure that it can support the monitoring of follow-up actions on reported MOR cases (para. 5.22(a));**

(g) **closely monitor the timeliness of reporting MOR cases and take targeted action in warranted cases such as cases of frequent and long delay in reporting (para. 5.22(b));**

(h) **closely monitor the long outstanding MOR cases to ensure that timely follow-up actions have been taken and properly recorded (para. 5.22(f)); and**

(i) **conduct post-completion reviews of major procurement projects undertaken by the CAD (para. 6.7).**

Response from the Administration

8. The Administration agrees with the audit recommendations.

PART 1: INTRODUCTION

1.1 This PART describes the background to the audit and outlines the audit objectives and scope.

Background

1.2 The Civil Aviation Department (CAD) is committed to a safe, efficient and sustainable air transport system. Its primary functions are three-fold:

(a) ***Provision of air traffic control (ATC) services.*** It provides ATC services and flight information to flights arriving and departing the Hong Kong International Airport (HKIA — Note 1) and aircraft overflying the 276,000 square kilometres Hong Kong Flight Information Region;

(b) ***Regulation of the civil aviation industry.*** As a regulator, it sets aviation safety and security standards, oversees the compliance by the Airport Authority, airlines and aircraft maintenance organisations with such standards, and maintains a licensing system for aviation professionals; and

(c) ***Investigation of aircraft accidents or serious incidents.*** It conducts the investigation of civil aircraft accidents or serious incidents that occurred in Hong Kong with the objective of preventing recurrence.

1.3 The Air Traffic Management Division (ATMD) of the CAD is responsible for the provision of ATC services for aircraft movements at the HKIA and aircraft overflying within the Hong Kong Flight Information Region. To maintain a safe, orderly and expeditious flow of air traffic, the air traffic controllers of the ATMD are assisted by facilities including the ATC system, radar systems, navigation aids, communication equipment and information technology systems. The Air Traffic Engineering Services Division (AESD) is responsible for the planning, provision and maintenance of ATC facilities. The CAD has about

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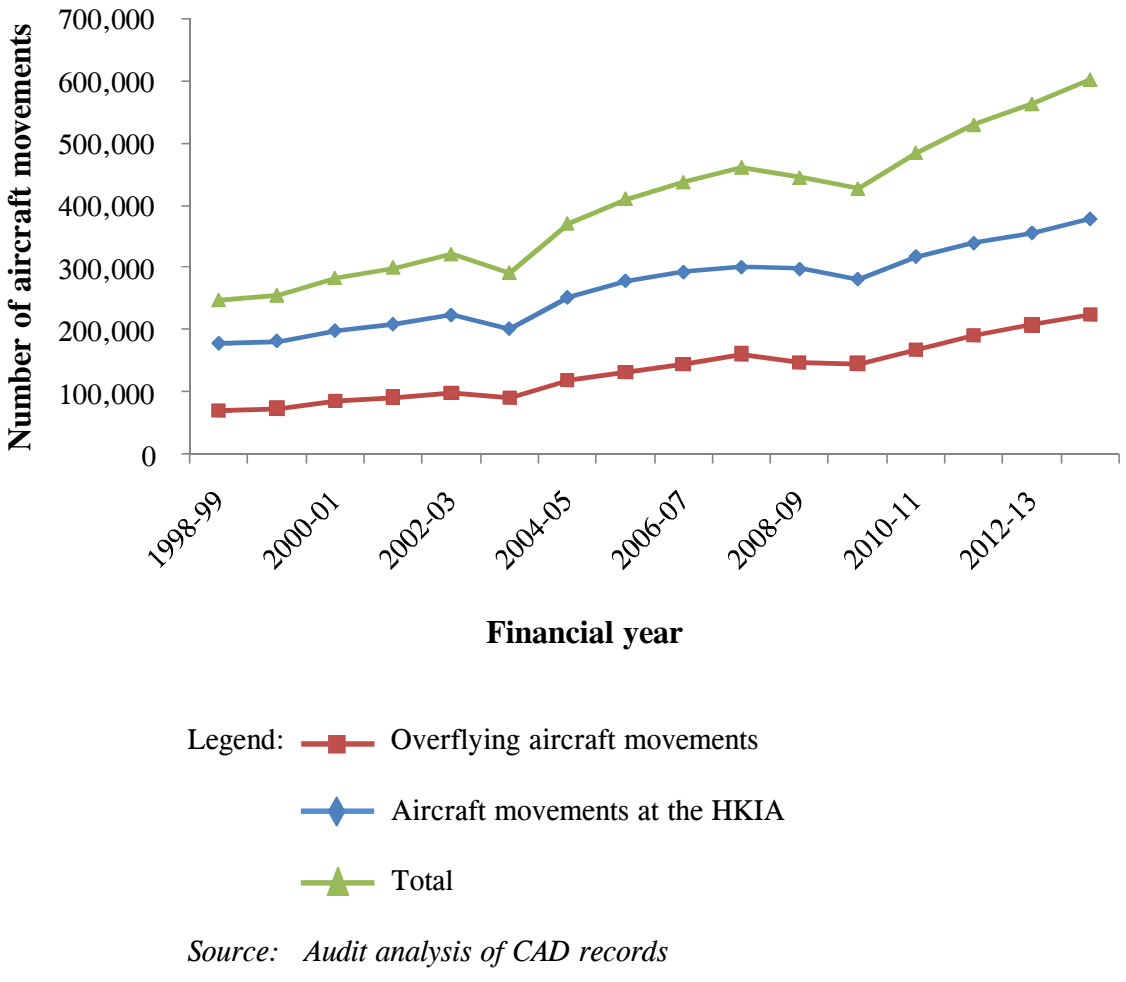
Note 1: *The responsibilities to develop and manage the HKIA rest with the Airport Authority which is a statutory body established under the Airport Authority Ordinance (Cap. 483).*

580 staff working in its ATMD and AESD. For 2014-15, their estimated expenditure totalled $668 million. An organisation chart of the CAD is shown in Appendix A.

1.4 Figure 1 shows that the air traffic (in terms of aircraft movements) handled by the CAD from 1998-99 (the commencement of the HKIA's operation at Chek Lap Kok) to 2013-14 had increased from 177,759 by 113% to 378,617 for HKIA traffic and from 70,561 by 217% to 223,775 for overflying traffic. According to the CAD, for the same period, the number of staff working in its ATMD and AESD had increased by 7.7%. In its latest long-term development plan, the Airport Authority has forecasted that the aircraft movements at the HKIA would reach 602,000 in 2030, more than triple the number recorded in 1998-99.

Figure 1

Air traffic handled by the CAD
(1998-99 to 2013-14)



Source: Audit analysis of CAD records

ATC system

1.5 The ATC system, comprising advanced electronic systems, is an essential tool enabling air traffic controllers to provide safe, reliable, effective and efficient ATC services. In 2006, the Chief Executive of the Hong Kong Special Administrative Region announced in the 2006-07 Policy Agenda an initiative to replace the ATC system and develop a new CAD headquarters on the Airport Island (Note 2). The need to replace the existing ATC system arose because:

(a) from the opening of the HKIA in 1998 to end of 2006, the number of aircraft movements at the HKIA had increased by 72%. Over the same period, over-flight traffic through the Hong Kong Flight Information Region had also grown by 95%;

(b) the existing ATC system was designed in early 1990s and was approaching its full design/handling capacity. Some components of the existing system were already out of production and the system was being sustained through the redeployment of existing parts where possible. There was limited scope for system upgrading and enhancement; and

(c) without replacing the existing ATC system by a more up-to-date system, there would be insufficient system capacity to cope with traffic growth.

1.6 In May 2007, the Administration obtained the Legislative Council (LegCo) Finance Committee's approval of $1,565 million to replace the ATC system. The new ATC system was targeted for commissioning in December 2012. To ensure the timely completion of the new CAD headquarters project (see para. 1.5) and a seamless transition to the new ATC system, the CAD set up a dedicated project team (Note 3) to oversee the preparation and implementation of

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Note 2: *One of the reasons for developing the new CAD headquarters was to house the new ATC system which would require a space three times that for the existing ATC system. The new CAD headquarters project is covered in Chapter 3 of the Director of Audit's Report No. 63.*

Note 3: *The project team headed by an Assistant Director-General of Civil Aviation was supported by a group of multi-disciplinary staff including Air Traffic Control Officers, Air Traffic Flight Services Officers, Aeronautical Communications Officers, Electronics Engineers, Senior Architect, Senior Electrical and Mechanical Engineer and non-civil service contract staff.*

both projects. While the construction works of the new CAD headquarters project were completed in June 2012 as scheduled (Note 4), as at October 2014, the contract work for the new ATC system was still in progress. The latest estimate in July 2014 was that the new ATC system would be ready in 2015.

Other ATC equipment to support the HKIA's runway operation

1.7 The HKIA has two parallel runways which were put into operation by phases, i.e. the first one in 1998 and the second one in 1999. Over the years, the CAD has installed a number of ATC equipment to support the operation of the two runways. One of the equipment known as the precision runway monitor (PRM) radar costing $101.4 million was commissioned in 2000. However, the PRM radar has been put in standby mode since 2005.

ATC service related charges

1.8 Under the Government's "user pays" principle, the amortised capital cost and the recurrent cost for providing ATC services are recovered through:

(a) ATC service charges collected by the Government from the Airport Authority (which in turn will take into account the ATC service charges when determining the airport charges it collects from the airline operators); and

(b) en-route navigation charges (for overflying aircraft without landing at the HKIA) collected directly from airlines by the Government.

In 2013-14, the CAD collected ATC service charges of $755 million from the Airport Authority and en-route navigation charges of $265 million from airlines.

Note 4: *There was a delay in tendering the design-and-build contract of the new CAD headquarters (as none of the bids received in response to the first tender invitation met the tender requirements). However, the subsequent contract works were completed on schedule.*

Monitoring aviation safety

1.9 Safety has always been a top priority in the civil aviation industry. Hong Kong's aviation related safety legislations, rules and regulations are set in accordance with the International Civil Aviation Organization (ICAO — Note 5) standards and recommended practices. The CAD has also promulgated regulatory requirements and guidance materials for the industry to follow.

1.10 The CAD has different teams of professional grade officers to discharge its various safety regulatory functions. The CAD provides these staff with the necessary training and also publishes internal procedures for them to follow. Various CAD regulatory offices have their respective sets of audit and inspection programmes to verify if the industry partners are in compliance with the corresponding regulatory requirements. The CAD has set up an Air Traffic Management Standards Office under its Air Services and Safety Management Division (ASMD) to oversee the safety of the ATC operations on an on-going basis.

1.11 In the universal safety oversight audit conducted by ICAO in 2009, Hong Kong was found to have maintained a very high standard of safety oversight system (i.e. achieving an overall score of 94.47% as against a global average of 57.74%). Hong Kong was ranked 6th amongst over 180 states or administrations that had been audited by ICAO.

1.12 In addition to its comprehensive safety oversight system, the CAD also monitors any hazardous or potentially hazardous incidents through a mandatory occurrence reporting (MOR) scheme with a view to maintaining a close surveillance on the level of aviation safety.

Note 5: *ICAO was established under the Convention on International Civil Aviation with the objective to promote development of international civil aviation in a safe and orderly manner. It publishes standards and recommended practices in various aspects for civil aviation.*

Audit review

1.13 The Audit Commission (Audit) has recently conducted a review of the CAD's administration of the ATC and related services with a view to identifying room for improvement. The review has focused on the following areas:

(a) management of the new ATC system project (PART 2);

(b) management of the PRM project (PART 3);

(c) administration of ATC service related charges (PART 4);

(d) administration of the MOR scheme (PART 5); and

(e) way forward (PART 6).

Audit has found room for improvement in the above areas and has made a number of recommendations to address the issues.

Acknowledgement

1.14 Audit would like to acknowledge with gratitude the full cooperation of the staff of the CAD during the course of the audit review.

PART 2: MANAGEMENT OF THE NEW ATC SYSTEM PROJECT

2.1 In 2007, the CAD obtained funding of $1,565 million to replace its ATC system. According to the LegCo Finance Committee paper, the new ATC system (with a planned capacity for handling 490,000 aircraft movements in 2025 as forecast by the Airport Authority) was targeted for commissioning in December 2012. The new ATC system is a safety-critical and complex system, comprising 14 sub-systems and 3 training/simulator systems. To facilitate project management and benefit from being able to select from a wider pool of suitable individual equipment/systems in the market, the CAD implemented the new ATC system project through eight major contracts. The contracts were awarded by the Government Logistics Department (GLD) on behalf of the CAD. Details of these contracts are shown in Table 1.

Table 1

Eight major contracts for implementing the new ATC system project (31 August 2014)

Contract	Contract commencement date	Contract status as at 31.8.2014	Total estimated contract value ($ million)	Actual expenditure up to 31.8.2014 ($ million)
(a) Air Traffic Management System (ATMS) Contract variation No. 1 Contract variation No. 2	2 February 2011	Contract work in progress (Note 1)	486.0 42.4 46.8 575.2	154
(b) Air Traffic Services Data Management System	16 September 2011	(Note 2)	135	44
(c) Aeronautical Information Management System	9 December 2011	Contract work completed as scheduled with Acceptance Certificates issued	55	31
(d) Aeronautical Messaging System	13 January 2012		23	13
(e) Communication Backbone	23 April 2010		31	27
(f) Communications and Recording System	18 February 2011		126	36
(g) Relocation and Expansion of Air Traffic Services Message Handling System	16 July 2012		23	11
(h) Ancillary and Technical Support Systems	31 October 2011		65	57
		Total	1,033.2	373 (Note 3)

Source: *CAD records*

Note 1: *The ATMS contract work comprised two phases. Phase 1 contract work for operating the new ATC centre in the CAD headquarters was in progress. Completion date of Phase 1 work was originally scheduled for June 2013, which was subsequently extended to December 2013 (see para. 2.11). After completion of Phase 1 work, the transition from the existing system to the new ATC system would take another six months. Phase 2 contract work refers to the conversion of the existing air-side ATC centre into a back-up centre.*

Note 2: *Contract work for the system has been substantially completed except for the system integration with the ATMS.*

Note 3: *The difference between the total estimated contract value and the actual expenditure is attributed to:*

(a) optional maintenance service charges of $128 million have been included in the total contract value of the eight contracts which would only be payable if the maintenance service is procured;

(b) contract (a) has not yet been completed; and

(c) for contract (b), after the satisfactory completion of the system integration with the ATMS, a further contract payment of $61 million would be made.

2.2 The tender documents for the eight major contracts were prepared by the CAD, and vetted by the GLD and Department of Justice (DoJ). Except one contract which was let out by single tender as approved by the Director of Government Logistics, the other seven contracts were let out by open tenders in accordance with the Stores and Procurement Regulations. Approval of the Central Tender Board (Note 6) was given for the use of marking schemes for tender evaluation for five contracts, while no marking scheme was used for the other three contracts. Tender Assessment Panels with experienced engineering and ATC personnel were established by the CAD to evaluate the tender offers. After completion of the tender evaluation for each contract by the respective Tender Assessment Panel, each recommended tender was considered by the Central Tender Board. All the eight contracts were approved by the Permanent Secretary for Financial Services and the Treasury (Treasury) on the advice of the Central Tender Board.

2.3 Of the eight major contracts, the ATMS contract (see item (a) in Table 1 in para. 2.1) is the most complex in terms of scope, design, system software development, functional and system interoperability requirements. As shown in Table 1, the ATMS contract had experienced delay in implementation and there were two contract variations totalling $89 million (i.e. 18% of the original contract value). The other seven major contracts were substantially completed within their scheduled times and with minor contract variations.

2.4 In the funding application for the new ATC system in 2007, the Finance Committee was informed that the existing ATC system would reach the end of its usable life in 2012 and that some components of the existing system were already out of production and the system was being sustained through redeployment of existing parts where possible. However, as at October 2014, the new ATC system was not yet in operation as the ATMS contract had not yet been completed. This review examined the implementation progress of the ATMS contract with a view to identifying issues that warrant attention and the key challenges ahead.

Note 6: *From 2010 to 2012, the Board was chaired by the Permanent Secretary for Financial Services and the Treasury (Treasury), and comprised four members including the Director of Government Logistics, Deputy Secretary for Development (Works)2, Legal Adviser (Works), Development Bureau and Deputy Secretary for Financial Services and the Treasury (Treasury)3.*

Implementation progress of the ATMS contract

2.5 In 2007, the CAD set up a dedicated project team to oversee the preparation and implementation of new ATC system project (see para. 1.6). In 2007 and 2008, the project team conducted six visits of various aviation authorities to learn from their experiences in planning and operating the ATC centres and state-of-the-art systems for drawing up suitable requirements in the tender documents. Table 2 is a chronology of key events in implementing the ATMS contract.

Table 2

Chronology of key events in implementing the ATMS contract

Date	Key event
November 2009	Tender invitation
February 2011	Contract awarded
May 2011	Detailed Design Review
January 2012	The CAD submitted a request for contract variation No. 1 to the GLD for the GLD Tender Board (Note)'s approval
June 2012	The GLD Tender Board approved contract variation No. 1
July 2012	Factory Acceptance Tests conducted
February 2013	The ATMS contractor submitted Site Acceptance Tests Procedures
June 2013	• The CAD submitted a request for contract variation No. 2 to the GLD for the GLD Tender Board's approval • Factory Acceptance Tests conditionally accepted by the CAD
October 2013	The GLD Tender Board approved contract variation No. 2
August 2014	Site Acceptance Tests started

Source: CAD records

Note: The GLD Tender Board chaired by the Director of Government Logistics is the authority for approving contract variation with accumulated values up to 30% of the original contract value.

Contract variation No. 1

2.6 At the Detailed Design Review stage in mid-2011, the CAD and the ATMS contractor identified areas for improvement in the ATMS on operational efficiency and safety grounds. After various discussions with the ATMS contractor, the CAD in January 2012 submitted a request to the GLD to seek the GLD Tender Board's approval for acquiring the following additional requirements in the ATMS by way of contract variation:

(a) enhancement of the scope of data synchronisation between the live system and the ultimate fallback system;

(b) enhancements of aircraft arrival sequence logic and human-machine interface for handling of missed approach flights, and improving operational efficiency of coordination among various operational units within the CAD as well as interoperability with the neighbouring ATC centres; and

(c) simulator system expansion by increasing the number of simulator training and input operator positions from 32 to 48.

2.7 According to the CAD, the additional requirements were not included in the original ATMS contract because:

(a) the enhancement of the ultimate fallback system (item (a) of para. 2.6) and new ICAO requirements (such as adequate Air Traffic Management contingency arrangements for the Asia-Pacific Region) were introduced after the tender closing of the ATMS contract;

(b) the system enhancements (item (b) of para. 2.6) were related to new functions added to the existing ATC system/operation over a three-year period after the tendering of the ATMS in 2009. Therefore, these functions were not included in the original contract; and

(c) the simulator system (item (c) of para. 2.6) was originally planned for share-use for training of air traffic controllers and evaluating the ATC procedures. After award of the ATMS contract, detailed training need analysis for the new system had been conducted and more training time

than originally planned was found necessary for the newly introduced features/functionalities. As regards procedure evaluation, due to steady air traffic growth in the Hong Kong Flight Information Region and positive development in Pearl River Delta airspace in recent years, additional efforts in procedure evaluation were required which could not be foreseen when inviting tenders for the ATMS contract in 2009.

2.8 The CAD also provided the following justifications to the GLD Tender Board for meeting the additional requirements through a contract variation:

(a) the ATMS was a complex and mission-critical system. Modifications on the proprietary software supplied by the ATMS contractor were required. The software was covered by exclusive intellectual property rights over the source codes. There was no other potential and suitable supplier with such technical expertise who could provide the service;

(b) for compatibility/interchangeability of the additional requirements with the existing equipment and services of the ATMS, it was not cost-effective and had risks if the variations were managed/implemented under a separate contract; and

(c) variation of the existing contract, instead of entering into a new contract with the ATMS contractor, was preferred as the requirements could be met under the same terms and conditions of the current contract (i.e. the target completion date of contract would remain unchanged).

In June 2012, the GLD Tender Board approved contract variation No. 1 at a cost of $42.4 million (or 8.7% of the original contract value).

Contract variation No. 2

2.9 During the procedure evaluation and training sessions of the ATMS (commencing in August 2012), the CAD identified the need to implement further system enhancements to improve the operational efficiency (see para. 2.10(a)) as well as to meet new requirements of the ICAO Global Air Navigation Plan

(GANP — Note 7) and Regional Performance-based Navigation Implementation Plan (PBN — Note 8) (see para. 2.10(b)).

2.10 In June 2013, the CAD submitted a request to the GLD to seek the GLD Tender Board's approval for a second contract variation to implement further system enhancements. According to the CAD, these enhancements were not covered in the original contract or contract variation No. 1 because:

(a) with the evolution of the project and more insight gained from the hands-on experience during the training sessions, new or enhanced functionalities (in particular functions in air traffic flow management and human-machine interface) were found necessary to improve the operational efficiency and competency of the air traffic controllers in managing the increased airspace capacity which would in turn enhance flight safety; and

(b) the enhancements were related to meeting the new requirements of ICAO viz. the GANP (which was endorsed in November 2012) and PBN.

2.11 The CAD also informed the GLD Tender Board that:

(a) the acquisition of the enhancements through a contract variation was appropriate for reasons similar to those of contract variation No. 1 (see para. 2.8); and

(b) the revised contract implementation plan (i.e. a deferment of the Phase 1 completion date of the ATMS by six months from June to December 2013) was acceptable.

In October 2013, the GLD Tender Board approved contract variation No. 2 at a cost of $46.8 million (or 9.6% of the original contract value).

Note 7: *The ICAO's GANP sets out the regulatory requirements, procedures and technology associated with performance improvement initiatives. Through the implementation of Aviation System Block Upgrades framework in the GANP, it is expected that civil aviation could achieve global harmonisation, increased capacity, enhanced operational efficiency and improved environment globally.*

Note 8: *The PBN for the Asia and Pacific Region provides a high-level strategy for the evolution of the navigation applications to be implemented in the short term (2008-2012) and medium term (2013-2016).*

Longer time taken for system testing than scheduled

2.12 After the issue of contract variation No. 2 in October 2013, the target completion dates of some milestones in the contract were correspondingly adjusted. A comparison of the target and actual completion dates is shown in Table 3, generally reflecting slippages.

Table 3

Target and actual completion dates of various milestones of the ATMS contract (as at October 2014)

Milestone	Target/contractual date of completion	Actual date of completion
Contract commencement	2 February 2011	2 February 2011
Detailed Design Review	11 May 2011	25 May 2011
Submission of Detailed Design Document for Government's approval	10 August 2011	7 December 2011 (see para. 2.6)
System design/manufacturing	8 February 2012	13 June 2012
Submission of Factory Acceptance Tests Procedures for Government's approval	7 March 2012	3 February 2012
Submission of Site Acceptance Tests Procedures for all equipment for Government's approval	11 April 2012	1 February 2013
Factory Acceptance Tests	18 July 2012	21 June 2013 (see para. 2.13)
Site Acceptance Tests for Phase 1 ATMS	18 October 2013*	Tests started in August 2014
Completion date of Phase 1 ATMS and system integration	20 December 2013*	Not yet commenced

Source: *CAD records*

Remarks: *Revised contractual milestone dates (i.e. by an extension of six months) due to contract variation No. 2 are marked with asterisks.*

2.13 ***Factory Acceptance Tests.*** According to the contract provision, the purpose of the Factory Acceptance Tests was to demonstrate that under the simulated environment specified in the agreed test procedures, the ATMS would generally be compliant with the technical and operations requirements specified in the Final System Specification. The Factory Acceptance Tests were initially scheduled for completion on 18 July 2012. However, during the Factory Acceptance Tests conducted between 18 June and 18 July 2012, a total of 204 deficiencies/observations were recorded. The CAD requested the ATMS contractor to rectify the problems and conducted further tests between July and October 2012 to verify the rectification work. However, it turned out that the further test results were not up to the CAD's expectation. The ATMS contractor continued its rectification work, and by June 2013, 181 of the above 204 deficiencies/observations had been rectified with only 23 still outstanding. On the other hand, another 104 deficiencies/observations were newly identified during the verification process. In view of the successful rectification of a large number (181) of deficiencies/observations and the ATMS contractor's undertaking to rectify and verify all the remaining 127 outstanding deficiencies/observations (23 plus 104) by the Site Acceptance Tests stage, the CAD conditionally accepted the Factory Acceptance Tests results.

2.14 ***Site Acceptance Tests.*** According to the contract provision, the purpose of the Site Acceptance Tests was to demonstrate that the system was capable of complying with every clause of contract specifications. The Site Acceptance Tests Procedures were due for submission on 11 April 2012. However, the first set of Site Acceptance Tests Procedures was not submitted until 1 February 2013 (see Table 3 in para. 2.12). According to the CAD, with experience gained during the Factory Acceptance Tests, it was agreed between the CAD and the ATMS contractor that scenario-based test should be included in the Procedures. The scenario-based test, using live traffic as far as practicable, would enable more thorough checks on the system functions, performance and reliability as it would emulate live operations. Since March 2013, the ATMS contractor had made several submissions of the Site Acceptance Tests Procedures and they were agreed in May 2014. The Site Acceptance Tests commenced in mid-August 2014 (Note 9).

Note 9: *According to the CAD, the tests commenced after necessary site preparation and demonstration by the ATMS contractor of its readiness for the tests.*

2.15 ***Delay in commissioning the new ATC centre.*** In July 2013, in response to enquiries from a Member of the LegCo Panel on Economic Development, the Transport and Housing Bureau said that:

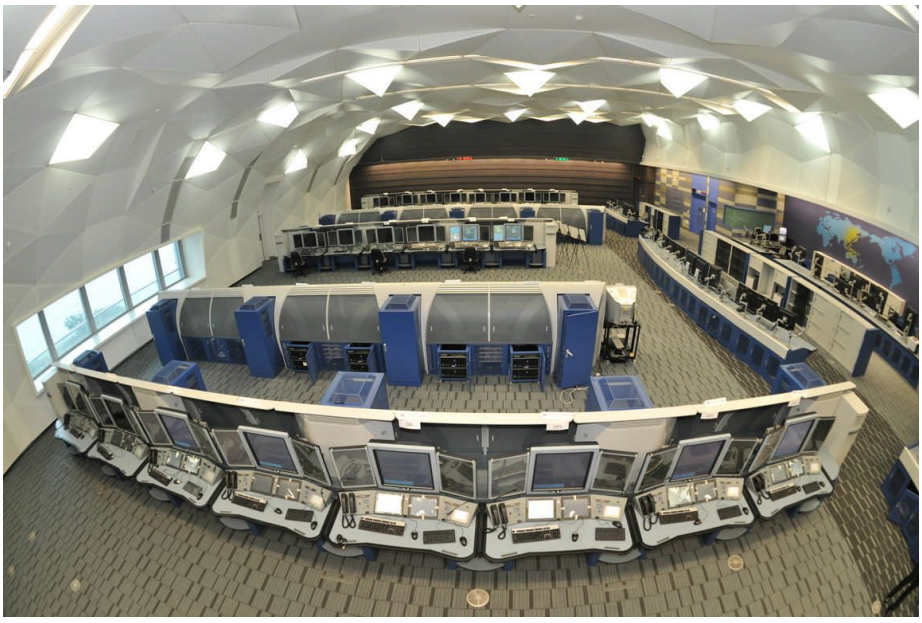
(a) due to delay in tendering the contract of the new CAD headquarters (which houses the ATC system — see Note 4 to para. 1.6) coupled with the need to optimise the new ATMS and the longer time taken to test and evaluate the system than expected, commissioning of the new ATC centre (of 900 square metres) could not commence in December 2012 as originally scheduled (in the Finance Committee's paper of May 2007). Installation of other systems had been substantially completed and acceptance tests were in progress; and

(b) it was expected that enhancement and functional testing of the ATMS would be completed in the first quarter of 2014 and the earliest operation of the new ATC centre was estimated to be in the second half of 2014.

However, due to longer time taken to rectify the deficiencies (see paras. 2.16 to 2.18), in July 2014, the ATMS contractor estimated that the new ATC system would only be ready for operation in 2015. Photograph 1 is a picture of the new ATC centre with ATC equipment installed but not yet put into use.

Photograph 1

New ATC centre



Source: CAD records

Challenges ahead

Outstanding deficiencies/observations in the ATMS

2.16 According to the conditions of the CAD's acceptance of the Factory Acceptance Tests results in June 2013, the rectification and verification of the 127 outstanding deficiencies/observations were scheduled for completion by the Site Acceptance Tests stage. Audit noted that the CAD had been continuously monitoring the progress of the rectification/verification work, and had raised concern with the ATMS contractor on whether these deficiencies/observations could be cleared prior to the commencement of the Site Acceptance Tests. In response, the ATMS contractor informed the CAD that:

(a) the outstanding items had been reviewed and action would be taken to address the software changes prior to the commencement of the Site Acceptance Tests; and

(b) additional personnel resources would be added to address the deficiency/observation backlog.

2.17 Based on CAD records, between July 2013 and June 2014, only 51 (40%) of the 127 outstanding deficiencies/observations had been rectified. Meanwhile, during user's training and testing sessions, the CAD collected some 1,100 comments from its staff. As at mid-June 2014, 420 of these comments remained outstanding and required follow-up with the ATMS contractor. According to the CAD, it is not unusual to have a considerable number of non-safety critical system observations for a highly complicated and large-scaled system.

2.18 Site Acceptance Tests are on the critical path of the ATMS contract. The revised target completion date of the Site Acceptance Tests was October 2013. However, the Tests only commenced in mid-August 2014 (see para. 2.14). The considerable number of outstanding deficiencies/observations in the ATMS remaining to be followed up during the Site Acceptance Tests is a risk area that needs to be properly managed to ensure the successful delivery of the new ATC system and to minimise further project delay.

Operation issues of the existing ATC system

2.19 In the funding application of 2007, the Finance Committee was informed that the existing ATC system would reach the end of its usable life in 2012 and that some components of the system were already out of production and the system was being sustained through redeployment of existing parts where possible (i.e. limiting the scope for expansion of capacity and posing constraints on maintenance). However, due to the delay in implementing the ATMS contract mentioned above, the existing ATC system will have to be used until the new ATC system is available, possibly up to 2015 (see para. 2.15). This is another risk area that needs to be addressed as evidenced by the following operational issues:

(a) ***Operating above the planned capacity.*** The planned capacity of the existing ATC system in terms of the number of active flight plans it can handle at any one time is 1,000. Based on the CAD's statistics, during the period from January to June 2014, there were a total of 122 days (67% of the 181 days) on which the number of active flight plans actually handled was above the planned capacity of 1,000 (see Table 4). According to the CAD, since flight plans are required to be submitted well before the actual flight departures/arrivals, effective measures have been taken to even out the flight plans processing work by putting them in the wait queue if the number of flight plans received is above the processing capacity of the system; and

Table 4

Number of days with active flight plans handled above the planned capacity of 1,000 (January to June 2014)

Month	Number of days with active flight plans handled above 1,000	Range of flight plans handled	Average number of hours in a day with active flight plans above 1,000
January 2014	21	1,014 – 1,086	3.0
February 2014	24	1,002 – 1,104	3.9
March 2014	21	1,006 – 1,074	1.8
April 2014	25	1,002 – 1,110	3.6
May 2014	17	1,004 – 1,060	1.3
June 2014	14	1,016 – 1,120	3.0
Overall	122	1,002 – 1,120	2.8

Source: Audit analysis of CAD records

(b) ***Increasing number of surveillance data display problems.*** Since 2000, the CAD has introduced a system availability target of 99.9% to measure and give an early alert of the performance of the ATC system. One of the functions of the ATC system is to display various data (including flight data and surveillance data) for air traffic controllers' operation. In 2011, the CAD also introduced a safety performance indicator to measure the 12-month moving average of the number of surveillance data display problems (i.e. frozen/hang-up) on individual console positions. Based on the CAD's statistics, while the ATC system availability had been consistently above 99.9% which was in full compliance with the international best practice, there was an increasing trend in the number of display problems of the existing ATC system from January 2011 to June 2014 (see Figure 2). During the 12-month period from September 2012 to August 2013, there were actually 10 months in which the number of display problems had exceeded the then safety performance indicator of "six". The CAD considered that the increasing number of display problems was attributable to:

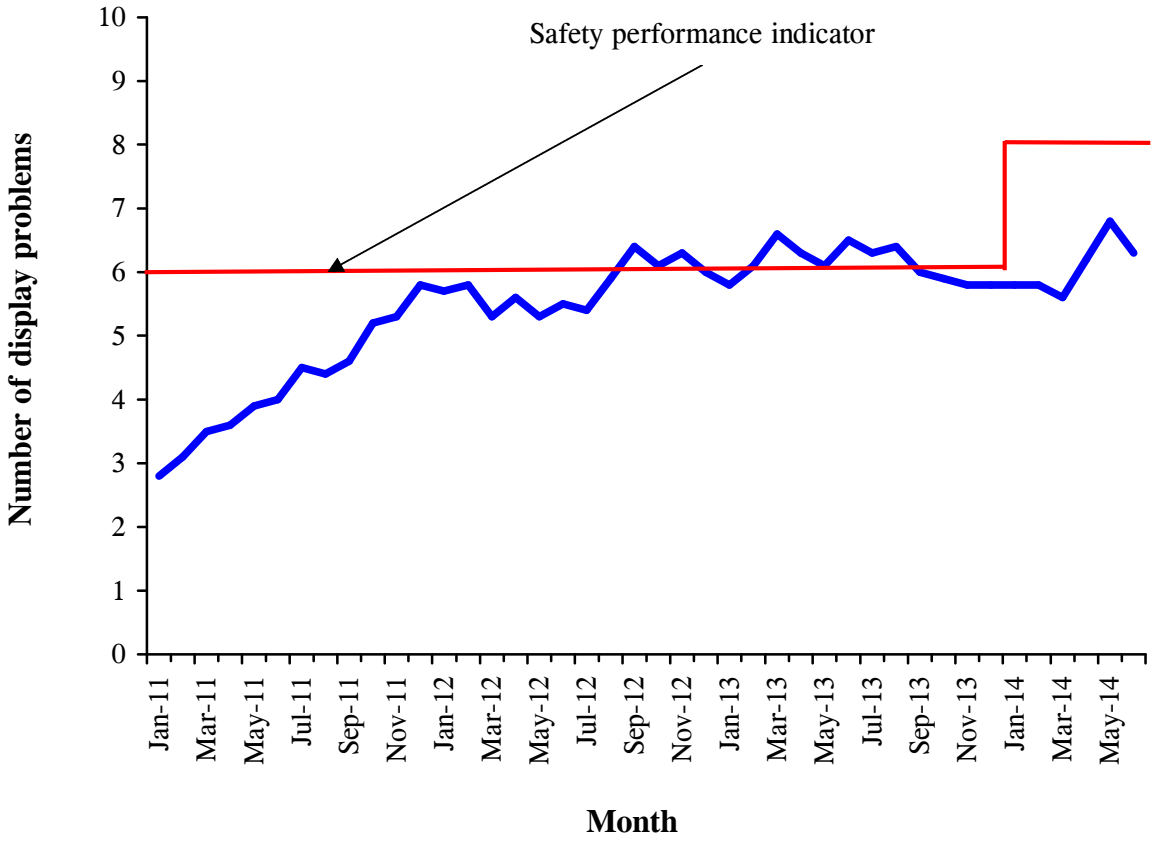
(i) insufficient cooling/ventilation at surveillance data display consoles due to inherent weaknesses in the design of existing building layout which might not provide the best operating environment, particularly for 24-hour operation of the ageing hardware equipment;

(ii) continuous increase in air traffic leading to higher system loading in terms of more frequent key strokes and heavier local area network traffic, especially at busy control positions; and

(iii) ageing effect in the hardware of surveillance data display after continuous operations of almost 16 years with spare parts no longer available from the market, but from the CAD's stock.

Figure 2

12-month moving average
number of surveillance data display problems
(January 2011 to June 2014)



Source: *Audit analysis of CAD records*

Remarks: *Since January 2014, the CAD has revised the safety performance indicator from six to eight until the commissioning of the new ATC system.*

2.20 While the CAD had put in place measures to meet the 99.9% ATC system availability target, the ageing effect of the existing ATC system was becoming more apparent as evidenced by the increasing number of surveillance data display problems. There were also occasions that flight plans had to be put in the wait queue. The CAD needs to take measures to address these issues.

Areas for improvement

Additional requirements after contract award

2.21 In September 2013 when processing the application for contract variation No. 2, the GLD Tender Board queried if the CAD had critically reviewed its requirement to procure all essential items during the first contract variation. The Board pointed out that the practice to seek multiple contract variations was very unsatisfactory as the CAD should have included all essential requirements in the tender specifications of the ATMS in the first place and to ensure value-for-money purchase for the Government. The Board suggested that the CAD should review its tendering strategy and better plan its purchases in the future to take into account additional requirements in the pipeline. In this connection, Audit noted that for the PBN related enhancement (see para. 2.9) included in contract variation No. 2, the PBN was endorsed by ICAO in September 2011, i.e. before the CAD sought approval for contract variation No. 1 in January 2012. In response to Audit enquiry, the CAD said that it had taken some 9 to 12 months to develop and finalise the operational procedures prior to establishing the technical and functional requirements and hence the CAD could not incorporate the requirements into contract variation No. 1. In Audit's view, the CAD needs to make greater efforts to include additional user requirements in the contract work at the earliest possible opportunity.

Need for a ceiling on project estimate

2.22 The CAD obtained the Finance Committee's approved funding of $1,565 million for the new ATC system project. It turned out that the total contract value of the eight major contracts under this project (including contract variations) only amounted to $1,033.2 million. Audit understands from the CAD that while there would be further procurement of spares, operational and technical training packages and other ancillary systems/facilities such as front-end processor system under the ambit of the new ATC system project commitment, it is likely that significant unused funds would remain in the project commitment. To tighten financial control, the Financial Services and the Treasury Bureau (FSTB) needs to consider imposing an expenditure ceiling on the project estimate of the ATC system where the spending is projected to be significantly lower than the approved project estimate.

Audit recommendations

2.23 **Audit has *recommended* that the Director-General of Civil Aviation should:**

(a) **in conjunction with the ATMS contractor, expedite action in rectifying the outstanding deficiencies/observations in the ATMS and closely monitor the remaining contract work to minimise further project delay;**

(b) **step up maintenance efforts to address surveillance data display problems (frozen/hang-up) in the existing ATC system;**

(c) **continue the efforts to deal with the issues of operating the existing ATC system until the new ATC system is available; and**

(d) **include all user requirements with time implication in a contract so that the contractor can factor in such requirements in his work programme, and for those requirements arising after the award of contract, make greater efforts to include them in the contract work at the earliest possible opportunity.**

2.24 **Audit has *recommended* that the Secretary for Financial Services and the Treasury should consider imposing an expenditure ceiling on the unused project estimate of the ATC system.**

Response from the Administration

2.25 The Director-General of Civil Aviation agrees with the audit recommendations in paragraph 2.23. He has said that:

(a) the CAD had been tracking the progress with the ATMS contractor on the outstanding items from the Factory Acceptance Tests (see para. 2.16) for early rectification through various channels, including the weekly teleconference between senior management of the two parties;

(b) with the measures taken to even out the flight plans processing work (see para. 2.19(a)), the system availability had been consistently above 99.9% which was in full compliance with the international best practice; and

(c) regarding the display problems in paragraph 2.19(b), the CAD had taken proactive maintenance programme since 2010 to maintain the surveillance data display availability consistently above 99.9%. To minimise disruption to air traffic controllers' work, the CAD had put in place both operational and engineering arrangements such that air traffic controllers could make use of the adjacent data display or backup data display to continue with the work in the event of a display problem, which could be resolved within a short period of time.

2.26 The Secretary for Financial Services and the Treasury agrees with the audit recommendation in paragraph 2.24. He has said that he has no objection to imposing an expenditure ceiling on the revised project estimate of the ATC system given that ATC system is one of the very few capital non-works projects with a commitment involving more than $1,000 million. That said, he would like to supplement with the following information on the ATC system as a capital non-works project:

(a) according to Financial Circular No. 2/2012 "Procedures for making changes to the Estimates of Capital Works Reserve Fund", the CAD is not allowed to deploy any surplus in the project estimate to fund other expenditure items outside the ambit;

(b) the CAD is required to indicate the estimated cash flow requirement for the project on a yearly basis in the context of the draft estimates for Capital Works Reserve Fund for the budget year. The difference between the approved project estimate and the current estimate upon award of contract is not a genuine surplus which the CAD could make use of for any other purposes; and

(c) the existing mechanism of imposing an administrative cap on capital works projects is only an internal arrangement as bureaux/departments are allowed the flexibility of seeking to increase the cap where necessary. This should also apply to the ATC system.

PART 3: MANAGEMENT OF THE PRM PROJECT

3.1 This PART examines the CAD's management of the PRM project and suggests areas for improvement.

Implementation of the PRM project

3.2 In June 1996, the Administration obtained funding of $602 million in money-of-the-day prices (Note 10) from the Finance Committee to procure additional special equipment and systems and construct additional government facilities to support the operation of the second runway of the HKIA. Included in the funding application was a PRM radar and a building cum tower (subsequently known as ATC back-up tower) to house the PRM radar and an ancillary ATC centre for contingency use, and to provide space for office and equipment rooms for the CAD and other government departments. The estimated cost was $90.1 million for the PRM radar. In the funding application submitted to the Public Works Subcommittee (PWSC) of the Finance Committee, Members were informed that:

> *"The PRM radar is required to monitor aircraft to guard against any deviations from their flight paths under independent operation (i.e. landings and departures on both runways) enabling full utilisation of the capacity of the two runways. Without this PRM radar, the airport can only be operated under restricted segregated mode (i.e. one runway used exclusively for aircraft landings and the other used exclusively for aircraft departures but not at the same time, i.e. staggered use of the two runways will be necessary) and its capacity will be limited to 50 movements per hour which is*

Note 10: *Money-of-the-day prices were the estimated costs of the project after allowing for forecast increases in prices. The capital cost of works of the $602 million was made up of:*

- *(a) PRM radar and other ATC equipment for the CAD ($229.4 million);*
- *(b) meteorological equipment for the Hong Kong Observatory ($34.9 million);*
- *(c) building and airfield facilities including the tower to house the PRM radar ($192.9 million);*
- *(d) contingency ($22.8 million); and*
- *(e) inflation allowance ($122 million).*

expected to be exceeded by the forecast traffic demand around 2000-01. The PRM must therefore be available before traffic demand exceeds runway capacity under restricted segregated mode."

3.3 The target commissioning of the PRM radar was September 1999, i.e. about a year after the target commissioning of the second runway in October 1998. In the event, the second runway and the PRM radar were commissioned in May 1999 and January 2000 respectively. The actual expenditure of the PRM radar was $101.4 million (i.e. $11.3 million more than the estimated cost due to higher than expected tender prices). A picture of the PRM radar on top of the ATC back-up tower is shown in Photograph 2.

Photograph 2

The PRM radar on top of the ATC back-up tower

Source: CAD records

3.4 ***Runway operation mode.*** Ever since the second runway came into operation in 1999, the segregated mode of operation has been adopted, i.e. with the north runway used exclusively for arrival and the south runway for departure (see Figure 3). Only when weather conditions permit would the south runway be used for landing (mainly freighters and light aircraft), i.e. the operation on the south runway is similar to dependent mixed mode of operation (see para. 3.8(b)).

Figure 3

Segregated mode of operation of the HKIA's runways

Source: *CAD records*

Remarks: *The direction of runway operation depends on the wind direction. Under normal circumstances, aircraft have to take-off and land against the direction of wind. In simple terms, when the wind blows from the southwest direction, aircraft will land and take-off from the northeast. When northeasterly winds prevail, the runways have to be operated in reverse direction (i.e. southwest) for take-off and landing.*

Utilisation of the PRM radar

3.5 In September 1999, the CAD started to explore the functions of the PRM radar and associated operation procedures with a view to resolving any safety-related issues before implementing the PRM project. The CAD noted that the PRM radar could be used for monitoring the arrival of aircraft in the following three ways:

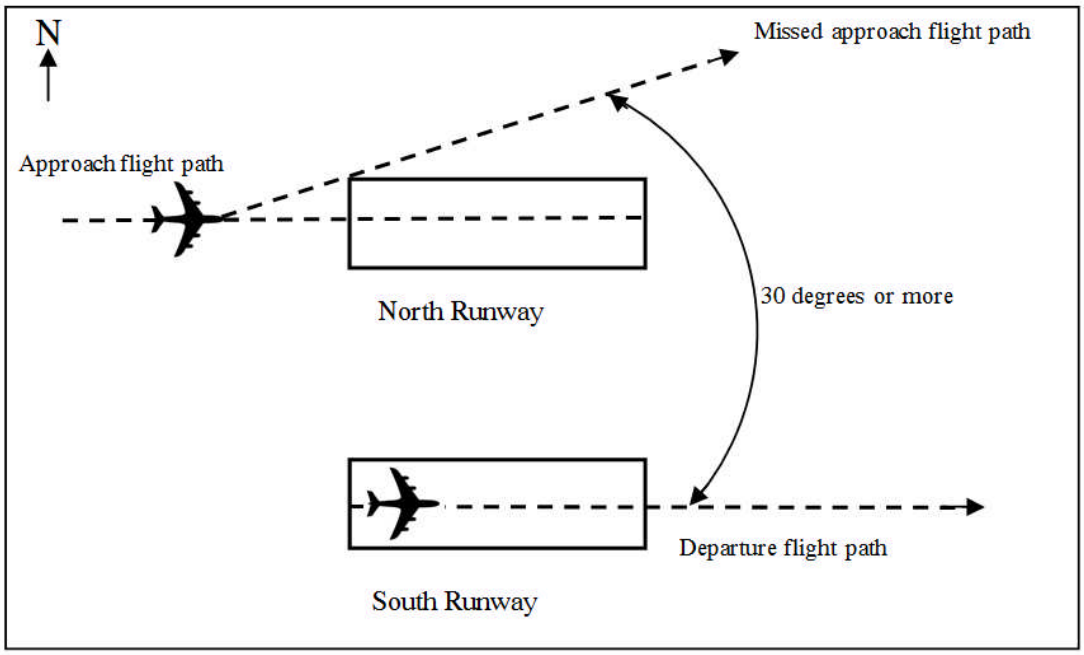
(a) ***Providing essential distance information.*** The two runways of the HKIA were each equipped with an instrument landing system to provide accurate guidance signals for use by aircraft for landing under all weather conditions. An integral part of the instrument landing system was a distance measurement equipment which provided essential distance information to pilots. The PRM radar could provide such essential distance information when the distance measurement equipment was out of service (e.g. under maintenance);

(b) ***Monitoring final approaches.*** When the north runway was used for landing from the northeast (see Remarks of Figure 3 in para. 3.4) during a busy traffic session, there could be occasions when arrival aircraft were each separated with a minimum distance of three nautical miles. The high speed and high precision performance of the PRM radar would be of considerable help to the air traffic controllers in monitoring and ensuring the minimum separation between aircraft on final approach; and

(c) ***Monitoring missed approaches in relation to departures.*** Because of the terrains around the airport, there was insufficient airspace to meet the ICAO's requirement of a 30 degrees divergence between a missed approach aircraft (towards the north runway) and a departing aircraft (from the south runway) when the two runways were used in the southwest direction (see Figure 4). The CAD expected that with the PRM radar, it could closely monitor the departing aircraft and the aircraft on missed approach to ensure safety by giving prompt warning to aircraft deviating off track.

Figure 4

The ICAO requirement on missed approach flight path in relation to departure flight path



Source: Adapted from ICAO manual

3.6 The PRM radar was used for the above three purposes commencing from March 2001 (i.e. about 15 months after the commissioning of the PRM radar — Note 11). However, in December 2002 (20 months later), the use of the PRM radar for monitoring missed approaches in relation to departures (see para. 3.5(c)) was discontinued because the CAD found an alternative solution for meeting the ICAO's requirement by streamlining the flight procedures. In January 2005 (another two years later), the CAD also discontinued the use of the PRM radar for the remaining two purposes (see para. 3.5(a) and (b)). According to the CAD:

Note 11: *According to the CAD, during January 2000 and March 2001, time was spent on optimising the system for operational use, evaluating and finalising the ATC PRM operations procedures, publishing internal and flight operations notifications, and training up air traffic controllers. All the tasks were completed in mid-February 2001.*

(a) air traffic controllers responsible for monitoring approaching aircraft could also provide essential distance information to pilots by using other radars when the distance measurement equipment was not in working order;

(b) because of operational experience gained, pilots and air traffic controllers had become more conversant with the landing procedures and the speed control measures. As a result, deviation from the target minimum spacing was rare and separation assurance could be achieved without PRM monitoring; and

(c) under the circumstances, the PRM radar had been put into standby mode from January 2005 onwards. As a result, the annual maintenance cost of the PRM radar had been reduced from the previous $1.1 million to the present level of $0.2 million.

3.7 Audit noted that since its commissioning in 2000, the PRM radar had not been used to support the independent mixed mode operation of the HKIA's runways, i.e. the intended use of the PRM radar to maximise the runway capacity stated in the funding application of June 1996 (see para. 3.2). The HKIA's runways had continued to be operating under the segregated mode (see Figure 3 in para. 3.4). Audit examination of CAD records and enquiries with the CAD revealed that there were various constraints (such as terrain and technology limitations) that needed to be overcome before the independent mixed mode could be put into operation for any capacity gain (see paras. 3.8 to 3.12).

Constraints in adopting independent mixed mode of operation

1990 New Airport Master Plan Study

3.8 In 1990, the then Provisional Airport Authority (Note 12) commissioned a consultancy study (i.e. the 1990 New Airport Master Plan Study) to prepare a comprehensive and environmentally acceptable scheme for the planning and implementation of the HKIA. Regarding the parallel runway system, five different modes of operation were studied:

(a) ***Segregated mode of operation.*** One of the runways would be used for arrivals, and the other for departures (i.e. the current mode of operation of the HKIA);

(b) ***Dependent mixed modes of operation.*** Under dependent mixed operation mode, both arrivals and departures would occur on each of the two runways. Depending on the extent to which aircraft on both runways had to be coordinated with one another, there could be three different types of dependent mixed operation modes, viz. Dependent Approaches and Departures mode, Independent Approaches and Dependent Departures mode, and Dependent Approaches and Independent Departures mode; and

(c) ***Independent mixed mode of operation.*** Independent mixed operations would allow each runway to function separately and without coordination with operations on the other runway, as if the runways were two different airports.

3.9 ***Implementation issues.*** Regarding the implementation of various operation modes, the 1990 New Airport Master Plan Study found that:

Note 12: *The Provisional Airport Authority was a statutory body set up in 1990 to prepare for the development of the HKIA. With the enactment of the Airport Authority Ordinance in 1995, the Provisional Airport Authority was reconstituted as the Airport Authority to carry forward the planning, funding, development and management of the HKIA.*

(a) ***Constraints.*** While there was no constraint in using the segregated mode and dependent mixed mode of operation, the following constraints were envisaged in implementing independent mixed mode of operation (see para. 3.8(c)):

(i) for independent departures, due to two peaks in the Tai Yam Teng and Fa Peng Teng areas of northeast Lantau Island (see Figure 5), the ICAO requirement (see Figure 6) could not be met when the runway operated in the northeast direction. Consideration should be given to terrain removal to facilitate independent departures in future (i.e. excavation of the two peaks by 11 metres and 60 metres respectively — also see para. 3.12(c)); and

(ii) for independent approaches, the ICAO regulation (see Figure 7) required that in the event of an aircraft heading off course from the north runway during approach (i.e. a missed approach), the arriving aircraft on the south runway would have to turn to the south. However, the terrain of the Lantau Island might block the aircraft in making such a south turn; and

(b) ***Proposed use of a new PRM radar.*** Independent mixed mode operation could be possible in the future when the ICAO standards and aircraft flight control navigation/surveillance technology had been well developed to a state that would facilitate such mode of operation. The Consultant proposed the use of a PRM radar at the HKIA to:

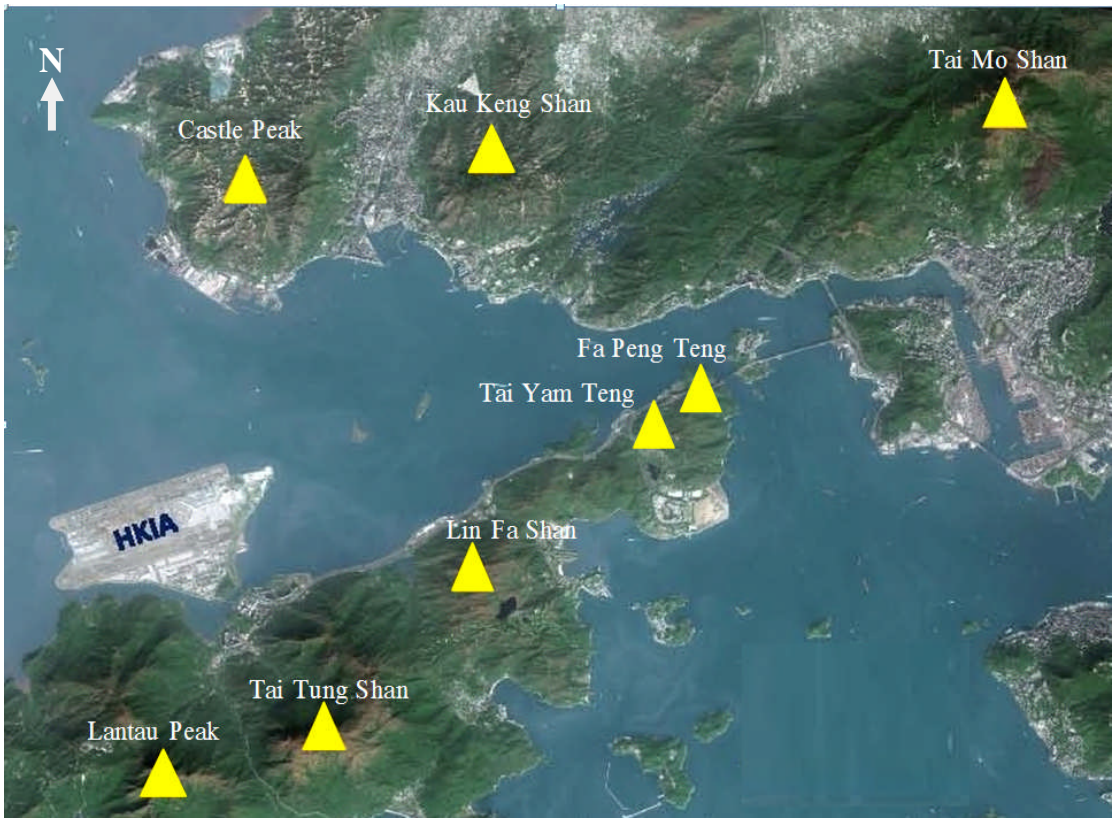
(i) monitor independent approaches and departures to and from the two runways;

(ii) monitor separation of aircraft from high terrain and from other aircraft; and

(iii) provide redundant coverage for the approach surveillance radar already planned for the HKIA.

Figure 5

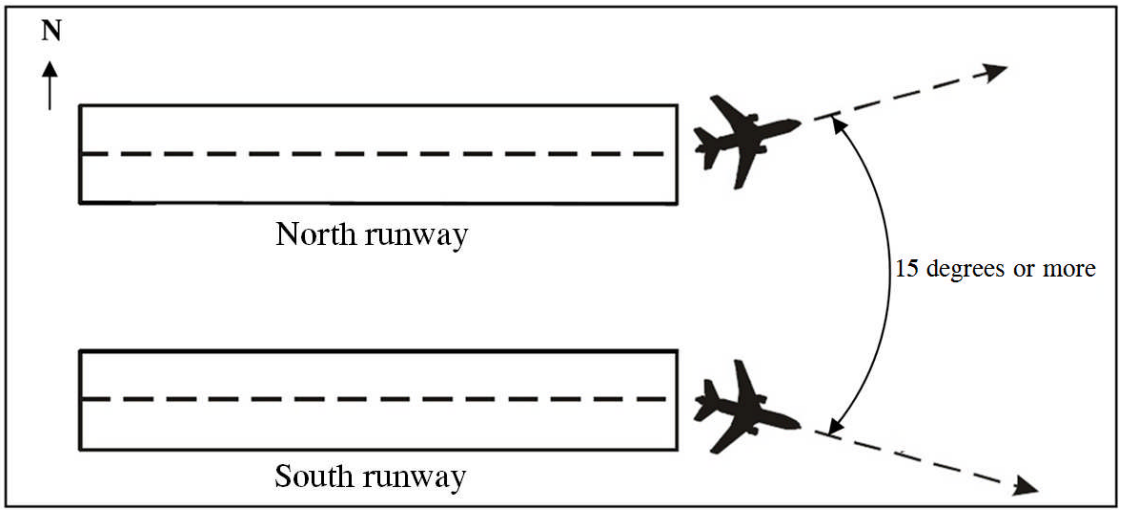
High terrain in south and northeast of the HKIA



Source: Adapted from CAD records

Figure 6

The ICAO requirement on flight paths under independent departures

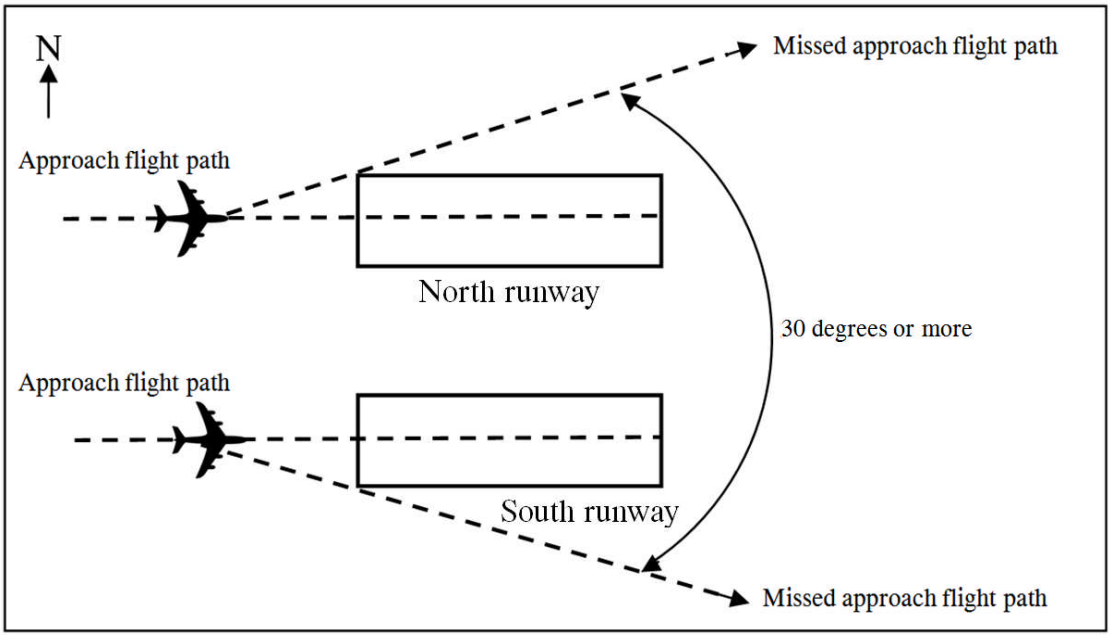


Source: *Adapted from ICAO manual*

Remarks: *The ICAO regulation requires that for departures under independent mode of operation, the flight paths of two departing aircraft must be at least 15 degrees apart immediately after take-off. Under the situation described in paragraph 3.9(a)(i), the flight path of aircraft taking off from the south runway might be blocked by the two peaks in Tai Yam Teng and Fa Peng Teng areas.*

Figure 7

The ICAO requirement on flight paths under independent approaches



Source: *Adapted from ICAO manual*

Remarks: *The ICAO regulation requires that for approaches under independent mode of operation, the missed approach flight paths of two aircraft must be at least 30 degrees apart. In the situation described in paragraph 3.9(a)(ii), the aircraft approaching the south runway should be directed to the south in order to meet the requirement. However, due to the terrain of Lantau Island, the aircraft could not make such a turn.*

1994 Airspace Design Study

3.10 In 1994, the CAD commissioned a consultancy study (i.e. the 1994 Airspace Design Study) on the detailed flight procedures and airspace allocations for the HKIA. Regarding the operation of the two runways at the HKIA, the Study found that:

(a) new technology and the ICAO procedures to permit simultaneous independent operations expected in earlier airport master plan studies had not happened; and

(b) there was no acceptable solution for total independent mode of operation due to natural obstructions, south and northeast of the HKIA (see Figures 5 to 7 in para. 3.9).

2008 Airspace and Runway Capacity Study

3.11 In order to enhance the airspace and runway capacity, a consultancy study in this regard was commissioned by the Airport Authority in 2008 and validated by the CAD. The Study re-confirmed that constraints on independent mixed mode of operation at the HKIA as reported in previous studies were still valid. The 2008 Study also found that, based on the ICAO's standards and analysis of other factors, such as the surrounding terrain, the operating environment, the infrastructure and the airspace of the HKIA, the practical maximum capacity of the two runways of the HKIA under segregated mode of operation was 68 movements per hour, which could be attained through a series of enhancement measures. It was concluded that there would not be further capacity gain by changing the runway operation to the more complicated dependent mixed modes of operation.

Audit enquiry with the CAD

3.12 Between July and October 2014, in response to Audit enquiries concerning the procurement decision of the PRM radar and the actions taken to address the constraints in adopting the independent mixed mode of operation, the CAD said that:

(a) although the 1994 Airspace Design Study was not able to identify a viable solution to the constraints, the use of new aviation technologies, including the PRM radar to mitigate the risks in adopting independent approach (see para. 3.9(a)(ii)), had not been ruled out by the CAD. The PRM radar had a very high update rate compared with conventional radar and could enhance the ATC surveillance capability. It was considered at the time of the procurement that its application could facilitate the adoption of independent mixed mode of operation at the HKIA;

(b) subsequent to the 1994 Airspace Design Study, the CAD noted that PRM radars could be used to enhance dual runway operations and meet the need for traffic growth. The CAD also noted that, based on the forecast traffic demand in 1996, the aircraft movements at the HKIA were expected to increase beyond the limit of 50 movements per hour under the segregated mode of operation by about 2001. A decision was therefore made in 1995 to make the purchase and funding approval was obtained in 1996. Visits to PRM installations in two overseas airports in 1997 reinforced the CAD's belief that the PRM radar was a practical means to enhance airport capacity under a constrained environment; and

(c) the CAD's subsequent assessment indicated that the extent of obstructing terrain on northern Lantau which would need to be removed was much more extensive than that estimated in the 1990 Study, rendering the independent mixed mode of operation at the HKIA not practicable through terrain removal.

Areas for improvement

3.13 Before seeking funding for the PRM radar in 1996, the CAD had been made aware of the constraints in adopting independent mixed mode of operation to maximise the utilisation of the capacity of the HKIA's dual runways by two consultancy studies in 1990 and 1994. In particular, the 1994 Study pointed out that there was no acceptable solution for total independent mixed mode of operation due to terrain obstructions, south and northeast of the HKIA. However, the CAD proceeded with the procurement of the PRM radar in the belief that there might be advancement in technology to permit simultaneous independent operations and the PRM radar could then support independent mixed mode of operation. In the event, the expected changes in technology did not happen. As a result, the PRM radar was only put into use for purposes other than supporting the independent mixed mode of operation of the HKIA's runways. Such other uses turned out to be supplemental and were discontinued after some 20 months to 4 years (see para. 3.6) thus raising the question on whether the public fund spent on the PRM radar was good value for money. The CAD needs to draw lessons from this case to improve its future management of ATC equipment projects.

Need for cost-benefit analysis

3.14 Audit noted that the CAD's decision to procure the PRM radar was based on various assumptions, including advancement in technology which were outside the CAD's control (see para. 3.12). Despite these uncertainties, there was no traceable record to show that the CAD had evaluated the project viability using a cost-benefit analysis before making the procurement decision. The CAD also could not produce records of the considerations leading to the procurement decision (Note 13). The CAD needs to strengthen its records management, in particular for major procurement decisions for better public accountability.

Need for adequate information in funding application

3.15 In the funding application of 1996, Members of the LegCo PWSC/Finance Committee were informed that the PRM radar was required for independent mixed mode of operation to enable full utilisation of the capacity of the HKIA's dual runways. However, LegCo Members were not informed of the associated constraints in adopting the independent mixed mode of operation and the implementation of which was contingent on advancement in technology. In Audit's view, it is important that both the pros and cons of a proposed project, including the potential risks inherent in the project, are provided in the funding application to enable LegCo Members to make an informed decision on whether to support the project.

Audit recommendations

3.16 **Audit has *recommended* that the Director-General of Civil Aviation should draw lessons from the PRM project with a view to improving the management of major equipment projects in future, including:**

(a) **strengthening project appraisal to ensure that all uncertainties/risks impacting on project viability are fully evaluated in a cost-benefit analysis before making procurement decisions;**

Note 13: *According to the CAD, due to the long time lapse and scattered handling offices of the PRM project, it was not certain whether the records were not available or could not be located.*

(b) **strengthening the records management of major procurement decisions for public accountability; and**

(c) **providing adequate information in the funding application for a capital project to enable the LegCo PWSC/Finance Committee to make an informed decision.**

Response from the Administration

3.17 The Director-General of Civil Aviation agrees with the audit recommendations. He has said that as concluded in the 2008 Study, the practical maximum capacity of the two runways at the HKIA under segregated mode of operation was 68 movements per hour (see para. 3.11) which could be achieved through a series of enhancements.

PART 4: ADMINISTRATION OF ATC SERVICE RELATED CHARGES

4.1 This PART examines the CAD's administration of ATC service related charges and suggests areas for improvement.

Charging arrangements for ATC services provided

4.2 Hong Kong is a contracting party to the Convention on International Civil Aviation (also known as Chicago Convention) and is responsible for providing ATC services to all aircraft operating in and out of the HKIA and within the Hong Kong Flight Information Region. The Chicago Convention provides that all contracting parties may impose reasonable charges on the aircraft for the use of such navigation services.

4.3 Under the Government's "user pays" principle, the full cost of providing ATC services is recovered through the following charges:

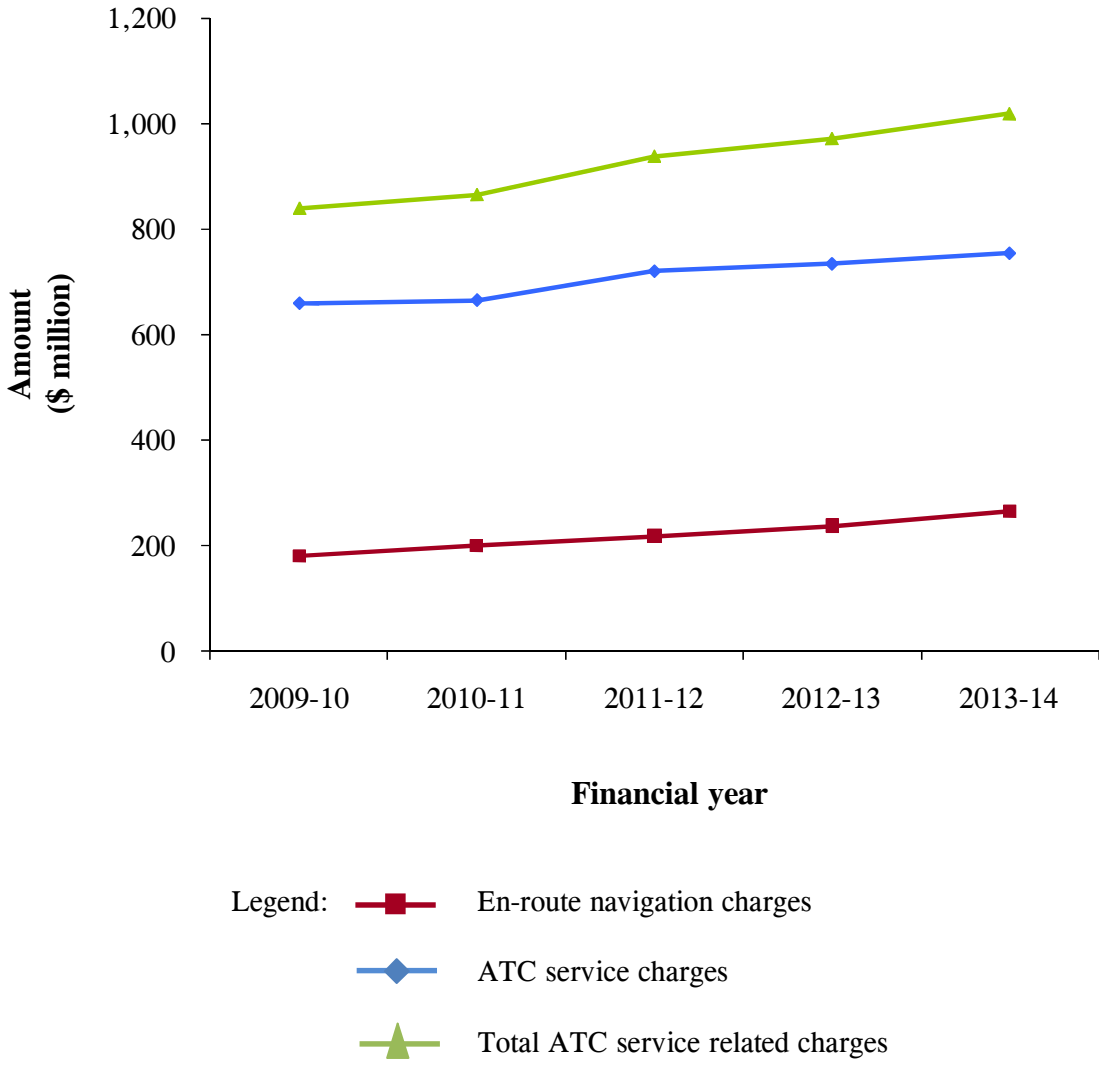
(a) ***ATC service charges.*** For ATC services provided to aircraft operating in and out of the HKIA, the CAD collects from the Airport Authority ATC service charges (based on which the Airport Authority determines the airport charges that it collects from the airline operators). In accordance with an agreement between the Government and the Airport Authority, on or before 1 September each year, the CAD is to provide the Airport Authority with an estimate of the ATC service charges for the coming financial year together with the CAD's projected cost estimates. The Airport Authority shall pay the Government the estimated ATC service charges by 12 equal monthly instalments on the 21st day of each month. Within three months after the expiry of each financial year, the CAD shall provide the Airport Authority with a statement of the final accounts showing the actual ATC service charges payable and adjustment (either by way of a refund of excess paid or a payment of any shortfall) shall be made within 60 days from the date of the delivery of the statement of the final accounts; and

(b) ***En-route navigation charges.*** For aircraft passing through the Hong Kong Flight Information Region, without landing at the HKIA, the CAD collects en-route navigation charges directly from the airlines concerned. The terms of en–route navigation charges are published in Gazette Notice as well as the CAD's Aeronautical Information Publication which are available on the Internet and open to access by all airlines. The current charge rate at $4.8 per nautical mile flown was published in the Gazette Notice of August 2000. Based on the flight data captured by its computer system, the CAD issues demand notes three times a month to cover flights from the 1st to 10th days, 11th to 20th days and 21st to the last day of the month. Demand notes for en-route navigation charges are to be settled within two weeks of the issue date.

4.4 Figure 8 shows the amount of ATC service related charges collected by the CAD from 2009-10 to 2013-14.

Figure 8

ATC service related charges collected (2009-10 to 2013-14)



Source: *Audit analysis of CAD records*

Review of en-route navigation charge level

4.5 It is the Government's policy that fees charged by the Government should be set at levels adequate to recover the full cost of providing the goods and services. The Financial and Accounting Regulations (Note 14) stipulate that Controlling Officers are responsible for ensuring that the fees and charges relating to services for which they are responsible are regularly reviewed and updated. According to Financial Circular No. 6/2006, Controlling Officers should ensure that the fee levels are conducive to achieving the target (such as full-cost recovery), taking into account fairness and friendliness to users.

4.6 Since the setting of the en-route navigation charge at $4.8 per nautical mile flown in 2000, the CAD completed four reviews of the charge level. In all the reviews, the CAD projected the charge level for the coming years based on the estimated costs of providing the service and the estimated nautical miles flown by the airlines. Based on comparisons of the projected charge levels with the existing charge level, the CAD recommended maintaining the en-route navigation charge at the current level. The FSTB agreed to the CAD's recommendations for the reviews conducted in 2001, 2008, and 2009, and rejected the CAD's proposal for the 2013 review to maintain the fee at the current level, which did not meet the full-cost recovery principle. In December 2013, the CAD submitted a revised proposal to adjust the en-route navigation charge level for 2014-15. The CAD's revised proposal was accepted by the FSTB in March 2014.

4.7 Audit noted that after implementing the en-route navigation charge level as recommended in each fees and charges review (i.e. maintaining at $4.8 per nautical mile), the CAD had not reviewed the implementation results. Audit analysed the cost recovery situation by comparing the actual costs of providing the en-route navigation services and the charges collected from 2001-02 (the year after implementing the current en-route navigation charge rate) to 2013-14 (see Table 5).

Note 14: *The Financial and Accounting Regulations are made by the Financial Secretary under the provisions of the Public Finance Ordinance (Cap. 2) for the better carrying out of the provisions and purposes of the Ordinance, and for the safety, economy and advantage of public moneys and Government property.*

Table 5

Comparison of en-route navigation charges collected and actual costs of providing the services (2001-02 to 2013-14)

Year	En-route navigation charges collected (a) ($ million)	Actual cost attributed to en-route navigation services (b) ($ million)	Difference (c) = (a) – (b) ($ million)
2001-02	161.7	128.8	32.9
2002-03	129.5	130.6	(1.1)
2003-04	120.9	126.3	(5.4)
2004-05	153.7	122.0	31.7
2005-06	171.3	131.0	40.3
2006-07	184.4	126.2	58.2
2007-08	201.0	125.1	75.9
2008-09	192.0	177.3	14.7
2009-10	179.7	178.8	0.9
2010-11	200.3	180.4	19.9
2011-12	218.1	187.1	31.0
2012-13	238.3	212.9	25.4
2013-14	265.1	226.3	38.8
Total	2,416.0	2,052.8	363.2

Source: Audit analysis of CAD records

4.8 The discrepancies between actual costs of providing the en-route navigation services and the charges collected as shown in Table 5 indicate a need for the CAD to conduct a review after implementing the en-route navigation charge level recommended in each fees and charges review to ensure that the charge level is conducive to achieving full-cost recovery. Audit noted that as at August 2014, the CAD had not implemented its proposed en-route navigation charge rate for 2014-15 because of the need to obtain legal advice on certain issues. The CAD needs to take this opportunity to re-examine the proposed charge rate with due regard to the latest cost projection and the full-cost recovery principle.

4.9 In response to Audit enquires, the CAD said that:

(a) the figures in Table 5 in paragraph 4.7 should be interpreted in the light of the economic environment and costing methodology. Revenue dropped significantly in 2002-03 and 2003-04 because of a substantial reduction in the airspace under the control of the CAD with effect from 1 November 2001 and the adverse impact of severe acute respiratory syndrome. As a result, the Government suffered deficits on en-route navigation services in these two years. From 2004-05 to 2007-08, robust economic recovery and growth of the aviation industry resulted in the revenue exceeding the costs. In 2008-09, the CAD revised the costing basis for the en-route navigation services to more accurately reflect the increasing resources devoted to this area. This, coupled with the global economic recession which caused a reduction in revenue, resulted in the surplus declining to $0.9 million in 2009-10. Since 2010-11, the revenue had risen in line with the strong traffic growth in the Asia-Pacific Region. This caused the surplus to increase to $38.8 million in 2013-14. However, it is expected that the total cost for en-route navigation services will increase when the new ATC system comes into operation; and

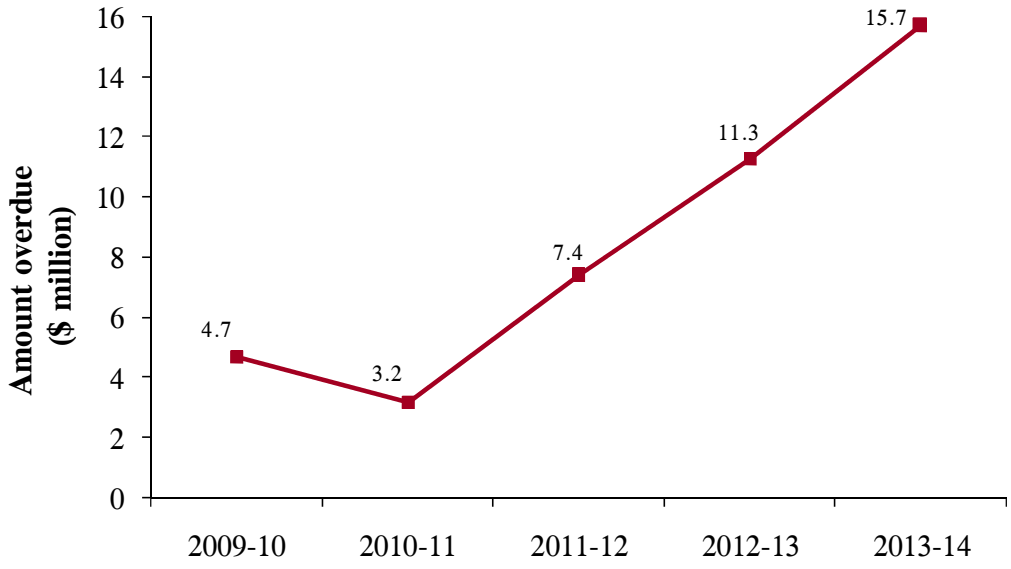
(b) the CAD did not review the implementation results after each fees and charges review in the past because this was not a Government-wide requirement. Nonetheless, the CAD agrees to conduct such reviews in future.

Collection of en-route navigation charges

4.10 According to CAD records, demand notes for ATC service charges are usually settled on time but those for en-route navigation charges are not always so. Figure 9 shows that the amount of overdue en-route navigation charges at year end had increased by 230% from $4.7 million in 2009-10 to $15.7 million in 2013-14. Though the amount involved remained relatively small as compared to the total revenue of $1,101.5 million over the same period, its significant increase percentage-wise is a cause for concern. An analysis of the $15.7 million overdue en-route navigation charges as at 31 March 2014 is shown in Table 6.

Figure 9

Overdue en-route navigation charges (2009-10 to 2013-14)



Source: *Audit analysis of CAD records*

Remarks: *As at 30 September 2014, the overdue amount of en-route navigation charges was $21.6 million.*

Table 6

Analysis of the overdue en-route navigation charges
(31 March 2014)

Amount overdue by each airline	Number of defaulting airlines	Total amount overdue ($ million)
Less than $50,000	155	1.0
$50,000 to less than $250,000	23	3.0
$250,000 to less than $500,000	4	1.5
$500,000 and above (Note)	5	10.2
Total	187	15.7

Source: Audit analysis of CAD records

Note: The amount involved in the largest default case (hereinafter referred to as Case A) was $6.4 million which had increased to $7 million by 30 September 2014.

Measures to tackle default cases

4.11 The CAD has laid down procedures for following up on overdue demand notes for en-route navigation charges. The timetable for the follow-up actions is shown in Table 7.

Table 7

Timetable for follow-up actions on overdue en-route navigation charges

CAD action	Amount owed by local airline operator		Amount owed by overseas airline operator	
	< **$50,000**	≧ **$50,000**	< **$50,000**	≧ **$50,000**
Issue of reminder	2 weeks		3 weeks	
Issue of warning letter (Note)	5 weeks		7 weeks	
Preparation of first legal letter to be signed by DoJ's counsel (Note)	8 weeks	–	11 weeks	–
Preparation of second legal letter to be signed by DoJ's counsel (Note)	14 weeks	–	17 weeks	–
Referral to DoJ (Note)	18 weeks	8 weeks	21 weeks	11 weeks

Source: *CAD records*

Note: *In practice, these steps are performed by batch on a monthly basis.*

Remarks: *The number of weeks is counted from the date of issue of demand note.*

Security deposit/banker's guarantee

4.12 According to the Gazette Notice on en-route navigation charges of August 2000 (see para. 4.3(b)), the Director-General of Civil Aviation may require an airline operator to lodge with the CAD:

(a) a security deposit equivalent to the anticipated charges that the operator shall incur for one month of operation by that operator. The CAD has the right to deduct from the deposit the amounts that are not settled within the time limit specified in the demand notes; and

(b) alternatively, a banker's guarantee of the same amount.

4.13 Audit noted that the CAD had not demanded security deposit or banker's guarantee from any airline operator. According to the CAD, there could be potential operational difficulties in implementing these measures. However, given the increasing trend of overdue en-route navigation charges (see Figure 9 in para. 4.10), there is a need to implement measures to provide coverage against revenue loss in default cases. In Audit's view, the CAD should explore the feasibility of demanding a security deposit or banker's guarantee on a case-by-case basis having regard to the operator's payment records.

Legal action against default cases

4.14 According to the Standing Accounting Instructions issued by the Treasury, where a Controlling Officer is satisfied that sums due to the Government arising from arrears of revenue are not recoverable, he should apply write-off procedures. In the past 10 years from 2004-05 to 2013-14, the CAD wrote off 101 cases of outstanding en-route navigation charges totalling $1.2 million. Of the 101 written-off cases, 96 (95%) involved less than $50,000 each for which the DoJ had advised that it was not cost-effective or viable to take legal action as the debtors were untraceable, insolvent or otherwise out of the jurisdiction.

4.15 Of the remaining five written-off cases involving more than $50,000 each, one case was written off in 2005 after consulting the DoJ. In 2006, the CAD consulted the DoJ about the possible sanction against the largest (in terms of amount) of the other four cases. In this case, the defaulting airline failed to pay en-route navigation charges totalling $391,066 from November 2004 to October 2005 when it ceased overflying Hong Kong airspace. However, after consulting the DoJ, and in the light of the fact that all recovery actions were futile, the CAD wrote off the outstanding amount of $391,066 in September 2006. Thereafter, the CAD wrote off three other cases of outstanding en-route navigation charges involving $75,951 to $232,248 each for similar reasons.

4.16 As at 30 September 2014, there were four cases of overdue en-route navigation charges (including Case A — see Note to Table 6 in para. 4.10) which involved over $500,000 each. The CAD should consider taking effective measures

to protect revenue, including reminding airline operators of their contractual obligation to pay en-route navigation charges and instigating legal actions against default cases as appropriate.

Audit recommendations

4.17 **Audit has *recommended* that the Director-General of Civil Aviation should:**

(a) **conduct a review after implementing the en-route navigation charge level recommended in each fees and charges review to ensure that the charge level is conducive to achieving full-cost recovery;**

(b) **re-examine the proposed en-route navigation charge rate for 2014-15 with due regard to the full-cost recovery principle; and**

(c) **take effective measures to prevent the loss of revenue in default en-route navigation charge cases, including:**

(i) **demanding a security deposit or banker's guarantee from specific airline operators using the CAD's navigation services on a case-by-case basis having regard to their payment records;**

(ii) **reminding the airline operators of their contractual obligation to pay en-route navigation charges when they first submit flight plans to the CAD for using the Hong Kong airspace and in all demand notes sent to them; and**

(iii) **taking legal actions against defaulting airline operators as appropriate.**

Response from the Administration

4.18 The Director-General of Civil Aviation agrees with the audit recommendations.

PART 5: ADMINISTRATION OF THE MANDATORY OCCURRENCE REPORTING SCHEME

5.1 This PART examines the CAD's administration of the mandatory occurrence reporting (MOR) scheme and suggests areas for improvement.

Requirements and procedures of the MOR scheme

5.2 According to the Safety Management Manual of ICAO, a fundamental activity of safety management is the accurate and timely reporting of relevant information related to hazards, incidents or accidents. ICAO has recommended, among other things, that aviation authorities should:

(a) establish a mandatory incident reporting system to facilitate collection of information on actual or potential safety deficiencies; and

(b) establish and maintain an accident and incident database to facilitate the effective analysis of information on actual or potential safety deficiencies obtained, including that from its incident reporting systems, and to determine any preventive actions required.

5.3 The requirements of the MOR scheme are laid down in the Air Navigation (Hong Kong) Orders 1995 (Cap. 448C), as follows:

(a) any aviation service provider or operating personnel specified in the legislation (e.g. a pilot, operator and manufacturer of an aircraft registered in Hong Kong, an air traffic controller and an aerodrome licensee or manager) shall make a report of any reportable occurrence within four days of such occurrence coming to his knowledge;

(b) a reportable occurrence is defined as any incident or defect of an aircraft or any ground facility which endangers, or which if not corrected would endanger the aircraft, the occupants or any other person (Note 15); and

(c) an aircraft operator shall retain the data from a flight data recorder which is relevant to a reportable occurrence for a period of 14 days from the date of the occurrence being reported to the CAD or such a longer period as the CAD directs.

5.4 According to the CAD's MOR guidelines issued in 1999, the objectives of the MOR scheme are to:

(a) ensure that the CAD is advised of hazardous or potentially hazardous incidents and defects;

(b) enable knowledge of these occurrences to be disseminated so that other persons and organisations may learn from them; and

(c) enable an assessment to be made by those concerned of the safety implications of each occurrence, both in itself and in relation to previous similar occurrences, so that they may take or initiate any necessary action.

Processing of occurrence reports

5.5 According to the CAD's MOR guidelines, the Flight Standards and Airworthiness Division (FSAD) is the central point for receipt, dissemination, storage and analysis of MOR data. It is responsible for:

Note 15: *To assist those who are involved in the MOR operation, the CAD has issued guidance on the types of occurrence (relating to aircraft operations, aircraft technical issues, and ground services and facilities) which must be reported. Examples are fire, uncontained engine failures, critically low fuel states and close proximity between aircraft.*

(a) carrying out evaluation to identify MOR cases that require the CAD's involvement in follow-up and to direct these cases to responsible CAD divisions for action (Note 16);

(b) recording those cases where follow-up action is needed as "Open" in the MOR database. All reports not requiring the CAD's follow-up action are recorded as "Closed" by the responsible division. For example, some reported occurrences may have been adequately dealt with by the reporting organisations. There is no justification for further investigation by the CAD although details of the occurrence and action taken do provide valuable information for dissemination and storage purpose. Such cases are categorised as "closed on receipt";

(c) coordinating and monitoring the progress until satisfactory closure of "Open" occurrences;

(d) disseminating occurrence information to those who need to know (through notices and bulletins);

(e) continuously monitoring all incoming data for significant hazards or potential hazards using previously stored data when appropriate, and alerting corresponding CAD specialist divisions and others as necessary; and

(f) regular monitoring of stored data to identify hazards or potential hazards.

Note 16: *The CAD divisions responsible for carrying out follow-up action on MOR cases are:*

(a) the ASMD for ATC related cases;

(b) the Airport Standards Division (APSD) for airport operation related cases; and

(c) the FSAD for cases relating to flight operation and aircraft engineering.

5.6 The CAD's MOR guidelines also specify that:

(a) if alternative reporting procedures have been established by the responsible divisions of the CAD other than the FSAD, such occurrence reports will be received and handled directly by the responsible divisions (Note 17); and

(b) in line with the international practices, it is the CAD's policy not to institute legal proceedings in respect of unpremeditated or inadvertent breaches of the law which come to light only because they have been reported under the MOR scheme, except in cases involving dereliction of duty amounting to gross negligence or recklessness. Nevertheless, to ensure aviation safety, the CAD may suspend or revoke a licence if an occurrence report suggests that a licence holder does not satisfy the licence requirements.

5.7 The FSAD uses a MOR database (Note 18) to capture information of MOR cases from receipt of the reports to closure of the cases. According to the CAD's laid-down guidelines, the FSAD is responsible for categorising the reports received, creating records in the database and forwarding relevant cases to responsible divisions (i.e. the ASMD, FSAD and APSD). The relevant division is responsible for assigning a risk level to each MOR case, taking follow-up action accordingly and updating the MOR database until the case is closed.

Note 17: *According to laid-down procedures of the ASMD and APSD, such MOR cases received and handled by them directly should centrally reach the FSAD for updating the MOR database.*

Note 18: *According to the CAD, the database is a primary means of providing MOR statistical data for addressing outside enquiries. It also provides a platform for the FSAD to manage MOR cases relating to flight operations and engineering events. The APSD and ASMD use their own control systems to manage MOR cases regarding the airport and air traffic events respectively.*

Areas for improvement

Management of MOR database

5.8 In June 2014, Audit obtained from the CAD an image of the MOR database (hereinafter referred to as the June version) for analysing MOR cases from 2009-10 to 2013-14. Audit analysis of the database image revealed that as at 16 June 2014, there were 3,336 MOR cases (of which 2,189 were closed and 1,147 were outstanding cases) in the past five years. Ageing analysis of the 1,147 outstanding cases showed that 811 (71%) had remained outstanding for over one year. In response to Audit enquiry, in August 2014 the CAD provided Audit with an updated version of the database image as at 12 August 2014 (hereinafter referred to as the August version), which showed that there were 3,374 MOR cases (of which 2,740 were closed and 634 were outstanding cases).

5.9 According to the CAD, the discrepancies between the June and August versions of the MOR database were attributable to:

(a) ***Updating the case status.*** The status of 509 cases with completed action but still shown as open cases in the June version database was updated in the August version;

(b) ***Reclassification of reported cases.*** 44 non-MOR cases were reclassified as MOR cases while 11 MOR cases were reclassified as non-MOR cases;

(c) ***Duplication cases.*** Four duplicated MOR cases were deleted; and

(d) ***Late input cases.*** There were nine late input cases. Eight of them occurring in 2012 and 2013 were uploaded to the MOR database in July/August 2014. The remaining case which occurred in January 2014 was reported to the CAD in July 2014 (Note 19).

A reconciliation of two versions of the MOR database is shown in Table 8.

Note 19: *In response to Audit's enquiry in September 2014, the CAD informed Audit that the late reporting case was found to be a non-MOR case after completing an investigation in September 2014.*

Table 8

Reconciliation of the June and August versions of the MOR database

	Number of outstanding MOR cases (a)	Number of closed MOR cases (b)	Total number of MOR cases (a) + (b)
June version database	1,147	2,189	3,336
Add or (Less):			
Outstanding case reclassified as closed	(509)	509	—
Case reclassified as MOR	—	44	44
Case reclassified as non-MOR	(9)	(2)	(11)
Case duplicated	(4)	—	(4)
Late input cases	9	—	9
August version database	634	2,740	3,374

Source: Audit analysis of CAD records

5.10 The MOR database is an important management tool for monitoring the progress of follow-up actions on reported hazardous or potentially hazardous occurrences and for trend analysis of significant aviation safety issues. However, the discrepancies found in the June version of the MOR database indicate weaknesses in the management of the MOR database because:

(a) the change of status of 509 cases was not timely reflected in the MOR database;

(b) the classification of 59 (44 + 11 + 4) cases in the MOR database was found to be inaccurate;

(c) some of the discrepancies were not reconciled in a timely manner as ageing analysis of the 568 (509 plus 59) cases showed that 298 (52%) of them occurred before 2013-14; and

(d) of the nine late input cases, eight cases (which occurred in 2012 and 2013) were uploaded to the database after a lapse of 17 to 29 months.

5.11 ***Audit analysis of the August version MOR database.*** The analysis has revealed room for improvement in the following areas:

(a) timeliness of reporting (see paras. 5.12 to 5.17); and

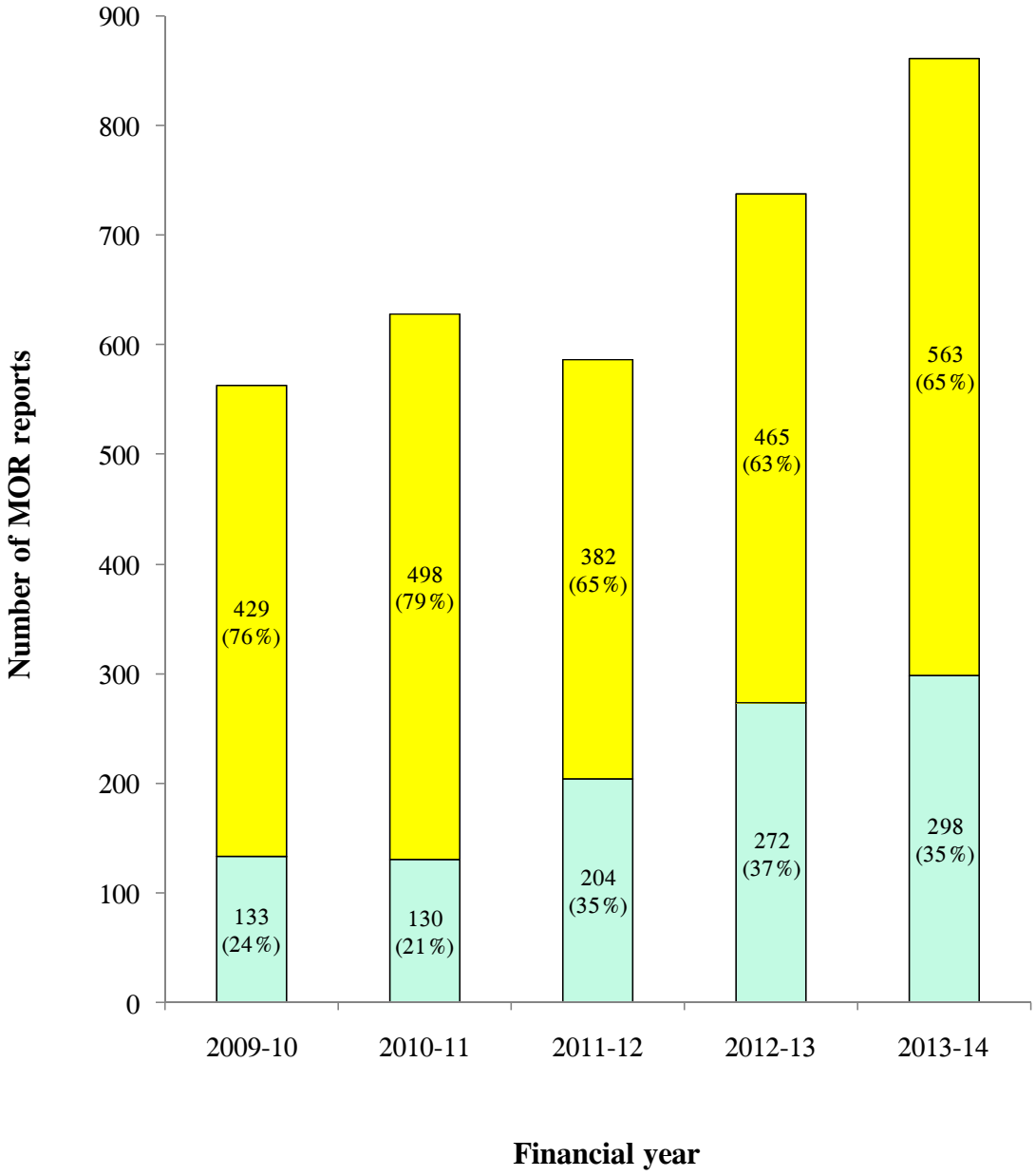
(b) management of MOR cases (see paras. 5.18 to 5.21).

Timeliness of reporting

5.12 Timeliness of reporting reportable occurrences under the MOR scheme contributes to aviation safety by enabling early identification of hazards and prompt dissemination of safety information. However, of the 3,374 MOR reports received by the CAD from 2009-10 to 2013-14, 1,037 (31%) could not meet the statutory four-day-reporting rule (see para. 5.3(a)). As shown in Figure 10, the percentage of late reporting increased from 24% in 2009-10 to 35% in 2013-14.

Figure 10

MOR reports received (2009-10 to 2013-14)

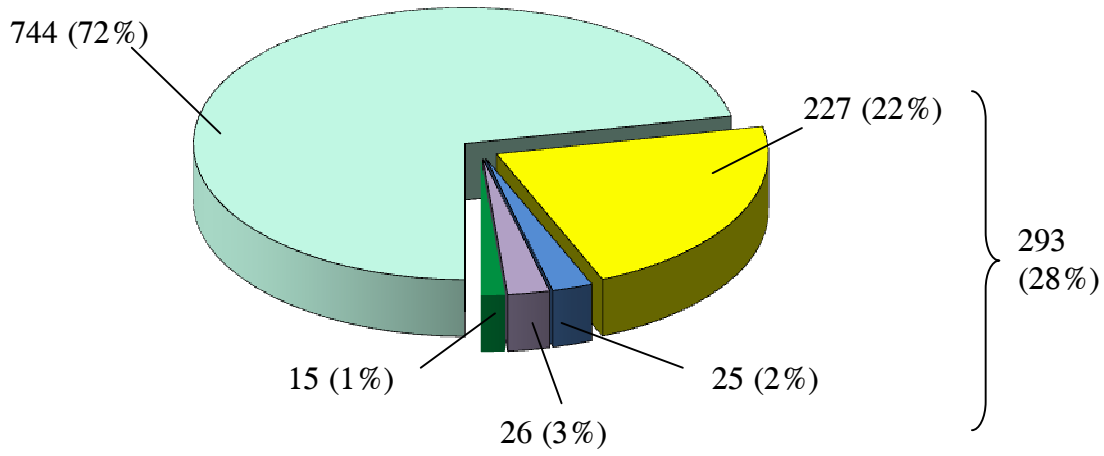


Source: Audit analysis of CAD records

5.13 As shown in the ageing analysis in Figure 11, 28% of the 1,037 late reports were received after 14 days (i.e. beyond the statutory retention period of data from a flight data recorder — see para. 5.3(c)).

Figure 11

Analysis of 1,037 late MOR reports (2009-10 to 2013-14)



Source: Audit analysis of CAD records

5.14 In response to Audit enquiry on the actions taken to improve the timeliness of reporting MOR cases, the CAD informed Audit in August and September 2014 that:

(a) the CAD had issued a notice to all airlines in July 2014 to remind them of the four-day-reporting rule;

(b) the CAD's MOR guidelines used the words "major" or "significant" to describe some reportable occurrences which would be subject to interpretation and very much dependent upon the situation. The reporting organisation might have to obtain further information in order to determine if the event was reportable or not;

(c) the overall objective of the CAD in operating the MOR scheme was to use the reported information to improve the level of flight safety and not to attribute blame. It was the international best practice to promote a non-punitive reporting culture, so as to encourage reporting of occurrences. As such, punitive action might not be the first consideration; and

(d) there might be cases that the reporting organisations/personnel only became aware of the occurrences after the statutory four-day-reporting period. Such cases should not be regarded as non-compliant cases. The CAD would consider revising the MOR reporting form to facilitate reporting organisations/personnel to indicate the dates when the occurrences come to their knowledge (if different from the dates of occurrences).

5.15 Audit understands that the CAD's practice is to provide a non-punitive environment in order to encourage reporting. However, a balance has to be struck to ensure that the effectiveness of the MOR scheme is not compromised. In Audit's view, there is a need to take targeted action in warranted cases such as those listed in paragraphs 5.16 and 5.17.

5.16 ***Frequent non-compliant cases.*** Audit analysis of the 1,037 late MOR reports showed that 84% were accounted for by three operators. In the past five years, the CAD had not reminded them to improve the situation until July 2014 (see para. 5.14(a)). There is a need to conduct similar analysis regularly to identify such cases for the CAD's senior management's attention and necessary follow-up action.

5.17 ***Long delay cases.*** Audit examined all the 15 MOR cases which had taken more than 180 days to report (see Figure 11 in para. 5.13) and found that in six cases (Note 20) the reasons for long delay were that the relevant operators only submitted the MOR reports to the CAD after completion of their own follow-up actions. The CAD needs to remind these operators that their own follow-up actions do not absolve them of their statutory responsibility to comply with the four-day-reporting rule. Long delay in reporting is not conducive to the timely dissemination of information on potential hazards for other aviation organisations/personnel to learn. The CAD needs to regularly review long delay cases to ascertain the underlying reasons with a view to taking appropriate actions to improve the situation.

Management of MOR cases

5.18 ***Assignment of risk level.*** According to the CAD's laid-down procedures, all MOR cases should be assigned a risk level upon receipt of the reports. With reference to the ICAO guidelines and building on past experiences, the CAD has developed a model for assessing the risk level of MOR cases taking into account the severity and likelihood of the occurrences. The FSAD and APSD use a scale of 1 to 7 to denote the risk levels, i.e. levels 6 to 7 are categorised as high risk, levels 4 to 5 as medium risk and 1 to 3 as low/no risk. The ASMD has followed the ICAO's classification of risk based on "aircraft proximity" (Note 21) and developed its risk categorisation, i.e. Categories A to D to denote cases of "risk of collision", "safety not assured (i.e. collision could result if no action taken by either the pilot or the ATC)", "no risk of collision" and "risk undetermined (due to insufficient information or conflicting/inconclusive evidence)", respectively.

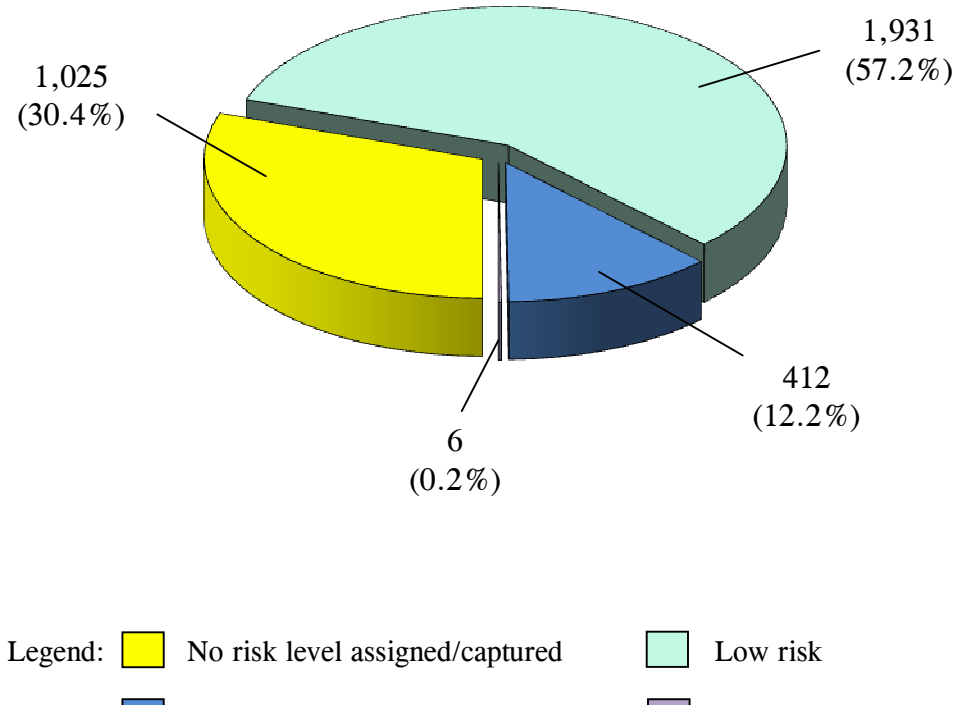
Note 20: *Of the other nine cases examined by Audit, three were in fact compliant cases but, due to input error, the dates of updating the database were mistakenly recorded as the dates of reporting the reportable occurrences. Four other cases were omission cases identified by the CAD during a licensing inspection. The CAD subsequently issued a warning letter to the operator concerned. Regarding the remaining two cases, the CAD informed Audit that they had been reclassified as non-MOR cases in September 2014 after investigations.*

Note 21: *ICAO defines "aircraft proximity" as a situation in which, in the opinion of a pilot or air traffic services personnel, the distance between aircraft as well as their relative positions and speed have been such that the safety of the aircraft involved may have been compromised.*

5.19 Depending on the risk level of an MOR case, the case officer may either carry out investigation or monitor the progress of investigation and corrective actions taken by the reporting organisations (e.g. for the low risk cases). After completion of all follow-up actions, the case officer may amend the risk level previously assigned if necessary. Audit analysis of the 3,374 MOR cases by risk levels recorded in the respective database revealed that 1,025 (30%) of them were without risk level assigned/captured (see Figure 12). Of the 1,025 cases, 967 were within the purview of the FSAD and APSD. The CAD needs to remind the responsible case officers to follow the laid-down procedures in assigning risk levels for MOR cases. The remaining 58 MOR cases were handled by the ASMD. The ASMD used non-numeric risk categorisation to classify the risk levels of ATC related cases (see para. 5.18) which could not be captured by the MOR database. The CAD may wish to consider enhancing the MOR database to capture such information to facilitate management review.

Figure 12

Analysis of 3,374 MOR cases by risk level (2009-10 to 2013-14)



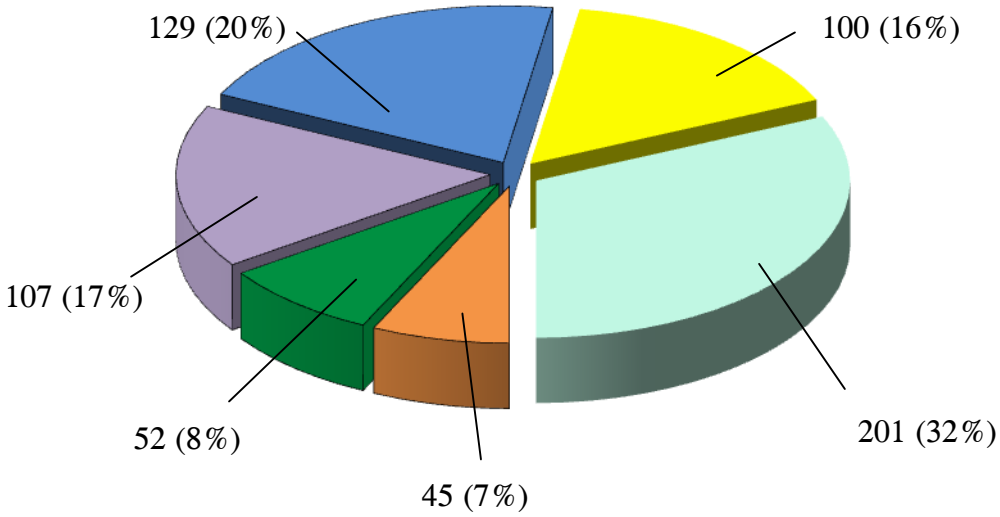
Source: Audit analysis of CAD records

5.20 ***Airport vehicles not giving way to aircraft.*** Audit examination of the 412 medium risk cases revealed that the most frequent incidents were related to "airport vehicles not giving way to aircraft" (33 cases from January to December 2012). Among the 1,025 cases without risk level assigned/captured, there were 75 similar incidents. According to the CAD, the APSD had followed up all these cases using its monitoring regime on airport operation (see para. 1.10), and had conducted a review on these cases in January 2013. The review found that these cases often occurred in apron area involving slow-moving taxiing aircraft and vehicles, i.e. not meeting the reporting criteria of an obstruction in runways or aircraft manoeuvring areas as mentioned in the CAD's guidelines on reportable occurrences. As such, the CAD had ceased to categorise these cases as reportable occurrences since 2013. Audit noted from APSD records that during January 2013 and March 2014, there were 66 cases of "airport vehicles not giving way to aircraft". In other words, there were a total of 174 (33 + 75 + 66) such cases from 2009-10 to 2013-14. In order to minimise the occurrence of such cases and to mitigate the associated risks, Audit considers that in addition to the current monitoring regime on airport operations, the CAD also needs to continue monitoring these cases (which may result in a hazardous or potentially hazardous situation) through the MOR system and instigate regulatory action if the situation persists.

5.21 ***Long outstanding cases.*** According to the CAD's laid-down guidelines, MOR cases should normally be closed within six months and any MOR case remaining outstanding for more than six months should be monitored on a monthly basis. Of the 3,374 MOR cases, 634 were outstanding as at 12 August 2014. Ageing analysis of these 634 cases showed that 201 had remained outstanding for over four years (see Figure 13). According to the dates of last action recorded in the MOR database, 117 of these 201 cases had no follow-up action recorded since 2009. For example, in one case concerning display error of aircraft engine speed, the case officer sought comments from a colleague in June 2009. However, the case record showed that no response was received and no further action had been recorded since June 2009. The CAD needs to closely monitor the long outstanding cases to ensure that timely follow-up actions have been taken in accordance with the laid-down guidelines.

Figure 13

Ageing analysis of 634 outstanding MOR cases
(12 August 2014)



Source: Audit analysis of CAD records

Audit recommendations

5.22 **Audit has *recommended* that the Director-General of Civil Aviation should:**

(a) **strengthen the management of the MOR database to ensure that it can support the monitoring of follow-up actions on reported MOR cases;**

(b) **closely monitor the timeliness of reporting MOR cases and take targeted action in warranted cases such as cases of frequent and long delay in reporting;**

(c) **consider revising the MOR reporting form to facilitate reporting organisations/personnel to indicate the dates when the reportable occurrences come to their knowledge (if different from the dates of the occurrences);**

(d) **remind case officers to strictly follow the laid-down procedures in assigning the risk levels for MOR cases and consider enhancing the MOR database to capture the risk information of the ATC related cases to facilitate management review;**

(e) **continue to monitor cases of obstruction of aircraft by airport vehicles through the MOR system and instigate regulatory action if the situation persists; and**

(f) **closely monitor the long outstanding MOR cases to ensure that timely follow-up actions have been taken and properly recorded.**

Response from the Administration

5.23 The Director-General of Civil Aviation agrees with the audit recommendations. He has said that in response to the audit findings on airport vehicles not giving way to aircraft, the CAD has taken actions (e.g. monthly airfield safety briefings, regular airport safety meetings and the production of a dedicated safety video) to enhance the airport community's awareness of such cases.

PART 6: WAY FORWARD

6.1 This PART summarises the major audit observations identified in earlier PARTs and examines the way forward.

Major audit observations

6.2 The ATC system, comprising advanced electronic systems, is an essential tool enabling air traffic controllers to provide safe, reliable, effective and efficient ATC services. In PART 2, Audit found that the existing ATC system was operating above its planned capacity, with frequency of surveillance data display problems increasing since 2011, but the new ATC system targeted for commissioning in December 2012 had experienced delay in implementation. Up to August 2014, there were considerable outstanding deficiencies/observations remaining to be followed up during the Site Acceptance Tests. The latest estimate was that the system would only be ready for operation in 2015.

6.3 In 1996, the CAD obtained funding to procure a PRM radar with a view to maximising the utilisation of the capacity of the HKIA by adopting independent mixed mode of operation for its parallel runways. The PRM radar costing $101.4 million was commissioned in 2000. In PART 3, Audit found that the CAD had been made aware of the constraints in adopting the independent mixed mode of operation by two consultancy studies in 1990 and 1994 (i.e. the ICAO's requirements on independent mixed mode of operation could not be met due to terrain obstructions south and northeast of the HKIA). However, the CAD proceeded with the PRM project in the belief that there might be advancement in technology to permit simultaneous independent operations and the PRM radar could then support independent mixed mode of operation. In the event, the expected changes in technology did not happen. As a result, the PRM radar was only put into use for purposes other than supporting the independent mixed mode of operation of the HKIA's runways. Such other uses also turned out to be supplemental and were discontinued after some 20 months to 4 years. The PRM radar has been put into standby mode since 2005.

6.4 Under the Government's "user pays" principle, the full cost of providing ATC services is to be recovered through the ATC service charges for aircraft using the HKIA and en-route navigation charges for aircraft using the Hong Kong airspace

only. In PART 4, Audit has found that there is a need for the CAD to conduct a review after implementing the en-route navigation charge level recommended in each fees and charges review to ensure that the charge level is conducive to achieving full-cost recovery. Moreover, in view of the increasing amount of overdue en-route navigation charges, the CAD also needs to consider implementing measures (such as security deposit) to provide coverage against revenue loss in default cases.

6.5 Safety has always been a top priority in the civil aviation industry. To improve the level of flight safety, the CAD has monitored hazardous or potentially hazardous incidents through the MOR scheme. In PART 5, Audit has found that there is a need to strengthen the management of the MOR database to ensure that it can provide accurate and up-to-date information to support MOR case management and trend analysis of significant aviation safety issues. Audit has also found that there is room for improving the timeliness of reporting MOR cases, and closer monitoring of the progress of long outstanding MOR cases.

Post-completion review

6.6 From time to time, the CAD has to undertake major procurement projects to upgrade/replace its ATC equipment in order to provide safe, reliable, effective and efficient ATC services. The problems identified in the projects for procuring the new ATC system and the PRM radar indicate the need for conducting post-completion reviews to draw lessons for the benefit of future similar projects.

Audit recommendation

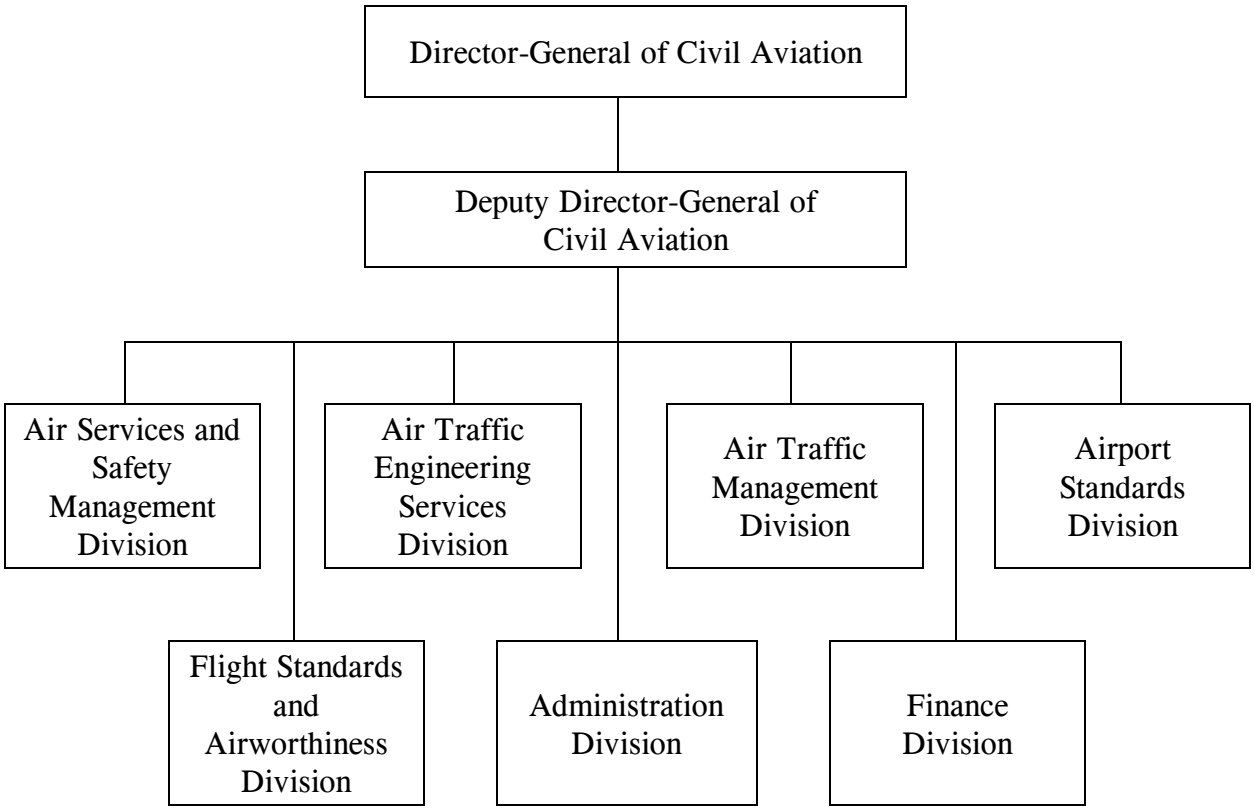
6.7 **Audit has *recommended* that the Director-General of Civil Aviation should conduct post-completion reviews of major procurement projects undertaken by the CAD (including the new ATC system project), taking into account the audit observations and recommendations in this Audit Report.**

Response from the Administration

6.8 The Director-General of Civil Aviation agrees with the audit recommendation.

Appendix A
(para. 1.3 refers)

Civil Aviation Department: Organisation chart (August 2014)



Source: CAD records

Appendix B

Acronyms and abbreviations

AESD	Air Traffic Engineering Services Division
APSD	Airport Standards Division
ASMD	Air Services and Safety Management Division
ATC	Air traffic control
ATMD	Air Traffic Management Division
ATMS	Air Traffic Management System
Audit	Audit Commission
CAD	Civil Aviation Department
DoJ	Department of Justice
FSAD	Flight Standards and Airworthiness Division
FSTB	Financial Services and the Treasury Bureau
GANP	Global Air Navigation Plan
GLD	Government Logistics Department
HKIA	Hong Kong International Airport
ICAO	International Civil Aviation Organization
LegCo	Legislative Council
MOR	Mandatory occurrence reporting
PBN	Regional Performance-based Navigation Implementation Plan
PRM	Precision runway monitor
PWSC	Public Works Subcommittee