For information
on 28 November 2016

Legislative Council Panel on Economic Development

New Air Traffic Control System

Purpose

This paper informs Members of the launch of the new Air Traffic Management System (ATMS) by the Civil Aviation Department (CAD) on 14 November 2016. An account of an incident relating to the new ATMS happened on 27 October 2016 before the full commissioning of the system is also provided for Members' information.

The Need for a New Air Traffic Control (ATC) System

2. Since the relocation of the Hong Kong International Airport (HKIA) to Chek Lap Kok in 1998, CAD had been using the Autotrac I, an air traffic management system developed by Raytheon (a United States-based firm) for managing air traffic in the Hong Kong Flight Information Region (HKFIR). The Autotrac I had been in use for 18 years, during which air traffic has grown by leaps and bounds both in Hong Kong and the region. With the foreseeable growth in air traffic in the coming years, in particular after the Three-runway System (3RS) at the HKIA is in operation, coupled with the advancement of aviation technologies and ever-enhancing flight safety standards, the original ATC System simply would not be able to cope with these new challenges and to take advantage of new opportunities. Therefore, the system replacement is inevitable and critical to the healthy development of Hong Kong's aviation sector as a whole.

Key Features of the New ATC System

3. The new ATC System, including the new ATMS branded "Autotrac III", also developed by Raytheon which was selected by CAD in 2011 after an open tender process in accordance with the established Government procurement procedure, has been implemented through a total of eight system contracts, namely:

System contracts	Brief description of functions
(i) Air Traffic Services Data Management System	Manage and display integrated air traffic services information
(ii) Aeronautical Information Management System	Manage and disseminate flight plans and "Notice to Airman" (NOTAM)
(iii) Aeronautical Messaging System	Process and exchange aeronautical messages with neighbouring Aeronautical Network Centres (ANCs)
(iv) Communication Backbone	Communication network for transmission of air traffic services information
(v) Communications and Recording System	Process and record air traffic voice and data communication
(vi) Relocation and Expansion of ATS Message Handling System	Process and exchange air traffic services and meteorological messages with neighbouring ANCs
(vii) Ancillary and Technical Support System	Centralised Monitoring and Control System, Telephone System and Power Supply System
(viii) Air Traffic Management System (ATMS)	Process integrated surveillance radar and flight data, arrival sequence and electronic flight progress strips

4. Seven of the systems (i.e. (i) – (vii) above) were commissioned in phases since 2013. After initial stage of optimisation that is common for large-scale avionic projects, all seven systems have been running smoothly. The last contract covers the new ATMS, which was fully-commissioned successfully on 14 November 2016, following a

Phased Functional Implementation (PFI)[1] process since June 2016. The new ATC System is designed to meet the latest international standards on technical, safety and ATC operational requirements, including enhanced flight information and data processing, advanced automatic safety net features, and more precise flight trajectory prediction functions. It meets the latest requirements set by the International Civil Aviation Organization (ICAO), and is on par with the most advanced international air traffic management technologies. With an enhanced capacity to handle 8 000 flight plans per day and simultaneously monitor 1 500 air or ground targets (5 times and 1.5 times of the Autotrac I respectively), the new system can handle the projected air traffic growth, including that to be brought about by the development of the 3RS of HKIA.

5. Furthermore, the new ATC System has built-in multiple fallback systems to tackle different scenarios, which can meet the ever-increasing stringent aviation safety requirements - an improved feature compared with the Autotrac I which had only one fallback system. The Fallback System is a separate but identical system to the Main System, which can immediately take up the role of Main System for continuing the operations of the system in the event of failure of the Main System. The Ultimate Fallback System could run independently (though with reduced functions which will limit the handling capacity) to sustain the operations of the system in the unlikely event of total failure of both the Main System and Fallback System, thus ensuring flight safety. In other words, in the highly unlikely occasion that the Ultimate Fallback System is activated, air traffic flow control is required. Of note is that the fallback system of the old ATMS had never been activated in the past 18 years though minor incidents/observations were noted occasionally as in any busy international airports.

6. All in all, the new ATC System is an essential vehicle for CAD to handle the ever-increasing air traffic in a safe, orderly and efficient manner.

Preparation for and Assessment of the new ATMS

7. In preparing for the launch of the new ATC System, the overarching principle of the Government was to maintain the highest

[1] The PFI approach to the implementation of the new ATMS refers to a step-by-step, incremental launch of different parts of the system in phases. The use of the new ATMS was progressively expanded in terms of operating time and the scope of service coverage over a period of about five months.

level of aviation safety. As an essential part of the entire ATC System replacement project, CAD conducted a series of stringent acceptance tests[2] on the new ATMS on par with international aviation safety standards and established Government procedures, as well as to ensure that the system operation was in compliance with the contract conditions and safety management requirements. On staff readiness, CAD formulated a comprehensive training plan which consisted of a series of systematic training modules for all air traffic controllers (ATCOs) and relevant staff, comprising computer-based training, simulator training, shadowing exercises[3], etc. They have been trained for more than 35 500 man-hours and carried out 11 500 man-hours of shadowing exercises in total. The training package provided to the ATCOs was similar to that offered by other overseas ATC centres for similar transition projects. On completion of the training package, all the ATCOs in CAD had to undergo rigorous objective assessment conducted by qualified training and checking officers before they were allowed to operate the new ATMS and proceed to the PFI to handle live traffic.

8. Apart from external training and assessment, during the PFI, CAD also distributed questionnaires to all ATCOs to gather their self-assessment of their own readiness to operate the new ATMS. Such arrangement also encouraged them to reflect their views should there be a need to strengthen training in any particular aspect. This self-assessment on readiness has been carried out on a named basis according to common international practice, in order to accurately assess staff readiness and, more importantly, to offer appropriate help and assistance to address the diverse needs of ATCOs. Before the full commissioning, most of the over 180 ATCOs indicated through the self-assessment that they were confident to use the new system to handle

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[2] Acceptance tests include the following components:

(a) **Factory Acceptance Tests** – 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.

(b) **Site Acceptance Tests** – to demonstrate that the system was capable of complying with every clause of contract specifications.

(c) **Flight Check Acceptance Tests** – to verify the accuracy of the displayed targets flying within the HKFIR.

(d) **Reliability Acceptance Tests** – to verify the reliability of the new ATMS including software and hardware through continuous 31-day normal operations.

(e) **System Integration Tests** – to verify the compatibility and interoperability of the new ATMS with other ATC Systems.

[3] In shadowing exercises, ATCOs used the new ATMS (and the new ATC System as a whole) to mimic real time air traffic operations carried out by the Autotrac I at the original ATC Centre.

live traffic. The remaining few controllers are either on leave or will proceed to retirement soon.

9. To follow up on the recommendation of the Public Accounts Committee of the Legislative Council, the Transport and Housing Bureau (THB) appointed the United Kingdom-based National Air Traffic Services (NATS) in November 2015 as an independent consultant to advise the Secretary for Transport and Housing on system readiness of the new ATMS and CAD's readiness. NATS was tasked to conduct four assessments on the new ATMS, namely a "snapshot" review based on the situation in December 2015 on the system technical aspects, operations and training documents of the new ATMS; confirmation of CAD's readiness for PFI; confirmation of CAD's readiness for full implementation of the new ATMS; and review of the "display degrade" incident which took place on 27 October 2016. NATS completed its first assessment in March 2016 and concluded that the ATMS engineering was safe, stable and reliable, and on a par with good practice in ATC centres in other jurisdictions, such as the United Kingdom and Singapore. The full report of NATS' **first assessment** issued in March 2016 is at **Annex A**.

10. In the first assessment, NATS also recommended CAD to adopt a PFI approach to allow more time for ATC staff to familiarise themselves with the system's functions and operations, which CAD accepted after reviewing the situation and making reference to overseas experience of other major international air navigation services providers. Such step-by-step, incremental approach was also built on the experiences gained from the implementation of the Autotrac I in 1998 when the airport was moved from Kai Tak to Chek Lap Kok. In the second assessment, NATS looked at CAD's readiness for the PFI. NATS was of the view that CAD had an overall robust, achievable plan and approach to the PFI. The full report of NATS' **second assessment** issued in May 2016 is at **Annex B**.

11. Since the commencement of PFI of the new ATMS on 19 June 2016, its operating time and scope of service coverage expanded progressively as scheduled for about five months. During the process, both good and adverse weather conditions, as well as day and night operations were covered. Through participation in the PFI, the ATCOs became more familiar with the operation of the new ATMS.

12. In its third review, NATS assessed CAD's readiness for full transition. NATS confirmed that CAD was ready for the full

commissioning of the new ATMS. NATS acknowledged the amount of professional work carried out by CAD in preparation for the full transition and completion of all relevant recommendations including those from previous assessments. NATS confirmed that CAD had established a robust evidence-based transition plan and was satisfied that CAD was ready to proceed with full transition as planned, well supported by clear entry and success criteria, robust fallback contingency measures if needed, and with demonstrated operational readiness in the areas of planning, people, procedures, equipment and safety management processes. A copy of NATS' full report on its **third assessment** issued in October 2016 is at **Annex C** for reference.

13. Arising from the 27 October 2016 incident (see paragraphs 15 to 17 below), THB invited NATS to conduct the **fourth assessment** on the impact of the incident on the full commissioning of the new ATMS. NATS confirmed the cause of the incident, and was confident that the cause had been identified and the issue satisfactorily resolved. NATS' assessment on CAD's readiness for full transition as previously concluded remained unchanged.

14. Based on the independent advice of NATS and the confirmation of CAD on its readiness in all respects, the Secretary for Transport and Housing endorsed the recommendation of CAD to fully commission the new ATMS on 14 November 2016. The decision to launch the new ATMS was fully supported by the President of the Hong Kong Air Traffic Control Association and the Chairman of the Civil Aviation Department Electronics Engineers Branch of Hong Kong Chinese Civil Servants' Association. Their respective statements are at **Annexes D and E**.

The Incident of "Display Degrade" on 27 October 2016

15. On 27 October 2016 during PFI, noting that the China International Aviation and Aerospace Exhibition would be held in Zhuhai, a flight data operator attempted to input into the new ATMS an unusual flight plan, the planned route of which did not enter the HKFIR, primarily for information of colleagues. The unusual flight plan triggered a "display degrade" incident.

16. THB invited NATS to assess the impact of the said incident on the full transition. NATS confirmed that the "display degrade" incident which affected only three workstations of the new ATMS without direct communication with flights was an automatic protection mechanism by

system design to contain the data mismatch at these workstations. NATS further confirmed that CAD's decision to revert to the Autotrac I immediately upon the "display degrade" incident was a decision "as intended", which "allowed the CAD to smoothly and safely transition out of PFI and maintain continuous operations without any safety or operational impacts". Moreover, the new ATMS was stable and no "system crash" was observed at any time.

17. With the cause of the incident identified, NATS also reviewed the actions taken by CAD to rectify the problem and was satisfied that enhancement measures, including the software fix and procedural changes, had been duly implemented and verified to both solve the problem and avoid the recurrence. NATS concluded that, with the software fix implemented, any similar unusual flight plan (i.e. without entry to the HKFIR) would be processed by the new ATMS for information by ATCOs as intended, without triggering the display degrade mode. For details of NATS' conclusion, please refer to the full report on the incident submitted by NATS to THB (**Annex F**).

Performance of the new ATMS after full commissioning

18. Since its full commissioning on 14 November 2016, the new ATMS has been providing safe, smooth and orderly air traffic services to flights operating in and out of the HKIA and through the HKFIR. The daily average of aircraft movements handled at HKIA was around 1 070, while the number of overflight daily movements was around 760. Feedback from the ATCOs on the new ATMS was generally positive. We understand from the airlines that their operations have been smooth since the full commissioning of the new ATMS. Local airlines have publicly supported the transition, which they think is key to the future development of the aviation industry (**Annexes G and H**).

19. As per CAD's previous experience in the transition to the Autotrac I when moving from Kai Tak Airport to the existing HKIA in year 1998, as well as the experiences of NATS, it is normal and common internationally that the new ATMS needs some time to optimise its performance and suit the local operating environment even after the full transition.

20. During the inaugural stage of the new ATMS operation, there were occurrences which warranted operational optimisation. For example, on 15 November 2016, the position of a departing aircraft was

temporarily not displayed on the radar screen of one workstation in the new ATC Centre while the positions and information of all other flights being monitored by the new ATMS remained intact. There was also a brief occurrence of split tracks[4] which disappeared automatically in a while. Through radar screen updates, the aircraft position was shown again automatically within 12 seconds.

21. The phenomenon of aircraft positions temporarily not displayed was not unique to the new ATMS; it was also observed occasionally in ATMSs elsewhere and in the Autotrac I, i.e. the old ATMS of HKIA. As with other ATMS developers, Raytheon has anticipated and addressed the issue when designing the Autotrac III. In Hong Kong, no matter the ATCOs use the old or the new ATMS, they can retrieve the position of an aircraft immediately or avoid split tracks by choosing an appropriate radar signal through the Main System in accordance with the established operational procedure. This procedure involves the switching to the "bypass mode" (in case of the old ATMS) or "local mode" (in case of the new ATMS).

22. The phenomenon mentioned above is a relatively minor occurrence which can be addressed through further optimisation of the ATMS in the light of operational experience. That said, these optimisation/updating exercises do not mean any compromise of flight safety. According to the experience of NATS, given the complexity of an ATMS, even with all reasonable efforts and endeavors, there could still be possibilities of setbacks during the introduction of a new system. To safeguard aviation safety, CAD has laid down procedures for trained and professional ATCOs to handle different situations. CAD will continue to look into any future occurrence to see if further optimisation of the new ATMS could be achieved.

23. For detailed background, please see at **Annex I** the press release issued by CAD on 19 November 2016.

Other Related Issues

24. There were recent media reports quoting anonymous source who claimed to be an air traffic controller alleging that CAD compelled ATCOs to change the grading in their self-assessment at staff readiness survey and threatened to demote or not to promote them if they did not

[4] "Split tracks" refers to the showing of two flight tracks of the same aircraft on the screen.

comply. Neither CAD senior management nor THB have received any complaint from staff in relation to the conduct of staff readiness surveys. The President of the Hong Kong Air Traffic Control Association also commented in public that ATCOs are generally satisfied with the new system. In any case, both THB and CAD have publicly stated that if individual staff members have any misgiving that their grievances or complaints cannot be properly addressed by the established channel, they may approach the Director-General of Civil Aviation, CAD senior management or THB direct. Should any misconduct be established upon proper investigation, this will be followed up by the appropriate authorities in accordance with established mechanism.

Conclusion

25. The full commissioning of the new ATMS represents a significant milestone in Hong Kong's aviation history. It will greatly enhance the competitiveness of the HKIA in the region. CAD will continue to closely monitor the performance of the new ATC System to ensure that highest safety standards are upheld. The Government will also spare no effort in meeting the challenges ahead, and in upholding the highest aviation safety standards, as well as its commitments to Hong Kong's public interests.

Transport and Housing Bureau
Civil Aviation Department
November 2016

Annex A

NATS

Performance
through Innovation

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Operational Readiness Assessment Of The New Air Traffic Management System

Prepared for the Transport & Housing Bureau, HKSAR Government

D2 Final Report

Issue 1.2

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Glossary

ARM	Availability, Reliability and Maintainability
AT3	AutoTrac III
ATC	Air Traffic Control
ATCC	Air Traffic Control Centre
ATCO	Air Traffic Control Officer
ATMS	Air Traffic Management System
CAD	Hong Kong Civil Aviation Department
CJS	Controller Jurisdiction
COTS	Commercial Off The Shelf
DB	Data Block
EFS	Electronic Flight Strip
ENG	Engineering
FDL	Flight Data List
HF	Human Factors
HK	Hong Kong
HKSAR	Hong Kong Special Administration Region
HMI	Human Machine Interface
I/B	Inbound
ICAO	International Civil Aviation Organisation
iFACTS	NATS Area Control Toolset (Conflict detection & resolution, task prioritisation, what if analysis)
iTEC	Interoperability Through European Collaboration
ITTF	Implementation and Transition Task Force
MSAW	Minimum Safe Altitude Warning
RAG	Red/Amber/Green Review
RBL	Range and Bearing Line
SA	Situational Awareness
SAF	Safety
SARP	Standards & Recommended Practices
SESAR	Single European Sky ATM Research
SIT	Situational Awareness (display)
SME	Subject Matter Expert
STCA	Short Term Conflict Alert
SUA	Special Use Airspace
TCC	Traffic Condition for Controller

THB	Transport and Housing Bureau
TWR	Tower
UFS	Ultimate Fall-back System

Assumed Knowledge

This document assumes the reader has knowledge of air traffic control and airport operations and is familiar with the project methodology detailed in Reference 1. It also assumes the reader would be familiar with basic terminologies for the subjects involved. Where acronyms are used, they are listed in the glossary or explained in the text.

Table of Contents

Executive Summary

Context

1. CAD is in the process of transitioning their ATC operations onto a new Air Traffic Management System (ATMS). The ATMS supports Tower, Approach/Departure, Terminal and Area operations. CAD have contracted Raytheon to supply, install and commission the system. CAD has been delivering ATC conversion training sessions, as well as fine-tuning/developing the associated ATC and engineering procedures/plans to complete its safety case report and enable operational readiness for transition, currently planned for June 2016.
2. NATS were employed by Transport and Housing Bureau (THB) to undertake an independent (snapshot) assessment of the operational readiness for transition of the new ATMS at December 2015, against the planned date for Day 1 transition of June 2016.
3. In order to achieve successful transition, CAD has to not only ensure that the engineering solution meets safety, integrity, availability, maintainability and usability / Human Machine Interface (HMI) requirements but also ensure that the technical system is fit for purpose in the context of the local specific operational environment. This will include surveillance, airspace and ATC procedures across Tower, Approach/Departure, Terminal and Area operations. This represents a significant and highly complex technology and people change programme.
4. Noting point 3 above, it is common that the engineering functionality / design and that of the local specific operational environment(s) need to be refined through an iterative process before becoming a good match. Accordingly it is both normal and expected that issues regarding the usability (i.e. Human Factors) of the system will be experienced as the engineering system is tested and validated.
5. It is emphasised to the reader that NATS has provided a snapshot of operational readiness at December 2015. Independently of NATS assessment, CAD already had in place planned system updates, training sessions and development of various procedures/plans to further enhance the operational readiness of the system. A comprehensive assessment of these activities and the overall plan between January 2016 and June 2016 was not within the scope of this study.

Method

6. This report provides evidence and commentary on the issues that NATS recommend to be addressed or managed to achieve a successful Day 1 transition.
7. In order to provide a clear status of transition readiness, NATS uses a Red, Amber, Green (RAG) status. The occurrence of Red or Amber status does not imply that the project is not under control, but is often an implication of the relative extent of complexity of the change programme and differences between the engineering setup and the local specific operational environment.
8. In making this assessment, NATS has considered the RAG status for the System Engineering (ENG) and Safety Assurance assessments (SAF) together with the results of the Human Factors (HF) and ATC assessments.

Findings

9. NATS considers the System Engineering and Safety Assurance of ATMS at December 2015 to be **Green** in that, based on the information provided, the control measures are in place and/or plans to implement them are credible (in terms of time, cost and quality). Limited further action is deemed necessary, with only areas of low impact to either Programme delivery, Operational Safety, or Service/Business Continuity having been identified. It should be recognised that these findings do not include those associated with the user display and HMI aspects of the ATMS as these have been considered separately in the HF assessment.

10. In making the Green assessment for ENG and SAF, NATS notes that the system engineering is safe, stable and reliable and in line with good practice. The assessment covers system robustness, cyber security, safety, integrity, stability, reliability, maintainability, availability, expandability, operational sustainability and integration with other sub-systems/systems. A small number of residual observations with potential low/medium impact are raised associated with assurance documentation together with the long-term maintainability and overall system life-cycle beyond Day 1 transition.

11. NATS considers the HF assessment at December 2015 to be **Amber**. An Amber assessment means that collectively the issues have the potential to impact upon delivery of service and need to be managed effectively. Specific areas that require improvement are given in this report. The assessment covers the effectiveness of HMI, such as user friendliness of system/controller functions, ergonomic design of the system.

12. In making the Amber assessment for HF, NATS notes a small number of residual observations with potential medium/high impact associated with specific issues, mitigation for which is provided within the HF high priority recommendations.

13. Details of the findings affecting Day 1 transition are in the main body of report.

Recommendations

14. Recommendations associated with the findings are included in the main body of the report. CAD has responded to reflect their current plans to address these findings.

15. Beyond the assessment scope of system readiness for Day 1 transition, there are some recommendations associated with best practice to further enhance system sustainability and maintenance beyond Day 1 transition. These are not considered to impact the technical readiness of the new ATMS or CAD have plans in place to deliver the assurance and confidence required; however for the overall operational readiness, these findings are recommended as requiring continued focus.

16. NATS has made 4 SAF and 11 HF high priority recommendations that are in progress by CAD at the time of writing. Active monitoring of high priority recommendations is normal.

17. The reader should note that it is NATS established best practice that identified issues can be addressed through a combination of improvements to the Engineered System, Training and/or ATC / Engineering procedures and plans. For instance, it is entirely appropriate and acceptable, subject to safety considerations, to mitigate a high priority HMI design issue through training and procedural changes, such that it can be managed until a system update removes the issue.

Overall assessment

18. NATS has assessed the overall operational readiness of the ATMS system at December 2015 for Day 1 transition in June 2016 as **Amber**. This should be interpreted as the overall operational readiness based on the status of contributing factors at December 2015 is at medium risk. It is normal practice for the project to complete the associated corrective actions within a clearly defined period (to be agreed with relevant stakeholders) to manage and reduce this risk.

19. Whilst no two operational transitions are identical, the number and severity of observations and recommendations raised by NATS is not unusual in relation to our experience of ATC transitions at a similar stage of development.

20. By successfully implementing the changes initiated by CAD and addressing the recommendations raised by NATS, it is expected that the Human Factors and overall operational readiness will be improved. NATS suggests that, following the delivery of this report, consideration be given to:

    a. Proactively monitoring NATS recommendations to validate the timely closure of corrective actions planned and proposed by CAD against defined success criteria; and

b. Continuing the Operational Readiness assessment following the delivery, testing and validation of forthcoming system updates of the ATMS to demonstrate convergence to an operational readiness appropriate for a controlled and successful operation transition. With this further work the consultant would, using established metrics, report progress of operational readiness of ATMS against the December 2015 snapshot and also target levels for operational transition.

21. In completing this report, NATS has compared this significant and complex transition to similar historical NATS transitions, including Heathrow, introduction of iFACTS to the Swanwick Centre, the transition to Prestwick Centre and the current transition at Prestwick to the SESAR iTEC platform. In this context, the scale of change faced by CAD is similar, and parallels exist between the challenges faced by NATS and by CAD. Common across these implementations has been the need to focus on Human Factors assurance across the whole transition period. The Human Factors recommendations raised in this report have parallels with NATS experience of transitions.

22. NATS would like to thank and commend CAD for the openness and support provided in undertaking and delivering this work. It is clear that staff and management are focused on achieving the successful Day 1 transition through their comprehensiveness and thoroughness of documentation, and preparatory work towards transition to the new ATMS.

1 Context and Study Scope

CAD is in the process of transitioning their ATC operations onto a new Air Traffic Management System (ATMS). The ATMS supports both Tower, Approach/Departure, Terminal and Area operations. Raytheon is providing the 'engineering' system under contract to CAD. CAD is installing the system, developing the associated ATC and engineering procedures/plans to enable readiness of operational transition, currently planned for June 2016.

Transport and Housing Bureau (THB) contracted NATS to undertake an independent assessment of the operational readiness of the new ATMS.

The Call for Tender (Reference 1) defined scope for the study. The key requirements are replicated below for convenience:

1. The Service Provider shall conduct on-site assessment (thereafter called "the Assessment") on the operational readiness and user friendliness of the new ATMS installed at CAD Headquarters and North Aerodrome Control Tower as details in paragraph 2.2 to 2.6 below (Section 2.1).
2. The Service Provider shall conduct an operational readiness review of the new ATMS, in terms of system robustness, safety, integrity, stability, reliability, maintainability, availability, and operational sustainability, integration with other sub-systems/systems, to be operated under an uninterrupted air traffic control environment within the designed operational life of the system (Section 2.2).
3. The Service Provider shall assess the effectiveness of Human Machine Interface (HMI) and associated usability, such as user friendliness of system/controller functions, ergonomic design of the system, human factors affecting different user groups (viz ATC operational staff, system support and engineering staff) in the effective operation and control of the system to support the current air traffic operations of some 1,200 flight movements and 700 overflying flights per day, as well as the projected traffic growth up to 2030 (Section 2.3).
4. The Service Provider shall evaluate the system expansion capability commensurate with projected air traffic growth (Section 2.4).
5. The Service Provider shall conduct the Assessment taking into account the Safety Case Report to be provided by Government to carry out a third party safety assessments with due emphasis to verify if the new ATMS and its software are operationally ready and safe for ATC operations. The Service Provider shall provide findings and practical recommendations to address safety concerns arising from the Assessment (Section 2.5).
6. The Service Provider shall evaluate the system compliance with relevant ICAO SARPS and international software development standard (Section 2.6).
7. The Service Provider shall meet with relevant CAD staff, and co-ordinate with CAD to acquire supporting documents (including the safety case report and safety documents) from the CAD and CAD's contractor(s) concerned during the conduct of the Assessment (Section 2.7).
8. The reports to be submitted by the Service Provider shall include, but not be limited to, the professional conclusion on the operational readiness of the new ATMS and effectiveness of HMI, as well as the pragmatic recommendations, with supporting reasons. All assumptions made in the Assessment shall be discussed and agreed with the Government and stated clearly in the reports (Section 3.5).

This document represents Deliverable D2 for the Operational Readiness Assessment for the New Air Traffic Management system, conducted by NATS Services (Asia Pacific) Pte Ltd for the Transport & Housing Bureau of the HKSAR Government. The project methodology was presented in Deliverable D1 (Reference 1). Section 2 of this report provides a recap of the methodology and analysis employed in the work, Section 3 provides the results of the analysis whilst Section 4 provides a list of recommendations for CAD as control measures for operational transition. Section 5 provides the conclusion of the report and proposes next steps.

2 NATS Methodology

2.1 Data Gathering and Scope

NATS methodology for undertaking this work is detailed in Reference 1. NATS main data gathering was on site in Hong Kong between 30th November and 4th December 2015. NATS provided an engineering SME, Human Factors SME and an ATC Operational SME all with direct and extensive experience of ATC operational transition.

CAD provided open and free access to staff and facilities to support NATS work. To undertake the review, NATS used industry standard criteria for both engineering and Human Factors assessment. NATS analysis focused on:

System Engineering and Safety Assurance;

a. Design assurance and software development compliance;
b. System architecture and integration to sub-systems;
c. Engineering training and procedures, including logistics, supportability and configuration;
d. Acceptance, transition and reversion plans;
e. Safety, ARM (Availability, Reliability and Maintainability);
f. Software assurance review to Eurocae ED109 guidelines; and
g. Readiness demonstrations and transition plans.
h. Cyber security compliance (against ISO 27002)

[Note – The Engineering and Safety Assurance methodology is outlined in Appendix 2].

Impact of Change (ATC)*; and

a. Understanding of change;
b. Understanding of procedures;
c. Overall user friendliness/ease of use; and
d. Perceived system reliability.

Human Factors;

a. Controller situation awareness and controller workload;
b. Teamwork and communications;
c. User acceptance;
d. Training; and
e. HMI design.

[*Note that the results from staff's assessment of impact of change overlap and re-enforce findings reported within the Human Factors analysis. For this reason, they are both reported under Human Factors].

In preparation for the site visit, CAD provided project, engineering (including cyber security), and operational documentation listed in Appendix 1.

The observations arising from the criteria for each of the three areas (System Engineering and Safety Assurance, Impact of Change / ATC Review, and Human Factors) were assessed against their potential impact (High, Medium or Low).

2.2 Overall Analysis

In order to provide an overall assessment of operational readiness NATS also provide a RAG at the Overall Operational Readiness level to reflect the potential impact of the issue, as illustrated in Figure 1 below.

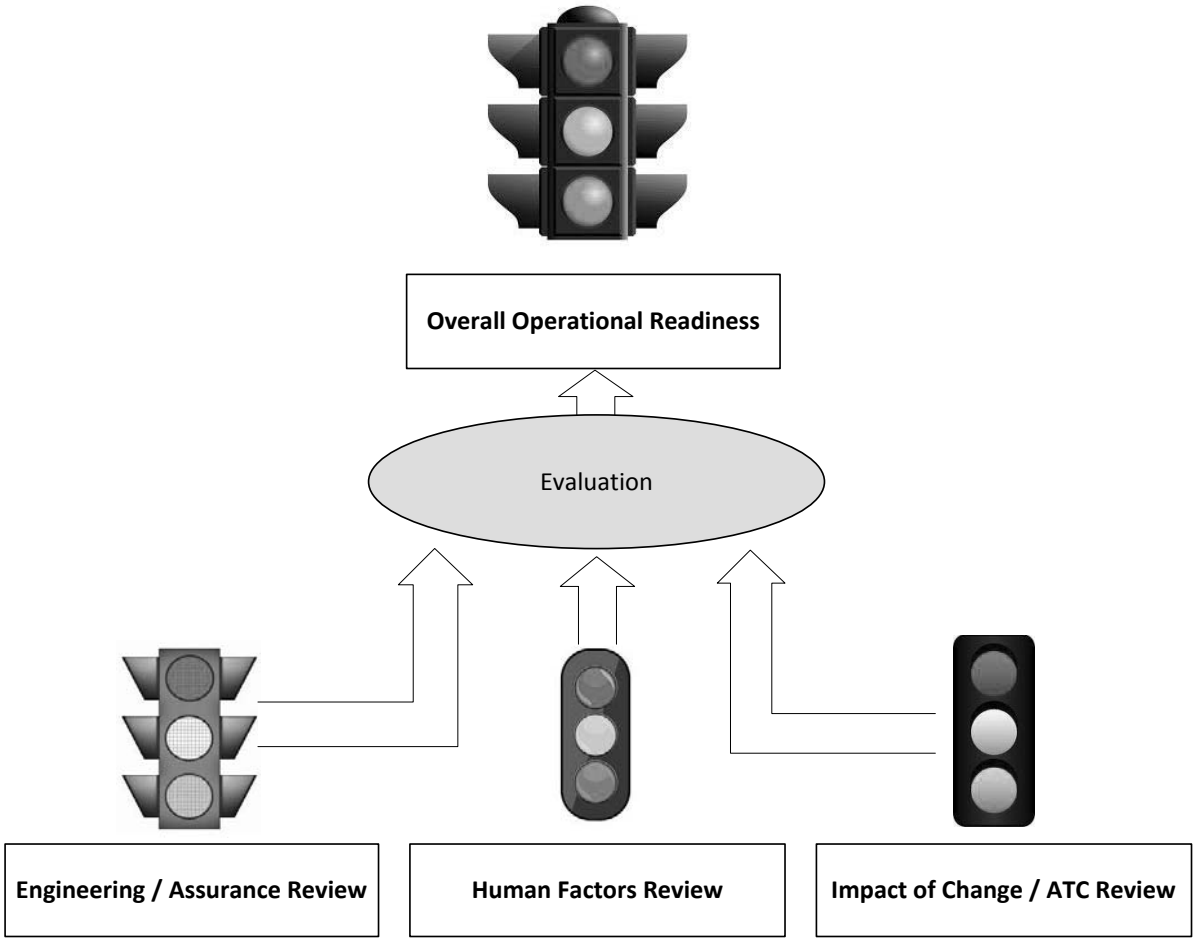


Figure 1 – NATS Assessment Methodology

The Overall Operational Readiness RAG is detailed below.

Overall Operational Readiness RAG Definitions	
Red	This means the overall operational readiness is at High risk. The project requires urgent support and attention from senior staff and stakeholders to achieve successful implementation. This is based on an evaluation of the contributing factors from the sub-ordinate reviews.
Amber	This means the overall operational readiness based on the contributing factors is at Medium risk. The project must complete corrective actions within a defined period (to be agreed and monitored with relevant stakeholders).
Green	This means the overall operational readiness based on the contributing factors is at Low risk. This means that any actions placed on the project (as agreed and monitored with relevant stakeholders) will be completed by dates agreed between the relevant parties of the Project.

2.3 Recommendations

In order to facilitate CAD's follow-up to this report, NATS has supplemented the observations with a set of prioritised recommendations as follows:

- **High** – a recommendation to be addressed prior to Day 1 (Operational transition) in response to an observation that has a high impact and/or occurs frequently. Active monitoring of High priority recommendations is normal;

- **Medium** – a recommendation to address an observation that can be managed in the short term but should be addressed after Day 1. For medium recommendations, plans should be developed and agreed before Day 1. Active monitoring of Medium priority recommendations is normal;
- **Low** – a recommendation that is intended to provide additional benefits, provides additional mitigation to another issue or is considered best / good practice. A low priority recommendation can be adopted either prior to or following initial transition.

3 Results

3.1 Understanding Operational Readiness Analysis

It is important to put the operational readiness results into context, specifically for an organisation such as CAD who are deploying Commercial Off the Shelf (COTS) engineering systems into a specific operation environment.

In order to achieve successful transition CAD has to not only ensure that the COTS solution meets safety, integrity, availability, maintainability and usability requirements but also has to ensure that the technical system is fit for purpose in the context of the local specific operational environment (which will include surveillance, airspace and ATC procedures). It is quite common that the COTS functionality and design and the demands of the local specific operational environment need to be refined before becoming a good match.

It is therefore normal and expected that issues regarding the usability (human factors) of the system will be experienced as the COTS system is tested and validated.

3.2 System Engineering and Safety Assurance Observations and Assessment (ENG/SAF)

Note – Grey shaded recommendations indicate those closed in the period between Dec 15 and the publication of the report (Feb 16).

REC Id	Recommendation	CAD Additional Remarks[1]	Assessed Potential Impact	Day 1 Priority
REC 1 (SAF)	Ensure the plans and schedules to complete the safety case documentation is aligned with the delivery of the dependent evidence artefacts needed to support the assurance arguments and claims (Goals) being made. .	The documentation as referenced in the ATMS Safety Case Report is either available or "work in progress" due to on-going or scheduled activities that have not reached their target completion dates. The respective SMEs (engineering and operational) would ensure the on-time delivery of outstanding documentation required in the Report, which itself is to be agreed before Day 1.	Low (Plans for documentation completion are credible – hence considered Low impact)	High (noting the impact of the availability of the safety case on transition timescales and requirement for active monitoring)
REC 2 (SAF)	Ensure the ATC and Engineering Fall-back procedures are completed and subject to verification, validation and training to ensure their effectiveness.	Fall-back procedures would tally with the Contingency Plan, the formulation of which includes the analysis / assessment of the engineering and operational aspects and is "work in progress" to be completed before Day 1. Consolidated Maintenance Training held in Jan 2016 has covered the fall-back procedures and drills to validate effectiveness of procedures. Fall-back procedures are standing tasks (Items B1-5 and B1-6) to be in place prior to Day 1 under CAD's Implementation and Transition Task Force (ITTF) which was established in July 2011.	Low	High (noting the impact on the safety case and transition timescales)

REC 3 (SAF)	The Safety assessment and safety case reporting for Fall-backs is built into the +Project schedule.	CAD have identified to NATS that contingency plan and arrangements are standing work items under CAD's ITTF to be in place prior to Day 1. The safety case of the fall-back procedures is covered under the ATMS Safety Case, which is being developed jointly with another external consultant. The developed ATMS Safety Case would be agreed before Day 1 with outstanding items (actions and documentation) completed, inclusive therefore of the fall-back procedure case.	Medium	High (noting the impact on the safety case and transition timescales)
REC 4 (SAF)	To ensure the predicted reliability and availability analysis that supports the ATMS Safety Case Report is developed in line with good practice and is technically accurate, the supporting analysis and data associated with dependent failure scenarios should be reviewed.	The ATMS has been designed to have Main and Fallback Systems, operating in full redundancy; Sys 1 and Sys 2 can interchange their roles of Main and Fallback. There are fallback operating modes within Main and within Fallback Systems to support ATC operations. To guard against common mode failure, ATMS is also equipped with an Ultimate Fallback System (UFS) provided by another company as a sub-contractor to Raytheon. UFS is a constantly running and readily available system to eliminate common mode failure. As an on-going practice, CAD monitors system performance against the RMA analysis figures, via for instance, Safety Performance Target (SPT) and Safety Performance Index (SPI) and makes practicable and corresponding enhancements in any areas that require attention. CAD is in the process of fine tuning the SPT and SPI for the new system with dedication meetings and workshops, attended by all stakeholders.	Medium	High (noting the potential impact to the validity of the safety case) **Recommendation Closed**

REC 5 (SAF)	CAD to complete the Software assurance for builds since Build 1 as identified in the preliminary version of ATMS Safety Case Report.	CAD have identified to NATS the current software assurance practices followed by CAD are supported by those listed below. These will continue for subsequent software builds to provide "integrity assurance for new ATMS software builds subsequent to build 1". These practices include the following elements aside from verification of planned items: • additional test; • stop-n-go during build verification • and ad-hoc and system performance by engineering and staff on self-verification at each build release, • small to large scale Normal ATC Operations (which is a form of shadowing) involving a sizable number of operational and engineering staff • training courses on Simulator (with same build deployed) • internal testing at factory by Contractor; • dry-runs at site and test readiness review with CAD • Planned Shadowing in first half of 2016 for the operational build.	Low	High (noting the impact on the safety case and transition timescales)

3.3 Human Factor Observations and Assessment

Note – Grey shaded recommendations indicate those closed in the period between Dec 15 and the publication of the report (Feb 16).

HF Issue	REC Id	Recommendation	CAD Additional Remarks[2]	Assessed Potential Impact	Day 1 Priority
When the AutoDB function moves the DB, it does not take into account the relative positions of the aircraft/TPS when moving the DB to new locations. It appears to locate empty space regardless of the position and order of the aircraft, resulting in frequent transposition of DBs and crossing of leaderlines.	REC 6 (HF).	Consideration should be given to significant re-design of the auto-de-conflict function of Data Blocks so that: (i) it recognises other elements on the SIT display and does not overlap with these elements; (ii) the label position does not transpose with adjacent Data Blocks; (iii) it preserves the relative position and order of the Data Blocks so that it remains consistent with the relative position and order of the actual aircraft.	This observation was reported to Raytheon during system acceptance tests and the project team handled it under a higher priority. Improvement made in phases with a recent on-site demonstration made during Build 3 verification period in Dec 2015 to fine-tune the exact implementation. Agreement made with Raytheon in August 2015 to have the leader line de-conflict algorithm delivered in Build 4 in March 2016. Part of the recommendation has been addressed in Build 2A, while the rest will be addressed in Build 4.	High	**High**
The timely availability of TCC indicator and critical ATC information is critical to maintain situational awareness and minimize potential human error. The observed operational practice required the controllers to copy all TCC, ActRq and Emphasis Indicator data entered into the	REC 7 (HF).	Rectify the loss of TCC green highlight and information on other controller-directed input fields when sector is handed over or combined and de-combined or an	This observation was drawn to the CAD's attention during Module 3 conversion training. The project team handled it under a higher priority. Recently, the system database has been adapted to move the TCC field to page 1 of FDL. The loss of TCC green	High	**High** **Recommendation Closed**

system on paper and then re-enter into system. The consequence of this mitigation created additional workload for the controllers. In addition, this mitigation introduces risk of controller errors in transcription errors on paper and data re-entering errors into the system The recent adaptation to move TCC field to page 1 of the FDL and the proposed enhancement in Build 4 (to be delivered in March 2016) which allows the Emphasis Indicators to be retained after sectors combine should resolve the issue. The adaptation and proposed Build 4 enhancements should be evaluated after implementation for assurance.		interim procedural solution.	highlight does not exist anymore.		
	REC 8 (HF).	Re-assess the suitability of the mitigation requiring the controllers to copy all TCC, ActRq and Emphasis Indicator data entered into the system on paper and then re-enter into system for sector handover and sector combine and de-combine.	This observation was reported to Raytheon during system acceptance tests and the project team handled it under a higher priority. Agreement has been made with Raytheon to implement enhancement in Build 4 to be delivered in March 2016. The enhancement allows the Emphasis Indicators to be retained after sectors combine/de-combine. ATC procedure will also be fine-tuned to eliminate the need to use paper.	**High**	**High**
EFS can be sorted by user preferences. There are about 20 different information categories. There are no operational rules or recommendations on how the ATCOs in each position should set the sort preference. It will be prudent to provide the controllers with guidance on best practice for the settings on sort preferences for the EFS; to make the presentation of EFS and EFS display consistent between controllers on the same sector groups as well as achieve consistent practice in management of EFS between ATCOs.	REC 9 (HF).	Provide controllers with guidance on specific EFS sort settings to standardise the EFS strip display parameters between relevant positions.	The need to define default settings was raised during a review of conversion training in Q3 2015. It is our plan to finalise the default settings after delivery of Build 4 in March 2016. CAD will take this recommendation into consideration when determining the default settings. Guidance on preferred settings will also be included in the Manual of ATC.	Medium	**High**
During the site visit (Dec 15) the distance displayed was seen to change erratically because of the SIT display update algorithm and have impact on controller's situation awareness and decision making. For example, the Finals Director and the Area South controllers use the RBL to sequence arrivals and I/B respectively and make critical judgements on the separation between the aircraft using the RBL. If the	REC 10 (HF)	CAD are asked to assure that that the distance and bearing information in RBL label has been corrected and that the solution will be monitored to ensure that it is sufficiently accurate and	The CAD project team has been well aware of the issue which has been fixed in Build 3 in December 2015, which was not available at the time of the NATS visit. Subsequent to the fix, the distance information becomes much more reliable than the existing system, in which the behaviour did not trigger any decision or	High	**High** **Recommendation Closed**

distance between the aircraft as shown by the RBL fluctuates, controllers will find it difficult to make correct judgements.		reliable.	judgement issues during the last 17 years. The impact of this change will be monitored closely.		
The "small" setting equates to 10 minutes of arc subtended at the eye for a viewing distance of 600mm, which is approximately 38% smaller than the minimum acceptable character height in HMI Standards.	REC 11 (HF)	Provide controllers with a recommended setting for font size for the critical ATC information to ensure consistency in legibility requirements. Currently, the "small" setting should be avoided where possible for safety critical ATC information.	CAD will provide controllers with recommended settings and this information will be included in the Manual of ATC.	Medium	**High**
Controllers and project team members report that the audio alerts for Safety net and Flight plan error alerts perceptually sound the same, even though in the software the alerts use different audio files. HMI standard for safety net requires that the audio alerts for such alerts should be distinct from alert functions with audio means. System error alerts are cautionary or advisory messages. The repeated audio for system errors should correspond with the criticality of the event. It should not be distracting and cause impacts on mental workload. There is a hotkey on the keyboard which is a "Cancel" audio alerts key and cancels all audio alerts with a suppression period of 10 seconds, including STCA and all safety net alerts. New safety events triggered during the suspension period will over-ride the suspension and trigger a safety alert.	REC 12 (HF)	Audio alerts for alarms in the Safety Net category, especially STCA, MSAW and SUA should be distinctly different from the audio alerts for flight planning error warnings.	This is relating to alert management requirements, which was reported to Raytheon during system acceptance tests, and the CAD project team handled it under a higher priority. Agreement made with Raytheon in July 2015 to have the enhanced function in Build 4. Different audio alerts will be used.	High	**High**
	REC 13 (HF)	CAD are asked to assure that the Audio alerts for alarms in the Safety Net category will be triggered when the hot key function which cancels all audio alerts is pressed, especially if the safety net event occurs immediately before, at the same time or immediately after the hot key is pressed.	CAD advised that the hot key function will only suppress the alarm for 10 seconds whenever it is pressed. New alerts will trigger the alarm despite hotkey being pressed to keep operational controllers alerted.	High	**High** **Recommendation Closed**

The Training Effectiveness mean scores in the Human Factors were low, reflecting that controllers require more training to improve their familiarity and ability to use the new system to carry out the current procedures. The controllers reported that they had forgotten a lot of what their learnt in previous modules. In addition, previous training modules were based on a previous build of ATMS and some of the knowledge from previous training modules were no longer applicable.	REC 14 (HF)	A unit training plan should be produced, specifying: (i) the training objectives based on the difference between Build 2 and Build 3 and; (ii) training objectives based on the difference between Build 3 and Build 4 and implement the training module.	During previous modules of conversion training, controllers were briefed of the new functions/behaviours of latest software build. CAD have advised that they will incorporate the recommendation into future conversion training plans.	Medium	**High** **Recommendation Closed**
Training tasks in the Human Factors Review which showed relatively lower scores were Combining / de-combining sectors and CJS absorption and handling traffic deviations due to weather. During the Module 3 simulation training, the fidelity of the traffic situation and scenarios were lower than expected compared to reality, in terms of: (i) traffic levels, (ii) complexity, (iii) weather severity, (iv) absence of practice in night-time operations and (v) unexpected events	REC 15 (HF)	Additional training modules should be included in the training programme, which include simulation exercises to ensure controller performance in high traffic levels and at least at sector capacity and complexity.	In response to feedbacks raised during Module 3 training, CAD has critically reviewed the training plan to ensure sufficient hands-on practice for controllers. Subsequent to the review in December 2015, Module 3A and Module 4 are planned to be included before transition activities.	High	**High**
	REC 16 (HF)	A unit training plan should be produced, specifying the training objectives for a variety of critical ATC events and emergencies, including severe weather, night-time operations and system failure, and implement the training module.	In response to feedback raised during Module 3 training, CAD has critically reviewed the training plan to ensure sufficient hands-on practice for controllers. Subsequent to the review in December 2015, the forthcoming Module 3A and Module 4 are planned to be included before transition activities. It is an established practice for ATC training to cover unusual situations and emergency training. Weather deviation scenario has been covered in Module 3 training and will also be included in Module 4 training to reinforce the skills of controllers. The other critical events have	High	**High**

			been incorporated in Module 4 training.		
Majority of the training tasks received a low response.	REC 17 (HF)	Controller performance should be measured and evaluated during all training modules to monitor training effectiveness and validate readiness and confidence.	Evaluation of controller performance against training objectives was incorporated in Module 3 training. Evaluation of staff readiness and confidence will be included in future training modules.	High	**High**
ATC manpower has been strained with officers deployed to work Replacement ATC system project related duties. The Project, Procedures and Training teams appear too small to effectively prepare for a transition of this size within the current transition timescales, The tight manpower situation of operational ATCOs has made it difficult to release staff from their operational roster for conversion training resulting in long intervals between training modules.	REC 18 (HF)	Consider alternative methods of increasing resource through rostering methods in current operation or increased supply through overtime agreement. Delaying the transition date would assist in the resolution of the issues stated above.	2 new controllers, 1 for each of Approach and Area streams have joined the CAD Project Team to assist in preparation of Module 4 training and subsequent transition activities. Adequate training and hands-on practice will be arranged for all operational controllers.	Medium	**High**
It is clear that system functionality issues have affected the Area ATC function to a much larger extent than the Tower or Approach functions.	REC 19 (HF)	Although it is understood that this approach would bring a number of new issues into the transition plan, consideration could be given to a phased transition with Tower followed by Approach / Area at a later date.	CAD is considering the phased transition of Tower operations first followed by the more complex Approach and Area operations. A transition plan has been developed to implement this approach in a controlled and progressive manner. Related safety assessment will be conducted to ensure identified risks be properly managed.	Medium	**High**
Crucial information was observed not being transferred during sector handovers between controllers. This should be	REC 20 (HF)	System software fix to resolve the loss of free text during sector handovers	To meet the unique operational setup for CAD, simultaneous inputs/changes to the same aircraft	High	**High**

completely rectified prior to ATC operation under live environment.		or an interim, procedural solution such as leaving this position permanently logged on without user handovers	by different controllers is not accepted by the system in the current design so as to maintain the data integrity., The CAD Project Team has been working with Raytheon to address several related issues. The proposed enhancements are under joint review and it is targeted to implement these changes in Build 4 in March 2016.		

3.4 Readiness of ATMS - System Engineering and Safety Assurance Results

NATS considers the System Engineering and Safety Assurance of ATMS at December 2015 to be **Green** in that, based on the information provided, the control measures are in place and/or plans to implement them are credible (in terms of time, cost and quality). Limited or no need for further action is deemed necessary, with only areas of low impact to either Programme delivery, Operational Safety or Service/Business Continuity have been identified. It should be recognised that these findings do not include those associated with the user display and HMI aspects of the ATMS as these have been considered separately in the HMI / Human Factors / ATC assessments.

In making the overall Green assessment for System Engineering and Safety Assurance NATS notes that the system engineering is safe, stable and reliable and in line with good practice. The assessment covers system robustness, safety, integrity, stability, reliability, maintainability, availability, and operational sustainability, integration with other sub-systems/systems. A small number of observations are raised associated with assurance documentation together with the long-term maintainability and overall system life-cycle beyond Day 1 transition. These are not considered to impact the technical readiness of the new ATMS or they have plans in place to deliver the assurance and confidence required; however for the overall operational readiness, these findings are recommended as requiring continued focus.

The assessment of the ATMS capacity and capability to cope with projected traffic growth for the Three Runway System for the HKIA was demonstrated during the Site Acceptance Testing of the ATMS, with additional room for equipment expansion to handle further increase of traffic. On this basis the system load tests correlate to predicted traffic growth.

NATS assessment of the ATMS cyber security policies, processes and technical controls measures focused on documentation provided by CAD (see Appendix 1) against ISO 27002 and ICAO requirements. Overall, the analysis indicates a good commitment to establishing an effective Information Security Management System, with a sound and broad list of activities supporting the implementation of security requirements. NATS suggest CAD further evidence and validate the documentation review to ensure that the people using and supporting the ATMS are working consistently in line with the documented processes.

3.5 Human Factor and HF Results

In order to achieve successful transition CAD has to not only ensure that the engineering solution meets safety, integrity, availability, maintainability and usability / Human Machine Interface (HMI) requirements but also has to ensure that the technical system is fit for purpose in the context of the local specific operational environment. This will include surveillance, airspace and ATC procedures across Tower, Approach/Departure, Terminal and Area operations. This represents a significant and highly complex technology and people change programme.

It is quite common that the engineering functionality / design and that of the operational environment(s) need to be refined before becoming a good match. Accordingly it is both normal and expected that issues regarding the usability (i.e. Human Factors) of the system will be experienced as the engineering system is tested and used for training.

NATS considers the Human Factors assessment as **Amber**. Noting the above, it is expected that issues of the type identified may be encountered prior to the implementation of an operational change, however unless they are addressed, the issues have the potential to impact upon delivery of service unless managed effectively. In making the Amber assessment for Human Factors NATS notes a small number of residual medium/high priority observations associated with specific issues, mitigation for which is

provided within the HF high priority recommendations. The assessment covers the effectiveness of HMI, such as user friendliness of system/controller functions, and ergonomic design of the system.

3.6 Overall Results

NATS has assessed the overall operational readiness of the ATMS system at December 2015 for a Day 1 transition in June 2016 as **Amber**. This should be interpreted as the overall operational readiness based on the contributing factors at December 2015 is at medium risk. It is normal practice for the project to complete the associated corrective actions within a clearly defined period (to be agreed with relevant stakeholders) to manage and reduce this risk.

Whilst no two operational transitions are identical, the number and severity of observations and recommendations raised by NATS is not unusual in relation to our experience of ATC transitions at similar stages of development.

4 Recommendations

Summarising the information presented in Section 3, NATS has made 4 System Assurance and 11 Human Factor high priority recommendations that are in progress by CAD at the time of writing, and are considered high priority to be addressed prior to operational transition.

It is normal practice for the project to complete the associated corrective actions within a defined period (to be agreed with relevant stakeholders) to manage and reduce this risk.

The reader should note that it is NATS established best practice that identified issues can be addressed through a combination of improvements to the Engineering System, Training and/or ATC / Engineering procedures. For instance it can be entirely appropriate and acceptable, subject to safety considerations, to mitigate a high priority HMI design issue through training and procedural changes, such that it can be managed until a system update removes the issue.

NATS understands that CAD had already planned system updates, training sessions and development of various procedures/plans earlier through its various established task force/working groups. By successfully implementing the changes initiated by CAD and addressing the recommendations raised by NATS, it is expected that the Human Factors and over-all operational readiness will be improved.

Beyond the assessment scope of system readiness and Day 1 transition, there are some recommendations associated with best practice to further enhance system sustainability / maintenance beyond Day 1 transition.

5 Conclusions and Next Steps

NATS has undertaken a short focused review of the operational readiness of the ATMS system at December 2015. The planned Day 1 transition date at the time of the study is June 2016.

NATS considers the outcomes of assessment for System Engineering and Safety Assurance of ATMS to be **Green**, whilst the Human Factors of the ATMS to be **Amber.** The overall Operational Readiness is **Amber**.

NATS has made recommendations, predominantly associated with Human Factors, a number of which are High Priority (necessary to be addressed prior to operational transition). By successfully addressing the recommendations raised by NATS it is expected that the Human Factors and over all operational readiness will be improved. NATS suggests that, following the delivery of this report, considerations be given to:

a) Proactively monitoring NATS recommendations to validate the timely closure of corrective actions planned and proposed by CAD against defined success criteria; and

b) Continuing the Operational Readiness assessment following the delivery, testing and validation of forthcoming system updates of the ATMS to demonstrate convergence to an operational readiness appropriate for a controlled and successful operation transition. With this further work the consultant would, using established metrics, report progress of operational readiness of ATMS against the December 2015 snapshot and also target levels for operational transition.

In completing this report, NATS has compared this significant and complex transition to similar historical NATS transitions, including Heathrow, introduction of iFACTS to the Swanwick Centre, the transition to Prestwick Centre and the current transition at Prestwick to the SESAR iTEC platform. In this context, the scale of change faced by CAD is similar, and parallels exist between the challenges faced by NATS and by CAD. Common across these implementations has been the need to focus on Human Factors assurance across the whole transition period. The Human Factors recommendations raised in this report have parallels with NATS experience of transitions.

NATS would like to thank and commend CAD for the openness and support provided in undertaking and delivering this work. It is clear that staff and management are focused on achieving the successful Day 1 transition through their comprehensiveness and thoroughness of documentation, and preparatory work towards transition to the new ATMS.

5.1 Additional Information / Insight

In addition to the Operational Readiness assessment, two specific issues were raised within our work with CAD associated with the programmatic elements of the transition that are reported below for completeness and further consideration.

Timing of Day 1 transition

The current readiness date for a so-called ‘Big-Bang’ transition is targeted for June 2016, which coincides with the typhoon season. Staff interviewed raised concerns that their ability to safely operate the new system in high levels of traffic, combined with significant weather deviations, would be compromised.

It was raised by two Operational Supervisors that they had concerns regarding their responsibility for managing workload of staff, using new equipment, with the increased complexity of major weather deviations in their airspace. Additional concerns were raised that significant weather over the South China Sea can re-route entire flows of overflying traffic into Hong Kong airspace causing further workload and complexity during this crucial transition period.

Avoidance of inclement weather and peak air traffic periods through suitable scheduling of transition date for an ATMS is common practice to minimize/avoid unnecessary risk.

CAD therefore should review if rescheduling the transition target date until October/November 2016 as this should significantly reduce the safety risk of increased workload and complexity caused by weather.

Irrespective of timing of the ATCC transition, the potential control measure of ATC Flow restrictions in Hong Kong airspace during transition to reduce traffic levels and workload via Tactical ATC flow, as proposed by CAD, are not considered the only means to contain controllers' workload during transition. NATS' suggests that consideration is given to imposing additional proactive measures, such as reduction in slot allocation, to ensure traffic levels and hence workload is managed appropriately.

Phased Transition – operation transition of Aerodrome Control Tower (TWR)

As another option other than the 'Big-Bang' transition, CAD have considered is the feasibility of Phased Transition approach such as the operation transition of TWR first, and subsequently the ATCC transition after an appropriate period of time. The nature of TWR operation is such that its operation is relatively less susceptible to the impact of weather conditions and it is less operationally dependent on/integrated with the ATCC operations. Compared to the Phased Transition of Approach, Area or TMC sectors, Phased Transition of TWR is expected to require less additional manpower resources, seemingly fewer safety risks and at the same time enhancing staff confidence in the new system. Such an option is of course subject to a safety assessment and relevant transition plan to verify its practicability.

Over the course of this study, CAD have developed an ATC Operation Transition Plan for Hong Kong ATC Centre & ADC Tower. NATS has reviewed this together with the Safety Case Assessment and Reporting System (SCARS) report. The Phased Functional Implementation plan is robust with cases of good practice including checklist driven briefings and practice drills prior to both shadowing activity and the live operational trials. Resources have been planned to include good availability of advisors and co-ordinators that are essential to successful outcomes with the PFI plan.

NATS suggest that CAD continue to assess progress through success criteria on and monitoring of handling unusual events that may occur during shadowing and operational trial sessions. Overall, Hong Kong CAD have presented a logical and well planned activity which has sound practice to enable a successful Phased Functional Implementation of the new Tower capability and a firm basis to move forward to full implementation.

References

1. D1 Methodology Report (Operational Readiness Assessment On New Air Traffic Management System for Transport & Housing Bureau, HKSAR Government) Issue 1.2, 2nd December 2015) NATS Private – Commercial in confidence

Item	Document
1	Organisation Structure (Project and Operational – Eng and ATC)
2	Project Issue Log – including all (i) issues raised, (ii) open and (iii) close, with date, rationale.
3	Project Deliverables list
4	Project High Level Design document
5	Top Level Project Management Plan
6	Contractor's list
7	User feedback
8	Preliminary draft version of Safety Case for Implementation and Transition of Replacement ATC System Project Ed 1 dd 30 Nov 2015
9	Safety Case Report for Air Traffic Management System Edition 1, 31 December 2015.
10	Manual of ATC
11	Divisional Information Circular
12	Communications Staff Meeting records
13	ATS Management Meeting records
14	Records of project progress briefings for operational and engineering staff
15	Airline briefing sessions records
16	Records of interactions with ATMS Contractors
17	Project SMS for Replacement ATCC – Hazard Log, AES/SMS/2110
18	PLN2/12/4 ATC Services/Replacement of ATC System/General
19	Network failure testing results
20	Target load testing results
21	Flight plan loading testing results
22	Airspace Management Manual (ASMM), Ed 1.2 December 2013, Amendment 2 March 2015, CAD
23	ATMS Hazard Log, HKCAD-ATMS-04-039 2.0 Hazard Log.xlsx
24	Monthly Project Report for ATMS – Project Plan, Programmed and Progress Report
25	Raytheon Response to Questions from 24 April Teleconference with CAD and EC Harris
26	Raytheon Response to further questions sent 22 June 2015. Further questions for Raytheon 23 June 2015 + RTN responses.doc
27	Responses from Raytheon to clarification request sent 19 Aug 2015, Safety case request for clarifications from Raytheon 19-08
28	ATMS Safety Case Checklist
29	List of document references in ATMS Safety Case
30	Assessments on System Readiness of the new ATMS Cyber Security Measures V3
31	Cyber Security Manual for Air Traffic Services (ATS) Systems and Services Edition 2.0
32	Cyber Security Handbook for Air Traffic Services (ATS) Systems and Services Edition 2.0
33	CAD ANS Cyber Security Committee (CACSC) V3
34	CAD ANS Cyber Security Working Group (CACSWG) V3

APPENDIX 2 – Engineering and Safety Assurance Methodology

In support of the readiness activity a System Engineering and Assurance methodology has been used based on a number of contributing factors, primarily:-

- **Standards and Processes:** NATS have developed its engineering lifecycle and assurance processes based on internationally recognised industry standards, recommended practices and guidelines, in particular those employed across Europe.
- **Experience:** NATS has also successfully undertaken a number of large scale Programmes introducing significant changes to the UK Air Traffic Management Systems at Swanwick, Prestwick and Heathrow. The experiences from these Projects and Programmes have been used to inform and improve the NATS Processes.

Based on the contributing factors described above, the method for the Engineering and Assurance review has been to develop and apply a tailored framework of questions and queries associated with the engineering lifecycle, governance and assurance processes as applied in NATS for the delivery of major changes. These processes have been reviewed to extract the key elements applicable to this activity.

The methodology is graphically represented in Figure 2 below. As part of this framework NATS has taken its standard approach to systems performance and verification testing to review the adequacy of technical solution approaches covering pre-visit document reviews and on-site reviews of:

- Verification and validation approach and coverage; and
- Performance testing, soak tests, performance tests, functional testing, non-functional testing, fall-back mode testing.

NATS has also undertaken meeting and documentation-based reviews to assess the robustness and resilience of the solution, in particular:

- Design assurance and software development compliance;
- System architecture and integration to sub-systems;
- Engineering training and procedures, including logistics, supportability and configuration;
- Acceptance, transition and reversion plans;
- Safety, ARM (Availability, Reliability and Maintainability);
- Software assurance review to ED109; and
- Readiness demonstrations and transition plans.

Within the scope of this study, NATS cyber security assessment was a paper-based analysis against international standard for information security ISO 27002 and ICAO Doc 9985 requirements. This standard includes a number of areas as summarised below:

- Organization of Information Security;
- Human Resource Security;
- Asset Management;
- Access Control;
- Cryptography;
- Physical and environmental security;
- Operation Security;
- Communication security;
- System acquisition, development and maintenance;
- Supplier relationships;
- Information security incident management; and
- Information security aspects of business continuity management.

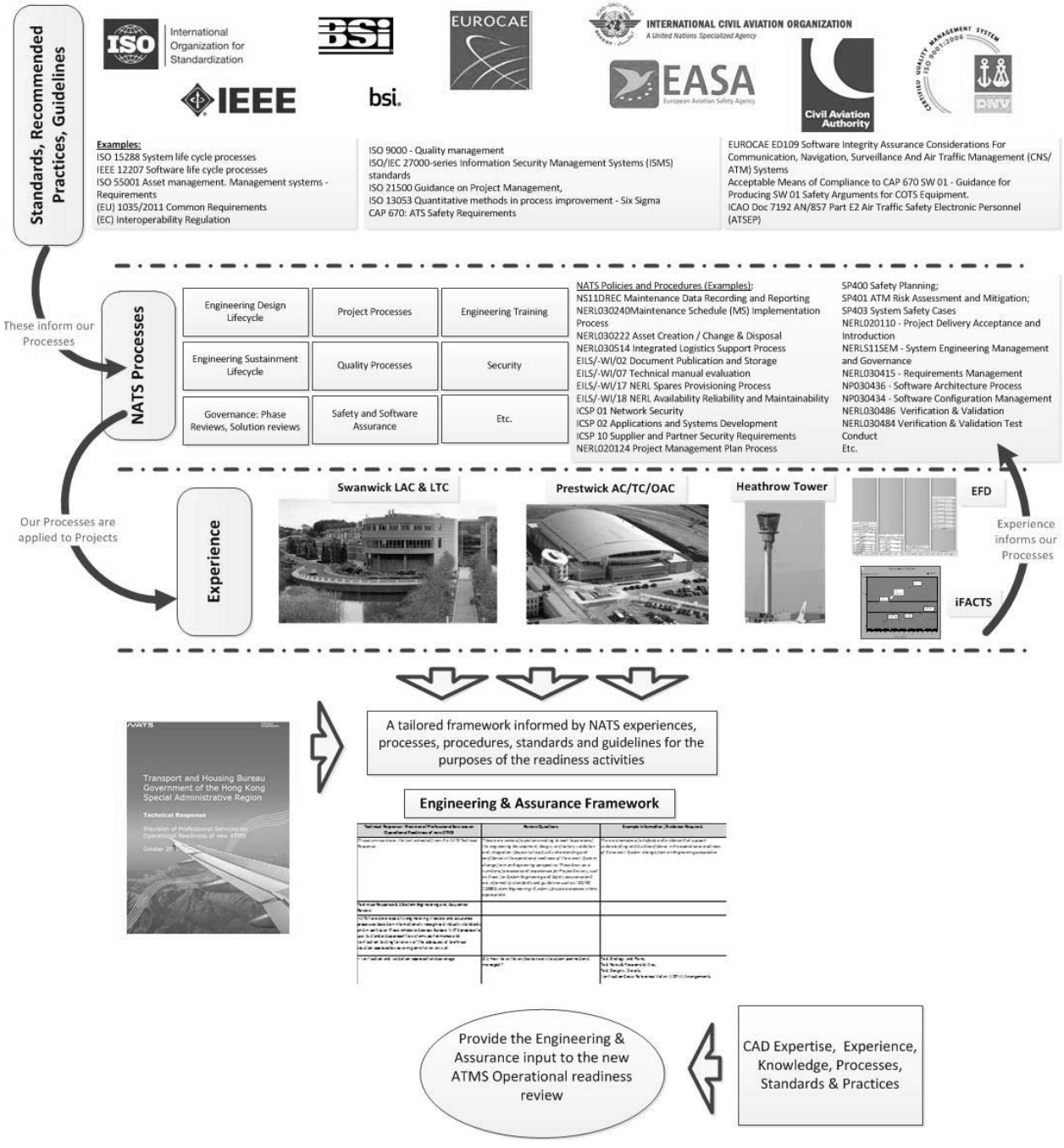


Figure 2- NATS Engineering and Safety Assurance Methodology

Annex B

NATS

Performance through Innovation

Transport and Housing Bureau - Hong Kong

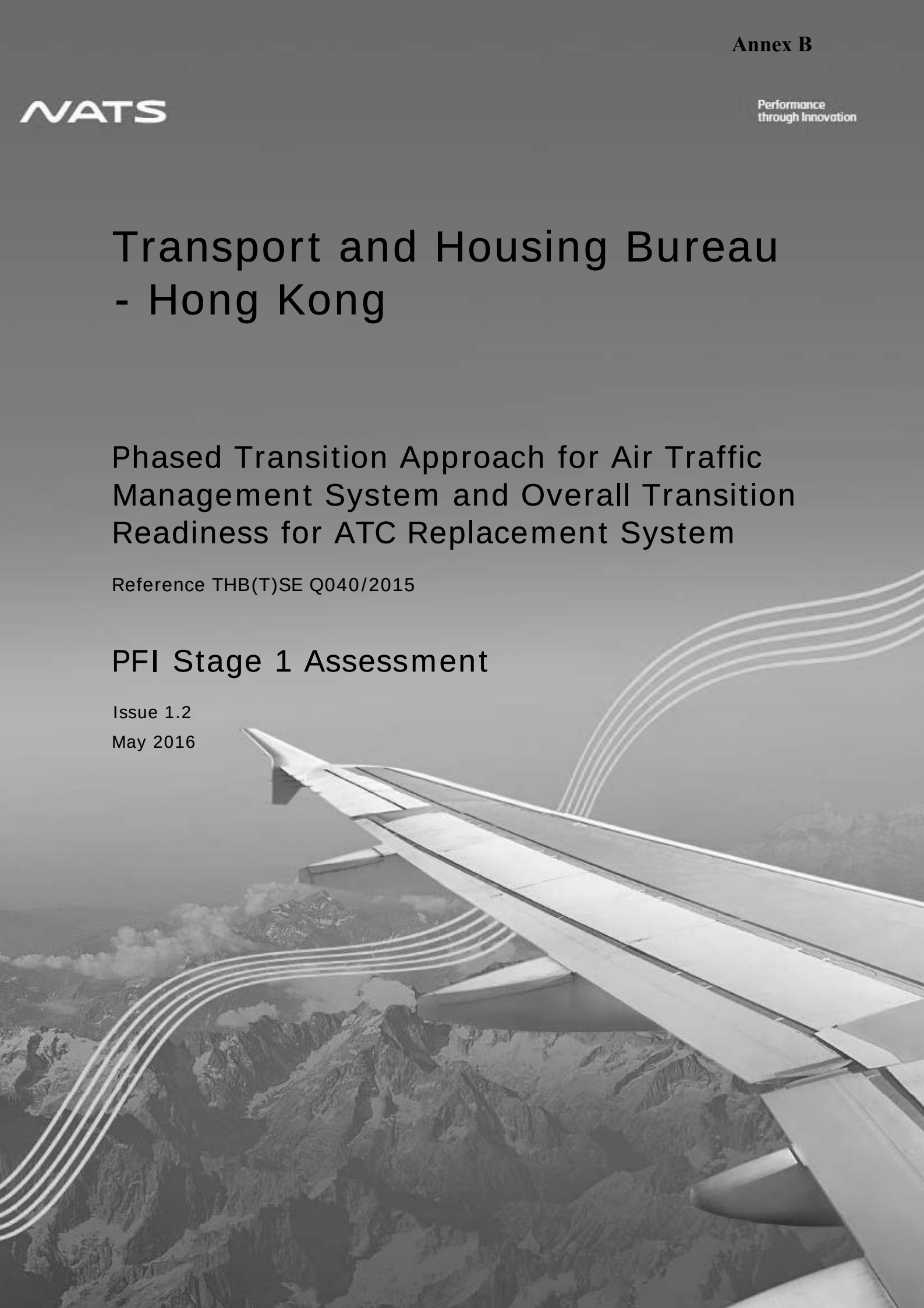
Phased Transition Approach for Air Traffic Management System and Overall Transition Readiness for ATC Replacement System

Reference THB(T)SE Q040/2015

PFI Stage 1 Assessment

Issue 1.2

May 2016



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Issue:	Version 1.2

Executive Summary

1. The Hong Kong Government has commissioned the construction and implementation of a new Air Traffic Management System (ATMS). The new ATMS being installed at the new Air Traffic Control Centre (ATCC) of CAD Headquarters is intended to replace the existing system installed at Air Traffic Control Complex commissioned in 1998.

2. NATS was first engaged by the Transport and Housing Bureau of the Hong Kong Special Administrative Region Government to assess system and staff readiness of the new ATMS based on a "snapshot" review in December 2015 under a "big-bang" implementation. NATS suggested in the study the possibility of a Phased Functional Implementation (PFI) of the new ATMS. CAD accepted NATS' recommended PFI and is using a two-phase transition scheme. Stage 1 of PFI is based on the initial operational transition of the North Aerodrome Control Tower (N-TWR) for limited hours per scheduled day with gradual extension to the remaining positions and adjustment of operational period. This is followed by a similar approach at the new ATCC for various airspace sectors, culminating in the complete transition to full Air Traffic Control (ATC) service with both the N-TWR and the new ATCC covering 24x7 operations (in Stage 2).

3. To support THB and CAD, NATS has been employed to provide independent assessment of the operational readiness of the ATMS system, and also to review and confirm the practicality of the overall PFI scheme and the readiness of the PFI Stage 1 (this report).

4. This study includes an assessment of the overall practicality of the PFI scheme, the readiness of the operational transition of the PFI Stage 1 Configuration, and also an update on the progress made by CAD on NATS' recommendations during the "snapshot" review back in December 2015 (Reference 1). The report is based on documentation made available to NATS between the end of the "snapshot" review up to end April 2016 (with supplementary information provided in early May 2016) and previous documentation and familiarity with the system established in conducting "snapshot" review.

5. Overall, NATS notes that there is a volume of high quality, detailed work providing a significant body of evidence to support all major aspects of the planned PFI. As such NATS believes CAD has an overall robust plan and approach to its ATMS transition. Particular areas of good practice include:

    a. CAD's overall approach to ATC training, planning, and rostering which are thorough and provide a comprehensive body of evidence; and

    b. The ATMS safety case and associated documentation which provide a comprehensive risk assessment and assurance process to undertake the PFI scheme.

6. NATS has made two recommendations to support CAD's planning and delivery of the PFI. These two recommendations are made as a result of this report which is accepted by CAD and corresponding actions have been in place to address them:-

    a. **Recommendation 2.1:** To support the senior management team to maintain and manage the overall progress through the PFI scheme, a single graphic of overall progress (reporting progress, successes, risks and issues) across the people, process, technology, communications and safety assurance should be

created and maintained. NATS believes this will accord greater clarity on CAD's overall status of preparedness, as well as being a method of providing oversight to third party auditors. [NATS notes that CAD has accordingly presented the progress, claim and supporting documentation for the overall PFI practicality in the Claim, Argument, and Evidence (CAE) structure in Appendix B.]

b. **Recommendation 2.2:** Previous experience in NATS of running systems in parallel / shadow mode operations has highlighted the importance of maintaining data integrity between two 'live' systems. Discrepancies between the data sets could potentially affect certain functions. NATS believes particular importance should therefore be placed on confirmation that all data supplied to the N-TWR by any 'shadowed function' is in line with the data at S-TWR. To support this, NATS proposes a specific activity and success criterion within the PFI Stage 1 Configuration plan for a shadowing activity prior to the initial PFI session and a specific objective/success criterion of each PFI session to ensure data integrity across the two 'live' systems is continuously monitored. NATS noted and is satisfied that:

   i. CAD has been implementing respective supporting equipment, trained staff, as well as procedures to carry out on-going data integrity checks to monitor and maintain data integrity between the two "live" systems; and

   ii. CAD has consolidated the engineering / technical documentation supporting equipment, staffing, procedures and mechanisms for data checking with defined follow-up actions recorded.

7. Previous analysis raised recommendations for CAD to address. NATS has found that, as a result of the continued good work within the CAD delivery, all recommendations for the purposes of PFI Stage 1 configuration have been addressed. It is also noted that CAD has been addressing the remaining recommendations that do not affect the PFI Stage 1 and are on track for closure. NATS will conduct a further review during Stage 2 assessment as planned.

8. In undertaking this review, NATS has conducted analysis for a total of 12 elements in 4 key aspects listed below (see Section 3.2 for details):

   a) The overall practicality of the PFI Scheme;
   b) Integrity and Validation of Safety Documentation in support of PFI (including the ATMS Safety Case);
   c) ATC / Engineering Procedures and Contingency; and
   d) ATC / Engineering Training.

9. NATS concludes that 10 of these elements have been duly addressed and closed. For the remaining 2 elements, which are considered "living documents", their finalisation depend on the timing of on-going processes and activities. NATS notes that the finalisation process is under control and within the established process of CAD. Accordingly, finalisation, review and closure of these 2 elements are expected prior to commencement of PFI Stage 1.

10. NATS notes that CAD, based on NATS' suggestion and CAD's own assessment on the overall system and operational readiness of the new ATC system, has decided to adopt a PFI approach incrementally from June 2016 onwards. This approach to commence PFI at N-TWR would minimise the impact from weather while allowing more time for ATC staff to familiarise themselves with the system's functions and

operations in phases, and help minimise the risk of providing full functional services in October/November2016.

11. Phased introductions of major system changes are used as standard practice within NATS, utilising 'shadowing' and live 'operational services', within a defined and well-controlled operating environment (COE) under the International Civil Aviation Organisation (ICAO) Safety Management Regime.

12. NATS compliments CAD on the amount of work carried out to a detailed level in preparation for PFI. NATS believes CAD has an overall robust, achievable plan and approach to the phased transition of the new ATMS. The body of evidence provided to NATS has demonstrated that CAD is addressing the PFI scheme in a practical and complete manner. As CAD has presented the progress, claim and supporting documentation for the overall PFI practicality according to the CAE model, NATS is satisfied that CAD is on track to commence in June 2016.

Table of Contents

SECTION 1: Introduction

1.1 Document Scope

The Hong Kong Government has commissioned the construction and implementation of a new Air Traffic Management System (ATMS). The new ATMS being installed at the new Air Traffic Control Centre (ATCC) of CAD Headquarters is intended to replace the existing system installed at Air Traffic Control Complex commissioned in 1998.

CAD's operational readiness and transition strategy has evolved, and as a result CAD is now planning on the basis of a phased transition. The phased transition scheme, hereafter called Phased Functional Implementation (PFI), is based on the initial operational transition of the North Aerodrome Control Tower (N-TWR) for limited hours per scheduled day with gradual extension to the remaining positions and adjustment of operational periods (Stage 1). This is followed by a similar approach at the new ATCC for various airspace sectors, culminating in the complete transition to full Air Traffic Control (ATC) service with both the N-TWR and the new ATCC covering 24x7 operations (Stage 2).

This document assesses the overall readiness and practicality of the operational transition of the N-TWR within the PFI scheme by reviewing, including but not limited to, the aspects of safety, ATC procedures, contingency procedures, training, maintenance and supporting safety documentation covered under the ATMS Safety Case Report and the relevant safety documents supporting transition readiness of PFI.

This document represents the Stage 1 assessment for the Tower Phased Functional Implementation. Section 2 provides the high level description of the PFI Stage 1 Configuration, and Section 3 provides the detailed assessment of the different elements of the Stage 1 configuration. Section 4 concludes the report and provides the outcomes and best practice guidance.

SECTION 2: PFI Configuration

2.1 Stage 1 High Level Description

The phased transition strategy to the new ATMS is based on two Stages. This document focuses on the PFI Stage 1 configuration.

The PFI Stage 1 configuration allows ATC executive control to be provided by the North Tower (N-TWR), whilst the area control executive control is provided by the existing Area Control Centre (ACC). In order to provide the data to the N-TWR, the new ATMS is running in parallel to the current ACC, with ATC staff inputting data to the new ATMS to ensure that the system and staff in the N-TWR have the appropriate data to provide the service. In this configuration the current South-Tower (S-TWR) provides the hot stand-by (contingency) to the N-TWR i.e. S-TWR is on 'shadowing' mode during the designated hours on scheduled days. In order to enter this configuration there are clear entry criteria and exit criteria. This configuration is summarised in Figure 1 below.

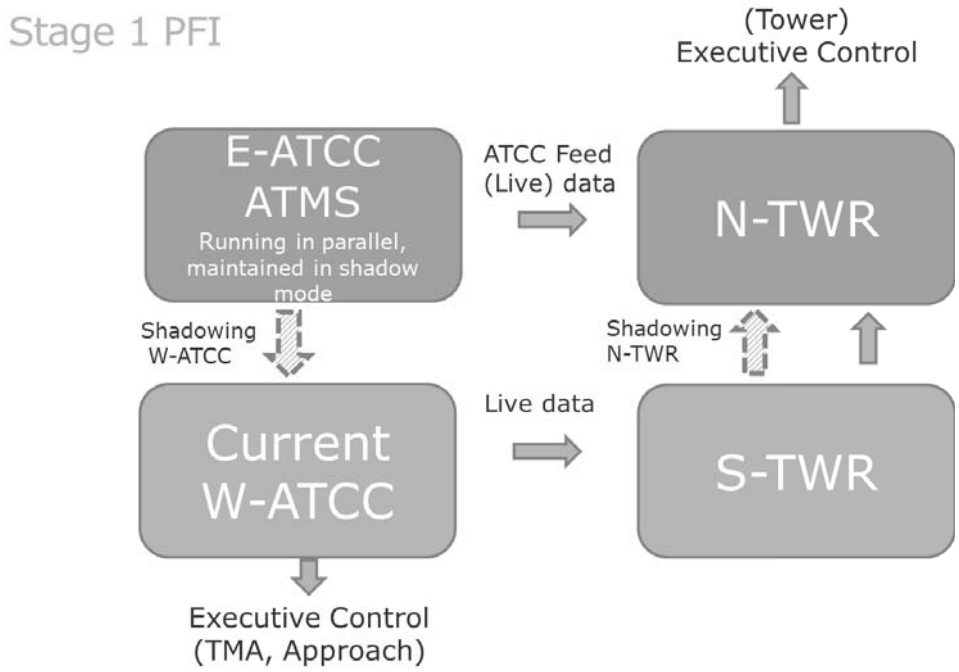


Figure 1

Within the PFI Stage 1 configuration, a number of sessions are planned, with the precise timing and nature of those sessions under active review (depending on the defined entry criteria such as meteorological conditions).

SECTION 3: Analysis of PFI Stage 1 Configuration

3.1 Methodology

The analysis is based on documentation made available to NATS between the end of the "snapshot" review of Phase 1 study in December 2015 and up to end April 2016 (with supplementary information provided in early May 2016) and previous documentation and familiarity with the system established in delivery of Phase 1 study.

Within the analysis NATS was tasked to respond to the following 4 key aspects:

- The overall practicality of the PFI Scheme;
- Integrity and Validation of Safety Documentation in support of PFI (including the ATMS Safety Case);
- ATC / Engineering Procedures and Contingency; and
- ATC / Engineering Training.

Supporting points, in the form of questions, being used to assess these aspects within the study are detailed in Appendix A. Where applicable the review is also supported by information and evidence from previous activities from the Operational Readiness Review of ATMS undertaken in December 2015. Each of these points will be discussed in Section 3.2, highlighting key findings from the documentation review, and associated points that need clarification from CAD as well as CAD's corresponding responses, which include clarification, additional information and/or action from CAD.

The review was achieved through assessing the following:

- Safety and related safety documentation;
- ATC procedures;
- Resourcing Plans;
- Contingency Procedures;
- Training;
- Maintenance and Engineering procedures; and
- Documents supporting transition readiness of PFI.

NATS has assessed the integrity, reasonableness, implementation of CAD's responses and, if outstanding, the potential impact for such items on PFI Stage 1 and the overall PFI scheme. This information is provided under the "Summary of Documentation Review" column. The assessed result of such items is registered under the "Status" column.

3.2 Overall Practicality of PFI Scheme

Ref	Question	Summary of Documentation Review	Status
S1.1	Are Resourcing Plans for all (ATC) required positions in place?	**Consideration**: A staffing plan, with detailed arrangements, for PFI sessions has been produced. Detailed plans are in place for PFI Stage 1 sessions. **Assessment**: NATS views that the plans are in place and the ATC staffing plan is robust.	CLOSED
S1.2	Are Resourcing Plans for all (Engineering) required positions in place?	**Consideration**: An Engineering resource plan equivalent to the ATC Resource Plan for PFI has been produced. The information provided for Engineering resource relates to the manpower resources required to support the transition and technical staff needed for PFI sessions in Stage 1. **Assessment**: NATS views that the plans are in place and the ATC staffing plan is robust.	CLOSED
S1.3	Are there problem raising and tracking linked to the appropriate phase of implementation ?	**Consideration**: The CAD Transition Review meeting includes both ATC and engineering representation. NATS also notes that a single database is employed, which CAD manages and prioritises issues associated with PFI for information integrity, timeliness and correctness. **Assessment**: NATS views that such a process is in place and effective.	CLOSED
S1.4	Is there a lesson learning review process in place for each PFI?	**Consideration**: The process is in place to review and manage lessons learnt, if any. This includes high level success criteria and specific success criteria defined for each session. **Assessment**: NATS views that such a process is in place and effective.	CLOSED
S1.5	Does the plan of activity have clear scope, timing and deliverables / success criteria? *(Does the plan of activity have clear equipment and test dependencies, scope, timing and deliverables / success criteria?)*	**Consideration**: There are details of the processes to be used for the PFI Stage 1 – these cover the pre-PFI activities and the processes used to confirm equipment availability and readiness. The processes include Engineering representation via the Responsible Officer (RO) of equipment (AESD/ATMD), the engineers and procedures. In relation to the equipment and test dependencies, the ability of the ATMS to be used for shadowing and provision of feed data is supported by previous shadowing experience. It is recognised that some of these documents are by nature "living documents" and require base lining and/or updates for PFI Stage 1. The confidence in the ATMS to support the Tower EFPS functionality for PFI Stage 1 and other functionality is further improved by subsequent software builds verification, validation evidence and additional test evidence. There are a number of on-going minor technical aspects being tracked and resolved in subsequent build verification tests via regular meetings on the Phased Transition Approach, which are part of the established processes. **Assessment**: CAD is in action to ensure that documents that are "living" by nature are finalised, updated if necessary, and	IN PROGRESS AND ON TRACK FOR PLANNED STAGE 1 PFI

		communicated before commencement of the PFI Stage 1 Configuration, as per normal CAD process. Noting the comprehensive nature and overall readiness of these documents, NATS is satisfied that the item is on course to closure subject to the final review prior to commencement of PFI to be registered in the updated Report.	
S1.6	Does the plan of activity have clear scope, timing and deliverables / success criteria? *(Does the plan of activity have clear scope, timing and deliverables / success criteria for completion of safety assurance)*	**Consideration**: The processes for entering and establishing the PFI Stage 1, which include checks to ensure the required safety management activities, have been satisfactorily completed. It is recognised that some of these documents are by nature "living documents" and require base lining and/or amendment for PFI Stage 1. **Assessment:** CAD is in action to ensure that documents that are "living" by nature are finalised, updated if necessary, and communicated before commencement of the PFI Stage 1 Configuration, as per CAD established process. By the degree of completeness of such documents, NATS is satisfied that the item is on course to closure subject to the final review prior to commencement of PFI.	IN PROGRESS AND ON TRACK FOR PLANNED STAGE 1 PFI

3.3 Integrity and Validation of Safety Documentation in support of PFI (including ATMS Safety Case)

Ref	Question	Summary of Documentation Review	Status
S1.7	Have safety documentation and the relevant supporting documents been reviewed for their integrity and validity?	**Consideration**: Safety Case Assessment Reports (SCARS) have been made available and these follow the CAD Safety Management System process. The SCARS undertaken include the record of the Subject Matter Experts (SMEs) involved. There are a comprehensive set of SCARS made available as part of this review. It is noted that confidence is gained as CAD has identified the requisite areas using the related Project and Transition mechanisms and associated forums. The majority of these elements are available for the PFI Stage 1, though they are spread across a large number of documents, which makes the assessment of completeness and robustness challenging. To address this CAD has now developed a single graphical argument for PFI that shows how each element comes together to form a complete picture of the assurance (see Appendix B). This is reflected in Recommendation 2.1. **Assessment**: With the action taken by CAD in the preceding paragraph, NATS views that this item is closed.	CLOSED

3.4 ATC / Engineering Procedures and Contingency

Ref	Question	Summary of Documentation Review	Status
S1.8	Are Plans for both Transition into and reversion from PFI sessions robust? (ATC)	**Consideration**: The reversion to the normal system is deemed to be the reverse of the transition, either at the planned time or due to a contingency situation. The ability to revert has been considered in the ATC Operational Transition Plan and the SCARS. The advanced publishing of the specific transition and reversion procedures, such as coordination with approach, CDC and use of the speakers are established normal practice in CAD. **Assessment**: NATS views that such plans are in place.	CLOSED
S1.9	Are Plans for both Transition into and reversion from PFI sessions robust? (Engineering)	**Consideration**: The reversion to the normal system is deemed to be the reverse of the transition, either at the planned time or due to a contingency situation. The ability to revert has been considered in the ATC Operational Transition Plan and the SCARS. CAD has reviewed the overall documentation to ensure that roles and titles for those responsible for calling off the PFI and reverting are clearly defined and consistent. **Assessment**: NATS views that this item is closed.	CLOSED
S1.10	Are the ATC Procedures identified for PFI and implemented as required?	**Consideration**: Safety assurance is provided in SCARS Report Operational Trial of the new ATMS in the North Air Traffic Control Tower **Assessment**: NATS views that this item is closed.	CLOSED

3.5 ATC / Engineering Training

Ref	Question	Summary of Documentation Review	Status
S1.11	Are ATC procedures, contingency procedures and ATC training in place?	**Consideration**: OPS Transition procedures will be published in advance to allow controllers to become familiar with them prior to OPS Transition. These procedures will enable controllers to brief themselves, feel comfortable with their ability to perform OPS Transition and have the opportunity to ask questions of the OPS Transition experts prior to the session. Paper copies of these procedures should be provided at all CWPs in case staff need to refer to them during OPS Transition. The Training Plan for the tower controllers has been provided. **Assessment**: NATS views that this item is closed.	CLOSED
S1.12	Are engineering procedures, contingency procedures and engineering training in place?	**Consideration**: Engineering and technical staff have undertaken training courses to maintain and support the systems associated with PFI stage 1; with 21 competent technical staff dedicated to the new ATMS available to support the PFI commencing June 2016. Consideration has been given to providing an Engineering and Technical staff briefing, including PFI Stage 1 specific training or familiarisation for Engineering and Technical staff. CAD has provided the plan for Engineering training (Training Plan 2016 Rev 1 (PFI)) and briefing presentation. Any Temporary Operating Instructions required will be issued and briefed as per CAD established processes. **Assessment**: NATS views that the procedures are in place.	CLOSED

SECTION 4: Conclusion, Outcomes and Best Practice Recommendations

Phased introduction of major system changes is a standard practice within NATS using 'shadowing' and live 'operational services' within defined and constrained operating environments (COE). The approach has been applied to

- iFACTS – the introduction of controller tools and removal of paper flight strips to London Area Control;
- New Prestwick Centre – the transition of Area, Terminal, Oceanic and Military Control Operations;
- Electronic Flight Data (EFD) – the introduction of new controller tools and removal of paper flight strips; and
- Prestwick Upper Airspace – the introduction of new Controller tools and Flight Data Processing.

NATS has completed an assessment of the overall practicality of the PFI scheme, the readiness of the operational transition of the PFI Stage 1 Configuration, and also an update on the progress made by CAD on recommendations made by NATS during the "snapshot" review back in December 2015. The analysis is based on documentation made available to NATS between the end of "snapshot" review up to end April 2016 (with supplementary information provided in early May 2016) and previous documentation and familiarity with the system established in conducting "snapshot" review.

Overall, NATS notes that there is a volume of high quality, detailed work providing a significant body of evidence to support all aspects of the planned PFI. It is also noted that CAD has been addressing the remaining recommendations resulting from the "snapshot" review that do not affect the PFI Stage 1 and are on track for closure. NATS will conduct a further review during Stage 2 assessment as planned. As such, NATS believes CAD has an overall robust plan and approach to their ATMS transition. Particular areas of good practice include:

- CAD's overall approach to ATC training, planning, and rostering which are thorough and provide a comprehensive body of evidence; and
- The ATMS safety case and associated documentation provide a comprehensive risk assessment and assurance process to undertake the PFI scheme.

In noting the areas of good practice NATS has made two recommendations to support CAD's planning and delivery of the PFI.

a. **Recommendation 2.1:** To support the senior management team to maintain and manage the overall progress through the PFI scheme, a single graphic of overall progress (reporting progress, successes, risks and issues) across the people, process, technology, communications and safety assurance should be created and maintained. NATS believes this will accord greater clarity on CAD's overall status of preparedness, as well as being a method of providing oversight to third party auditors. [NATS notes that CAD has accordingly presented the progress, claim and supporting documentation for the overall PFI practicality in the Claim, Argument, and Evidence (CAE) structure, in Appendix B.]

b. **Recommendation 2.2:** Previous experience in NATS of running systems in parallel / shadow mode operations has highlighted the importance of maintaining data integrity between two 'live' systems. Discrepancies between the data sets could potentially affect certain functions. NATS believes particular importance should therefore be placed on confirmation that all data supplied to the N-TWR by any 'shadowed function' is in line with the data at S-TWR. To

support this NATS proposes a specific activity and success criterion within the PFI Stage 1 Configuration plan for a shadowing activity prior to the initial PFI session and a specific objective/success criterion of each PFI session to ensure data integrity across the two 'live' systems is continuously monitored. NATS has noted and is satisfied that:

i. CAD has been implementing respective supporting equipment, trained staff, as well as procedures to carry out on-going data integrity checks to monitor and maintain data integrity between the two "live" systems; and

ii. CAD has consolidated the engineering / technical documentation supporting equipment, staffing, procedures and mechanisms for data checking with defined follow-up actions recorded.

The body of evidence provided to NATS has demonstrated that CAD is addressing the PFI scheme in a practical and complete manner. As CAD has presented the progress, claim, argument and supporting documentation for the overall PFI practicality, NATS is satisfied that CAD is on schedule for the PFI Stage 1.

References

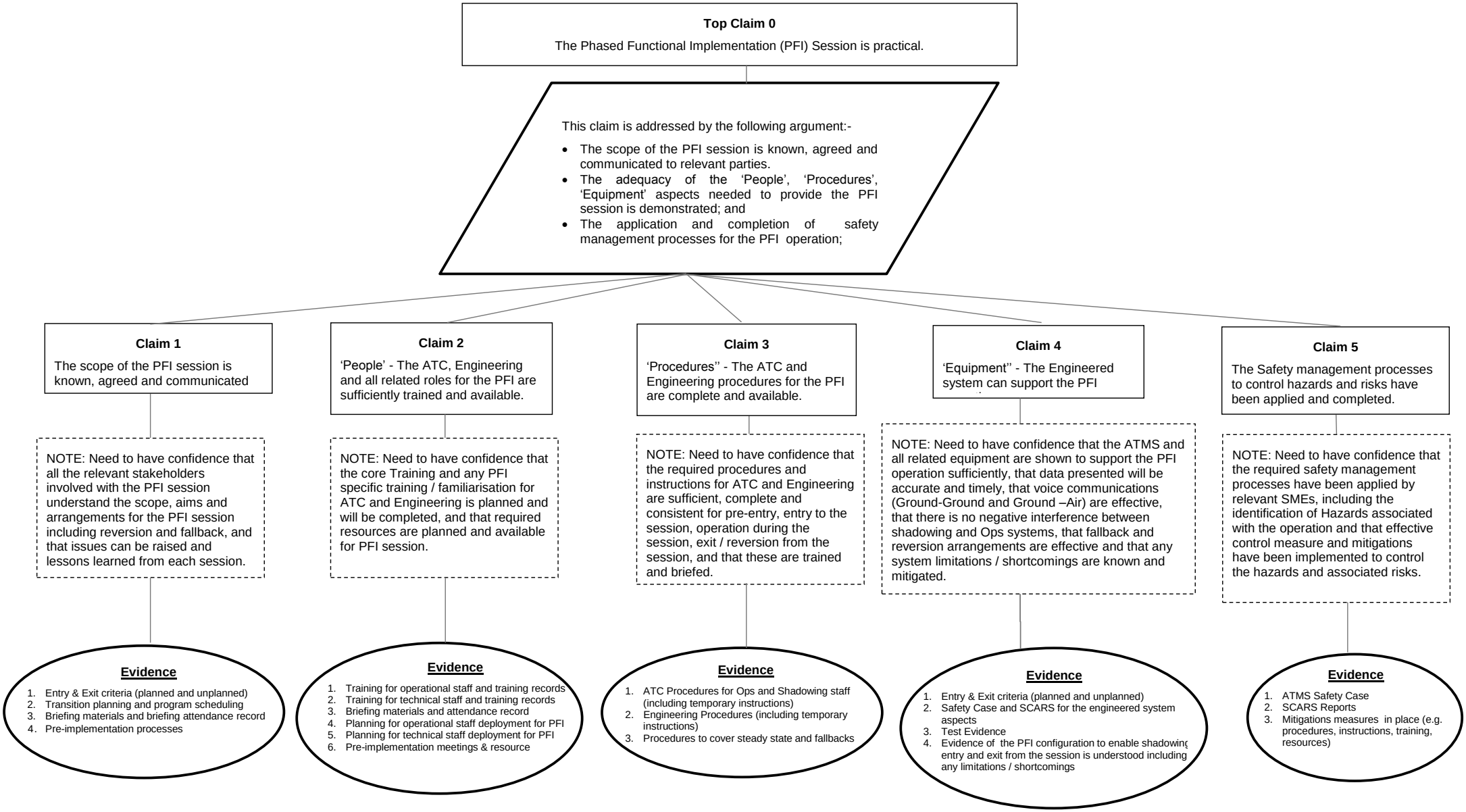
Reference	Title
1.	Operational Readiness Assessment of the New Air Traffic Management System, D2 Final Report (Issue 1.2, 15/03/2016)

Appendix A: Stage 1 Analysis

Required Phase 1 Study Scope	Supporting Questions
Practicality of the Overall PFI Scheme	Are Resourcing Plans for all required positions (ATC and Engineering) in place?
	Are there problems raising and tracking linked to the appropriate phase of implementation?
	Does the plan of activity have clear scope, timing and deliverables / success criteria?
	Is there a lesson learning review process in place for each PFI?
Integrity and Validation of Safety Documentation in support of PFI	Have safety documentation and the relevant supporting documents been reviewed for their integrity and validity?
ATC / Engineering Procedures & Contingency	Are ATC / engineering procedures changes identified for PFI and implemented as required;
	Are Plans for both Transition into and reversion from PFI sessions robust?
ATC / Engineering Training	Are ATC / engineering procedures, contingency procedures, ATC and engineering training in place?

Appendix B: PFI Claim, Argument, Evidence (CAE) Structured Notation

An 'example' generic structure for the PFI Stage 1 N-TWR Operations.



Annex C

NATS

Performance through Innovation

Transport and Housing Bureau - Hong Kong

Phased Transition Approach for Air Traffic Management System and Overall Transition Readiness for ATC Replacement System

Reference THB(T)SE Q040/2015

PFI Stage 2 and Full Transition Assessment

Issue 1.5

October 2016

Document Management

Publication details:

Issue:	Issue 1.5

Executive Summary

1. The Hong Kong Government has been implementing and transitioning to a new Air Traffic Management System (ATMS). The new ATMS being commissioned at the new East Air Traffic Control Centre (E-ATCC) of the Civil Aviation Department (CAD) Headquarters is intended to replace the existing system operating at the West Air Traffic Control Centre (W-ATCC) commissioned since 1998.

2. Transition to the ATMS has commenced through a well-thought out and planned Phased Functional Implementation (PFI) programme. Stage 1 of PFI (PFI 1) was based on the initial operational transition of the North Aerodrome Control Tower (N-TWR) for selected hours per scheduled day with gradual extension to the remaining positions and adjustment of operational period. The subsequent PFI Stage 2 (PFI 2) follows a similar approach at the E-ATCC starting with selected positions in various airspace sectors, culminating in the Full Transition to full Air Traffic Control (ATC) service from both the N-TWR and the E-ATCC covering round-the-clock ATC operations.

3. THB engaged NATS to provide independent assessment of the operational and system readiness of the ATMS based on a "snapshot" review in December 2015, and subsequently (April 2016) to review and confirm the practicality of the overall PFI scheme. The first analysis was completed in March 2016 (Reference 1) making recommendations for the operational readiness of the ATMS. The second analysis assessing the readiness of PFI 1 was delivered in May 2016 (Reference 2).

4. This follow-up study is to assess the readiness for Full Transition to the new ATMS, the associated capacity reduction scheme, and also includes the latest progress in addressing the recommendations made in the previous two assessment exercises (References 1 and 2).

5. To assess the readiness for ATMS transition, NATS has used a Claim, Argument and Evidence (CAE) structure to provide an analysis framework (see Section 3). This includes in scope planning and scope of change, people, processes, equipment and safety management processes to evidence a safe implementation of the new ATMS.

6. This analysis and report are based on documentation and clarifications made available to NATS over the period between April and September 2016, together with previous documentation and familiarity with the system established through previous site visits and studies. Under the CAE analysis framework, as part of this study, NATS has reviewed the ATMS Safety Case and the Implementation and Transition (I&T) Safety Case documents together with the associated substantiating documentation[1] by CAD, and is satisfied with the robustness of these safety cases as well as the integrity and validity of the substantiating documentation. With the foregoing, the action plans (Transition Plan and Contingency Plan) and on-going works in the areas of assessment under the CAE analysis framework, NATS is satisfied with CAD's overall readiness for Full Transition.

7. With regards to the staff readiness, NATS has reviewed the level of training, competence and confidence achieved for Full Transition, which is under active management by CAD. The analysis indicates that there is both sufficient and increasing staff readiness for Full Transition. In addition CAD is mitigating any

[1] The documentation includes ATMS Safety Case Report, I&T Safety Case Report, Safety Plans, Safety Case Analysis and Reporting System (SCARS) Reports, Hazard Logs, etc.

residual risk associated with staff readiness through measures including management of staff annual leave and by expert advisor support available to staff during and after the initial cut-over to the new system under the Full Transition.

8. Overall, NATS praises the structured and complete set of evidence that CAD has been able to provide against the CAE for both PFI 2 and Full Transition to the ATMS. The evidence has allowed NATS to review and be confident in the coverage and quality of information supporting a safe implementation of new ATMS. NATS has not uncovered any issues that would preclude the Full Transition. In the analysis NATS has also considered evidence of best practice including CAD's overall approach to ATC/engineering training, planning, and manpower rostering, which are thorough and provide a comprehensive body of evidence.

9. Given the timing of the report (prior to Full Transition) and the nature of assessing the readiness of a future event, in a small number of cases, necessarily, whilst required documentation has achieved mature draft, it can only be finalised once activities such as pre-PFI/cutover briefings, review meetings, attendance records, assessment results and activities have taken place (that are scheduled after publication of this Report). In these cases, NATS is satisfied that CAD's plans together with previous process and delivery have provided sufficient precedence and evidence, and these are assessed as "Based on the evidence available so far, NATS is confident that CAD will complete the item before the Full Transition."

10. As an outcome of the first assessment by NATS, CAD adopted a step-by-step PFI incremental approach to ensure system readiness and staff confidence while more effectively managing possible risks involved in the process including those induced by weather. NATS noted the merits of its recommended PFI scheme are in line with NATS' experience and international best practice. As of the date of writing this report, NATS also noted that CAD had completed PFI 1 successfully and are in progress with PFI 2, during which both good and adverse weather were encountered, where live air traffic was handled by the new ATMS in a safe, reliable and efficient manner.

11. In addition, the capacity reduction scheme to support Full Transition with associated documentation has been reviewed to be well-managed with strong elements of flexibility, dynamics, sensible controller workload management, close coordination with the industry/neighbouring ATC centres to minimise overall impact on air traffic and to minimise the implementation period. Capacity reduction in connection with the launch of a major ATC system/infrastructure is commonly practised including in NATS' various projects and NATS considers CAD's scheme sensible, and a recommended and prudent approach for a major international airport.

12. From NATS' experience of other similar transitions, NATS has made 2 general recommendations for post Full Transition (Note: No immediate action is required as these will not affect Full Transition) as the best practice to support CAD's on-going operations as follows:

    a. After CAD has successfully completed Full Transition to the new ATMS, it is proposed that close monitoring and feedback from ATC is maintained regularly through established means to ensure any system issues are solved or mitigated; and

    b. Consolidation of safety case related documentation and analysis for the whole ATMS project to facilitate easy future reference and maintenance under CAD's established Safety Management System process.

13. NATS considers all the recommendations as given in the previous two assessment exercises, as presented in References 1 and 2, fully addressed. These are reported in Appendices A and B respectively, and in summary:

    a. All remaining recommendations (totalling 14) that were made in the initial ATMS operational readiness review (i.e. during the first analysis) are now all successfully closed.

    b. The 2 previous recommendations remaining from the PFI 1 analysis (i.e. the second analysis) were both accepted and successfully closed.

14. In summary, NATS compliments CAD on the amount of professional work carried out to a detailed and achievable level in preparation for Full Transition and closure of all relevant recommendations including those from previous assessments. NATS confirms that CAD has achieved a robust evidence based approach and is satisfied that CAD is ready to proceed with Full Transition as planned, well supported by clear entry and success criteria, robust fall back contingency measures if needed, and with demonstrated operational readiness in the areas of planning, people, procedures, equipment and safety management processes, that together evidence safe implementation of the new ATMS.

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Glossary

Abbreviation	Meaning
ATC	Air Traffic Control
ATMS	Air Traffic Management System
CAD	Civil Aviation Department (Hong Kong)
CAE	Claim, Argument and Evidence (analysis framework)
E-ATCC	East Air Traffic Control Centre (new ATCC)
FIR	Flight Information Region
I&T	Implementation and Transition
N-TWR	North Aerodrome Control Tower
PFI	Phased Functional Implementation
SCARS	Safety Case Analysis and Reporting System
S-TWR	South Aerodrome Control Tower
W-ATCC	West Air Traffic Control Centre (existing ATCC)

Table of Contents

SECTION 1: Introduction

1.1 Document Scope

The Hong Kong Government has been implementing and transitioning to a new Air Traffic Management System (ATMS). The new ATMS being commissioned at the new East Air Traffic Control Centre (E-ATCC) of the Civil Aviation Department (CAD) Headquarters is intended to replace the existing system operating at the West Air Traffic Control Centre (W-ATCC) commissioned since 1998.

CAD is employing a phased transition to the ATMS referred to as the Phased Functional Implementation (PFI). The PFI is based on the initial operational transition of the North Aerodrome Control Tower (N-TWR) for selected hours per scheduled day with gradual extension to the remaining positions and adjustment of operational periods (Stage 1). Stage 1 was completed successfully in September 2016. This is now followed by a similar approach at the E-ATCC for various airspace sectors (PFI 2), culminating in the Full Transition to full Air Traffic Control (ATC) service with both the N-TWR and the E-ATCC covering round-the-clock operations.

NATS confirmed the overall practicality of the PFI scheme in the second analysis delivered in May 2016 (Reference 2). It is with this understanding that CAD has proceeded with PFI 1 (completed) and PFI 2 (in progress).

This document represents NATS' observations on the PFI 2 and the Full Transition operational readiness assessment. It assesses the overall readiness and practicality of the operational transition of the N-TWR and ATMS for the Full Transition by reviewing (but not limited to) the aspects of planning, stakeholder management, safety, ATC procedures, contingency procedures, training, maintenance and supporting safety documentation.

Section 2 provides the high level description of the PFI 2 and Full Transition configuration, and Section 3 provides the detailed methodology of the assessment. Section 4 provides the report's findings, with Section 5 providing the outcomes and best practice guidance.

SECTION 2: PFI and Full Transition Configuration

2.1 PFI High Level Description

The phased transition strategy to the new ATMS is based on two stages outlined below. The PFI Stage 1 was completed successfully in September 2016, and Stage 2 commenced in September 2016 which once completed, will lead to Full Transition.

The PFI Stage 1 configuration allowed ATC executive control to be provided by the new N-TWR, whilst the Area executive control was provided by the existing W-ATCC. The South Aerodrome Control Tower (S-TWR) and new E-ATCC were maintained in shadowing mode with full manning.

The PFI 2 configuration allows Aerodrome Tower control to be provided by the S-TWR, with the Area executive control to be provided by combinations of the existing ATC systems in W-ATCC and the new ATC systems in E-ATCC. This configuration is illustrated in Figure 1 below.

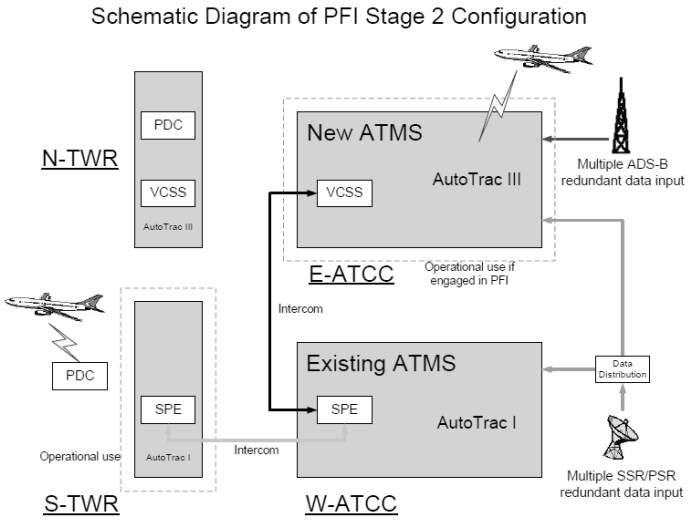

Figure 1

The progressive use of new ATMS across PFI 1 and PFI 2 is described below in Table 1.

Stage	Functions	Status
PFI 1	Partial Tower Operation: Selected control positions at N-TWR + E-ATCC in shadowing operation	**Completed successfully**
	Full Tower Operation: all control positions at N-TWR + E-ATCC in shadowing operation	**Completed successfully**

PFI 2	Partial E-ATCC Operation: Gradually extending from Approach Control Operation to Area Control Operation, Terminal Control Operation, and integrated operation + N-TWR in shadowing operation	**Completed successfully**
	Whole E-ATCC Operation: Integrated ATC Operation (including Approach Control Operation, Terminal Control Operation, and Area Control Operation) + N-TWR in shadowing operation	**(Progressing as planned)**

Table 1

Once PFI 2 sessions are completed successfully the ATMS will then enter into Full Transition where the entire N-TWR and E-ATCC are in round-the-clock operations. During the initial period of Full Transition, to ensure the operational and engineering practices will dovetail with ATC operation to provide harmonised and smooth ATC services, CAD is also deploying a temporary strategic air traffic capacity reduction scheme outlined in Section 4.11. During the initial periods following Full Transition, a 'hot stand-by' capability will be provided by the W-ATCC in case operations reversion[2] is necessary.

2 As a mitigation to any residual risk of unplanned or inadvertent system behaviour that impacts operations, CAD will maintain the ability to revert to the current ATC system until such time as the risk has been demonstrated to have been removed.

SECTION 3: Analysis of PFI Stage 2 Configuration

3.1 Methodology

In order to provide a clear framework with which to evidence the operational readiness of the ATMS, NATS and CAD have implemented a Claim, Analysis and Evidence (CAE) structure to meet the safety management process.

This methodology is based on clearly articulating the required high level claim ***("The People, Procedures and Equipment for each stage of the planned Phase 2 PFI and the complete transition of the N-TWR and the E-ATCC (Full Transition) are operationally ready.")*** and then identifying the sub claims that need to be true to achieve the high level claim. In this case the high level claim has been subdivided into five sub claims as follows:

- **Sub Claim 1** - The scope and plans of the PFI sessions and Full Transition are known, agreed and communicated to relevant parties, including any temporary traffic/capacity measures.
- **Sub Claim 2** - 'People' - The ATC, Engineering and all related roles for the PFI and Full Transition (including contingency) are sufficiently trained and available.
- **Sub Claim 3** - 'Procedures' - The ATC and Engineering procedures for the PFI and Full Transition (including contingency) are complete and available.
- **Sub Claim 4** – 'Equipment' - The Engineered system can support the PFI and Full Transition (including contingency) operation.
- **Sub Claim 5** - The safety management processes to control hazards and risks have been applied and completed.

Each of these claims is then associated with an Analysis statement that when evidenced fully will satisfy the sub claim. Once all the claims are evidenced, then the overall claim is considered to be true. The full CAE is detailed in Appendix C.

In order to assess the strength of the evidence provided, the documentation provided was reviewed to ensure completeness, appropriateness, and consistency. During the analysis NATS was in dialogue with CAD with requests for additional information and points of clarification.

For the purposes of the CAE, the PFI 2 and Full Transition were considered separately, and are reported as such in the following sections.

SECTION 4: Results

4.1 PFI 2 Sub Claim 1 (Scope and Plans)

CAE	NAT's requirement	NATS Comments on CAD Documentation	Status
1.1	Entry and Exit criteria (planned and unplanned)	Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
1.2	PFI planning and program scheduling	Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
1.3	Briefing materials and briefing attendance record	Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
1.4	Pre-implementation processes per session	Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
1.5	Evidence of Phase 1 lessons learning, issue tracking and closure	CAD provided sufficient evidence of detailed and open issue tracking and resolution, both in the N-TWR and the W-ATCC. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
1.6	Adequate temporary traffic arrangements are in place for PFI if required	PFI is scheduled at quiet operational periods and so no additional temporary traffic management strategies are necessary. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence

4.2 PFI 2 Sub Claim 2 - 'People'

CAE	NAT's requirement	NATS Comments on CAD Documentation	Status
2.1	Update on scheduled and completed training for operational staff	The controller assessment provided gives a clear status update and planned numbers to achieve PFI 2 and Full Transition. This is sufficient to represent a high level schedule supporting analysis. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
2.2	Update on scheduled and completed training for technical staff	Evidence provided shows adequate technical competencies for the systems and a sufficient pool of resource to ensure the availability of trained staff for the PFI 2 activities. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
2.3	Briefing materials and briefing attendance record	Both the operational instruction for the approach phase and the E-ATCC briefing material are comprehensive (including scenarios such as missed approaches, change of runway, transfer of flights to adjacent Area Control Centres - and also resumption due to occurrence of abnormal conditions. Attendance records indicate high coverage of operational staff and observers. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
2.4	Planning for operational staff deployment for PFI	Complete – evidence is sufficient for CAE.	Completed with sufficient evidence

2.5	Planning for technical staff deployment for PFI	There is clear evidence that the PFI Preparation Meetings cover the planned operational support by both engineering and technical staff, including overall engineering plan based on Manning Rosters. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
2.6	Pre-implementation meetings and resource	Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
2.7	ATC user feedback and acceptability is collected	Clear evidence that user feedback and confidence is being collected and tracked across different phases of training and shadowing. The overall rate and number of staff suitably validated and trained is sufficient to support the PFI 2 and Full Transition on the basis of the progress to date and plan. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence

4.3 PFI 2 Sub Claim 3 - 'Procedures'

CAE	NAT's requirement	NATS Comments on CAD Documentation	Status
3.1	ATC Procedures for operational and shadowing staff (including temporary instructions)	NATS initial assessment indicates that the Operational Transition Plan provides good evidence with reference to ATC procedures on transition into and out of PFI 2. Transfer of control and reversion procedures are well defined in the relevant sections of the Operations Instruction. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
3.2	Engineering Procedures (including temporary instructions)	Engineering procedures and temporary instructions provided. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
3.3	Procedures to cover fall backs	Procedures provided. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence

4.4 PFI 2 Sub Claim 4 - 'Equipment'

CAE	NAT's requirement	NATS Comments on CAD Documentation	Status
4.1	Confirm Equipment Entry and Exit criteria in 1.1	Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
4.2	Safety Case and Safety Case Analysis and Reporting System (SCARS) for the engineered system aspects	Safety case and SCARS Report provided. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
4.3	System Test Evidence	System test evidence provided. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
4.4	Evidence of the PFI configuration to enable shadowing, entry and exit from the session is understood including any limitations/ shortcomings	The provided schematic of both the ATMS and N-TWR across the PFI Stages 1 and 2 clearly defines the intended phases. Overall across the plan all elements of the system are being validated within reasonable constraints associated with manpower/available resources. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
4.5	Closure or mitigation of software observations raised since initiating PFI Stage 1	Good evidence that the system issues that have been identified in PFI 1 and system testing are being logged, prioritised, tracked and mitigated. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence

4.5 PFI 2 Sub Claim 5 - Safety Processes

CAE	NAT's requirement	NATS Comments on CAD Documentation	Status
5.1	ATMS Safety Case	The baselined ATMS Safety Case is adequate for PFI Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
5.2	New or amended SCARS Reports	The SCARS is in place to support the PFI Stage 2. Review meeting has been conducted to confirm that all mitigating controls have been satisfactorily implemented. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
5.3	Mitigations measures from SCARS in place (e.g. procedures, instructions, training, resources)	See 5.2. Relevant documentation provides evidence of good practice whereby observations can be escalated and reviewed against existing SCARS. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
5.4	Applicable safety related software observations are identified, prioritised and addressed	Complete – evidence is sufficient for CAE.	Completed with sufficient evidence

4.6 Full Transition Sub Claim 1 - Scope and Plans

CAE	NAT's requirement	NATS Comments on CAD Documentation	Status
1.7	Entry criteria and contingency arrangements	Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
1.8	Transition plan and programme scheduling	ATC operational transition plan and programme scheduling in place Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
1.9	Briefing materials and briefing attendance record	Plan is in place with established practice and precedence across both PFI 1 and PFI 2.	Based on the evidence available so far, NATS is confident that CAD will complete the item before the Full Transition
1.10	Pre-implementation processes (e.g. final transition readiness review meeting)	Plan is in place with established practice and precedence across both PFI 1 and PFI 2.	Based on the evidence available so far, NATS is confident that CAD will complete the item before the Full Transition
1.11	Evidence of stakeholder communications including service impact	NATS has received the capacity reduction plan and associated Notice to Airman - this evidences that capacity management measures are co-ordinated with stakeholders including airlines, Airport Authority Hong Kong, and cargo operators. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
1.12	Adequate temporary traffic arrangements are in place for transition	NATS agrees that the proposed capacity reduction scheme is appropriate and sufficient for Full Transition. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence

4.7 Full Transition Sub Claim 2 - 'People'

PFI 2	NAT's requirement	NATS Comments on CAD Documentation	Status
2.8	Training and experience levels for operational staff is recorded (including fall backs)	NATS notes the overall confidence levels from the training and simulation exercises - and that CAD has confirmed that these exercises include fall back procedures and high traffic levels. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
2.9	Training for technical staff and training records (including fall backs)	Submitted documents provide evidence of the engineering/technical training and staff capability at both first-line system maintenance and Subject Matter Expert support. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
2.10	Briefing materials and attendance record	Plan is in place with established practice and precedence across both PFI 1 and PFI 2.	Based on the evidence available so far, NATS is confident that CAD will complete the item before the Full Transition
2.11	Planning for operational staff deployment	Detailed plan has been provided for the tower and approach areas. Evidence sufficient for CAE. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
2.12	Planning for technical staff deployment	Same planning for technical staff deployment for both PFI (Ref. Item 2.5 under Section 4.2) and for the Full Transition. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence

2.13	Pre-implementation meetings and resource	Noted that this is evidenced for PFI (which is the natural priority at this stage) – CAD has confirmed the plan will be replicated for the Full Transition.	Based on the evidence available so far, NATS is confident that CAD will complete the item before the Full Transition
2.14	The W-ATCC and S-TWR contingency is resourced, monitored and maintained for the period of the warm standby	Detailed plan (shift worker) has been provided for the tower and approach areas. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
2.15	ATC user feedback is collected and acceptability demonstrated	Confirmed that this is sufficient for CAE on the basis that this practice is maintained to Full Transition. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence

4.8 Full Transition Sub Claim 3 - 'Procedures'

CAE	NAT's requirement	NATS Comments on CAD Documentation	Status
3.4	ATC Procedures (including temporary instructions)	Plan is in place with established practice and precedence across both PFI 1 and PFI 2.	Based on the evidence available so far, NATS is confident that CAD will complete the item before the Full Transition
3.5	Engineering Procedures (including temporary instructions)	Evidence has been provided previously for operation and maintenance of the new ATMS - CAD has detailed additional engineering procedures for Full Transition. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
3.6	Procedures to cover steady state, fall backs and contingency	The referenced chapters of the updated transition plan for fall backs and contingency are comprehensive and demonstrate controlled approach. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence

4.9 Full Transition Sub Claim 4 - 'Equipment'

CAE	NAT's requirement	NATS Comments on CAD Documentation	Status
4.6	System entry criteria and contingency arrangements	System entry and contingency criteria are clearly defined in the referenced material. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
4.7	Safety Case and SCARS for the engineered system aspects	NATS is content that the previous SCARS cover the system assurance for transition. The ATMS Safety Case Report and build verification reports are sufficient for this CAE, noting best practice associated with aligning the safety case with the build versions. The additional evidence of the meeting notes from the safety review also provides evidence that processes are in place to confirm all control measures identified to mitigate hazards are in place before implementation; such processes will be applied for transition if required. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
4.8	Closure or mitigation for Problem Tracking Reports raised in PFI Stage 2.	Review completed. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
4.9	System transition plan details migration to E-ATCC and N-TWR and maintaining availability of W-ATCC and S-TWR	CAD has provided evidence to demonstrate planned migration - the information demonstrates that the transition is sufficiently well planned with clear gates for entry and exit for Full Transition. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence

4.10 Full Transition Sub Claim 5 - Safety Processes

CAE	NAT's requirement	NATS Comments on CAD Documentation	Status
5.5	ATMS Safety Case	ATMS Safety Case Report is sufficient for Full Transition noting the best practice recommendations for aligning build and safety case versions. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
5.6	Implementation and Transition (I&T) Safety Case	The I&T Safety Case Report is a well-structured document providing clear traceability of the safety argumentation. NATS notes the continued good practice around the use and completeness of the SCARS. In addition to the Safety Case and SCARs evidence provided there is also evidence that processes are in place to confirm all control measures identified to mitigate hazards are in place before implementation; such processes will also be applied for transition if required. Complete – evidence is sufficient for CAE.	Completed with sufficient evidence
5.7	New or amended SCARS Reports/Transition Hazard Analysis	NATS notes that CAD has consistently applied the appropriate SCARS processes during PFI and in planning the Full Transition. It is appropriate that the SCARS for cutover will be completed shortly prior to Full Transition and this item is completed on the basis of established good practice and precedence.	Based on the evidence available so far, NATS is confident that CAD will complete the item before the Full Transition
5.8	Mitigations measures in place (e.g. procedures, instructions, training, resources)	NATS notes that CAD has consistently applied the appropriate SCARS processes during PFI and in planning the Full Transition. It is appropriate that the SCARS for cutover will be completed shortly prior to Full Transition and this item is completed on the basis of established good practice and precedence.	Based on the evidence available so far, NATS is confident that CAD will complete the item before the Full Transition

4.11 Capacity Reduction Scheme (Full Transition)

To support the Full Transition, CAD has implemented traffic capacity management measures as outlined below. These measures were introduced by CAD in full consultation with the Airport Authority Hong Kong and the local major carriers, and include protection for the cargo operators during their busiest time of year in the build up to Christmas.

The air traffic flow management aims to protect the Area Control Centre more than the Tower, and includes restrictions on adjacent Airports/Flight Information Regions (FIR). The measures that have been introduced are all appropriate for the scale of change and align to NATS' experience on large scale system introductions.

The NATS' review finds the measures to be well-managed with strong elements of flexibility, dynamics, sensible controller workload management, close coordination with the industry/neighbouring ATC centres to minimise the overall impact on air traffic and to minimise the implementation period. Capacity reduction in connection with the launch of a major ATC system/infrastructure is commonly practised including in NATS' various projects and NATS considers CAD's scheme sensible, and a recommended and prudent approach for a major international airport.

Traffic operating at the Hong Kong International Airport - Temporary reduction of runway capacity will be imposed in the Hong Kong International Airport for 4 weeks from 30 October to 26 November 2016. The hourly rate of air traffic movements will be suitably adjusted. In general, the maximum capacity at the Hong Kong International Airport will be lowered from 68 to 60 movements, i.e. 30 departures and 30 arrivals, per hour between 0000 Universal Co-ordinated Time and 1559 Universal Co-ordinated Time.

The figure was arrived based on 30 arrivals and 30 departures per hour. In the case of arrivals, a 2-minute sequence, i.e. 30/hour equates to about 5 Nautical Miles final spacing. This is a spacing which can be achieved even without a Final Approach Director position at present and does not require any consideration of Wake Turbulence separation standards in 99% of cases (the other 1% involving Super category, i.e. aircraft above the current heavy wake vortex category). Thus the complexity of sequencing and spacing for approach and Final Approach Director is generally quite low at this traffic level. For terminal control, due to the higher speeds of the aircraft and the airspace configuration, this equates to about 12 Nautical Miles spacing between aircraft at the arrival gate, which is a generally conservative figure that allows for some buffer in arrivals management sequencing and metering.

On the departure side, 2 minute intervals between departures is also demonstrated to reduce workload and complexity for the departure controller, with a reduced risk of critical catch-up situations. Momentary distraction operating the new system should not cause separation issues with 2 minutes providing almost a 50% margin over the minimum radar separation when airborne.

Traffic transiting HK FIR to and from Macao International Airport - These flights will be regulated by air traffic flow management of Minimum Departure Interval.

Other traffic transiting HK FIR - Air traffic flow management for these overflights will be implemented to maintain the amount of traffic entering Hong Kong FIR at a manageable level. Flights transiting Hong Kong FIR which originate from a limited number of designated aerodromes will be subject to Minimum Departure Interval of 8 to 10 minutes intervals. This had been tried out during the night shadowing in August 2016. Further air traffic flow management based on in-trail spacing will be imposed as per current practice as necessary. Adjacent air navigation service providers have been informed through recent International Civil Aviation Organisation regional meetings.

SECTION 5: Conclusion, Outcomes and Best Practice Recommendations

Phased introduction of major system changes is a standard practice within NATS using 'shadowing' and live 'operational services' within defined and constrained operating environments. Within NATS a similar approach has been applied to a number of recent transitions to new technology, including:

- iFACTS – the introduction of controller tools and removal of paper flight strips to London Area Control;
- New Prestwick Centre – the transition of Area, Terminal, Oceanic and Military Control Operations;
- Electronic Flight Data – the introduction of new controller tools and removal of paper flight strips; and
- Prestwick Upper Airspace – the introduction of new Controller tools and Flight Data Processing.

To support CAD's transition to the new ATMS, NATS has completed:

- Operational Readiness Assessment of the New ATMS (Reference 1).
- The transition readiness for ATC Replacement System PFI Stage 1 Assessment (Reference 2).
- The operational readiness of ATMS for PFI 2 and Full Transition (this document).

As an outcome of the first assessment by NATS, CAD adopted a step-by-step PFI incremental approach to ensure system readiness and staff confidence while more effectively managing possible risks involved in the process including those induced by weather. NATS noted the merits of its recommended PFI scheme are in line with NATS' experience and international best practice. As of the date of writing this report, NATS also noted that CAD had completed PFI 1 successfully and are in progress with PFI 2, during which both good and adverse weather were encountered, where live air traffic was handled by the new ATMS in a safe, reliable and efficient manner.

With regards staff readiness, NATS has reviewed the level of training, competence and confidence achieved for Full Transition, which is under active management by CAD. The analysis indicates that there is both sufficient and increasing staff readiness for Full Transition. In addition CAD is mitigating any residual risk associated with staff readiness through measures including management of staff annual leave and by expert advisor support available to staff during and after the initial cut-over to the new system under the Full Transition.

In addition, the capacity reduction scheme to support Full Transition with associated documentation has been reviewed to be well-managed with strong elements of flexibility, dynamics, sensible controller workload management, close coordination with the industry /neighbouring ATC centres to minimise the overall impact on air traffic and to minimise the implementation period. Capacity reduction in connection with the launch of a major ATC system/infrastructure is commonly practised including in NATS' various projects and NATS considers CAD's scheme sensible, and for a major international airport, a recommended and prudent approach.

From NATS' experience of other similar transitions, NATS has made 2 general recommendations for post Full Transition (Note: No immediate action is required as these will not affect Full Transition) as the best practice to support CAD's on-going operations as follows

- After CAD has successfully completed Full Transition to the new ATMS, it is proposed that close monitoring and feedback from ATC staff is maintained regularly through established means to ensure any system issues are solved or mitigated; and

- Consolidation of safety case related documentation and analysis for the whole ATMS project to facilitate easy future reference and maintenance under CAD's established Safety Management System process.

Given the timing of the report (prior to Full Transition) and nature of assessment of readiness of a future event, in a small number of cases, necessarily, whilst required documentation has achieved mature draft, it can only be finalised once activities such as pre-PFI/cutover briefings, review meetings, attendance records, assessment results and activities have taken place (that are scheduled after publication of this Report). In these cases, NATS is satisfied that CAD's plans together with previous process and delivery have provided sufficient precedence and evidence, and these are assessed as "Based on the evidence available so far, NATS is confident that CAD will complete the item before the Full Transition."

In summary, NATS compliments CAD on the amount of professional work carried out to a detailed and achievable level in preparation for PFI 2 and Full Transition and closure of all relevant recommendations including those from previous assessments. NATS confirms that CAD has achieved a robust evidence based approach and is satisfied that CAD is ready to proceed with Full Transition as planned, well supported by clear entry and success criteria, robust fall back contingency measures if needed, and with demonstrated operational readiness in the areas of planning, people, procedures, equipment and safety management processes, that together evidence safe implementation of the new ATMS .

References

Reference	Title
1.	Operational Readiness Assessment of the New Air Traffic Management System, D2 Final Report (Issue 1.2, 15/03/2016)
2.	Phased Transition Approach for Air Traffic Management System and Overall Transition Readiness for ATC Replacement System (Reference THB(T)SE Q040/2015) - PFI Stage 1 Assessment Issue 1.2, May 2016

Appendix A – Recommendations from Phase 1 report (Ref 1)

REC Id	Recommendation	Comments	Status
REC 1 (Safety - SAF)	Ensure the plans and schedules to complete the safety case documentation are aligned with the delivery of the dependent evidence artefacts needed to support the assurance arguments and claims (Goals) being made.	The artefacts and evidence referenced in the I&T Safety Case Report are complete and/or are planned to be completed before transition. I&T safety case provided. Sufficient evidence provided to close this item.	Closed
REC 2 (SAF)	Ensure the ATC and Engineering Fall back procedures are completed and subject to verification, validation and training to ensure their effectiveness.	CAD provided the fall back procedures. The evidence to substantiate the verification, validation and engineering training was provided. Sufficient evidence provided to close this item.	Closed
REC 3 (SAF)	The safety assessment and safety case reporting for fall backs is built into the project schedule.	Evidence on the fall back procedures for both ATC and Engineering are part of the completed I&T Safety Case Report, and completion of any SCARS specific for fall back /contingency - I&T safety case provided. Sufficient evidence provided to close this item.	Closed
REC 5 (SAF)	CAD to complete the software assurance for builds since Build 1 as identified in the preliminary version of ATMS Safety Case Report.	Test summary evidence for Build 3 and Build 4 has been provided. For completeness CAD provided the Build 5 Verification Summary, and an updated version was provided. Sufficient evidence provided to close this item.	Closed

REC 6 (Human Factors - HF)	Consideration should be given to significant re-design of the auto-de-conflict function of Data Blocks so that: (i) it recognises other elements on the situation display and does not overlap with these elements; (ii) the label position does not transpose with adjacent Data Blocks; (iii) it preserves the relative position and order of the Data Blocks so that it remains consistent with the relative position and order of the actual aircraft.	Recommendation is CLOSED – Verification test result indicates that Build 4 has delivered the requested change to the required standard. Sufficient evidence provided to close this item.	Closed
REC 8 (HF)	Re-assess the suitability of the mitigation requiring the controllers to copy all Traffic Condition for Controller, Action Required and Emphasis Indicator data entered into the system on paper and then re-enter into system for sector handover and sector combine and de-combine.	Recommendation is CLOSED – Fix was delivered in Build 4 and passed verification. Sufficient evidence provided to close this item.	Closed
REC 9 (HF)	Provide controllers with guidance on specific Electronic Flight Strip sort settings to standardise the Electronic Flight Strip display parameters between relevant positions.	Guidance on system preferences is documented in the official document for ATC staff to follow when operating the new ATMS prior to Full Transition. The same contents will be published upon Full Transition. Sufficient evidence provided to close this item.	Closed
REC 11 (HF)	Provide controllers with a recommended setting for font size for the critical ATC information to ensure consistency in legibility requirements. Currently, the “small” setting should be avoided where possible for safety critical ATC information.	Guidance on system preferences is documented in the official document for ATC staff to follow when operating the new ATMS prior to Full Transition. The same contents will be published upon Full Transition. Sufficient evidence provided to close this item.	Closed

REC 12 (HF)	Audio alerts for alarms in the Safety Net category, especially Short Term Conflict Alert, Minimum Safe Altitude Warning and Special Use Airspace should be distinctly different from the audio alerts for flight planning error warnings.	Agreement made with Raytheon to have the enhanced function in Build 4. Different audio alerts will be used. Recommendation is CLOSED – Fix delivered in Build 4 and passed verification. Sufficient evidence provided to close this item.	Closed
REC 15 (HF)	Additional training modules should be included in the training programme, which include simulation exercises to ensure controller performance in high traffic levels and at least at sector capacity and complexity.	Sample Module 4 Review of Readiness Form was provided. Sufficient evidence to close this recommendation.	Closed
REC 16 (HF)	A unit training plan should be produced, specifying the training objectives for a variety of critical ATC events and emergencies, including severe weather, night-time operations and system failure, and implement the training module.	Sample Module 4 Review of Readiness Form was provided. Sufficient evidence to close this recommendation.	Closed
REC 17 (HF)	Controller performance should be measured and evaluated during all training modules to monitor training effectiveness and validate readiness and confidence.	Recommendation is CLOSED - Evidence provided of evaluation of controller performance against training objectives has been incorporated in Module 3 and Module 4 and Shadowing. This includes controller confidence questions and self-analysis. Sufficient evidence provided to close this item.	Closed
REC 18 (HF)	Consider alternative methods of increasing resource through rostering methods in current operation or increased supply through overtime agreement. Delaying the transition date would assist in the resolution of the issues stated above.	Transition plan indicating the shadowing and assessment schedules together with the relevant assessment results has been submitted. A summary of the controller assessments to substantiate sufficient trained ATC resources to support Full Transition was provided to NATS. Sufficient evidence provided to close this item.	Closed

REC 20 (HF)	System software fix to resolve the loss of free text during sector handovers or an interim, procedural solution such as leaving this position permanently logged on without user handovers	Delivered in Build 4 and passed verification. Recommendation Closed. Sufficient evidence provided to close this item.	Closed

Appendix B: Previous Recommendations

ATMS Operational Readiness Recommendations

Reference	Recommendation	Status and Rationale
Recommendation 1	To support the senior management team to maintain and manage the overall progress through the PFI scheme, a single graphic of overall progress (reporting progress, successes, risks and issues) across the people, process, technology, communications and safety assurance should be created and maintained. NATS believes this will accord greater clarity on CAD's overall status of preparedness, as well as being a method of providing oversight to third party auditors.	Closed – The CAE structure was accepted and adopted as the analysis framework. This includes in scope planning and scope of change, people, processes, equipment and safety management processes evidence a safe implementation of the new ATMS.
Recommendation 2	Previous experience in NATS of running systems in parallel/shadow mode operations has highlighted the importance of maintaining data integrity between two 'live' systems. Discrepancies between the data sets could potentially affect certain functions. NATS believes particular importance should therefore be placed on confirmation that all data supplied to the N-TWR by any 'shadowed function' is in line with the data at S-TWR. To support this, NATS proposes a specific activity and success criterion within the PFI Stage 1 configuration plan for a shadowing activity prior to the initial PFI session and a specific objective/success criterion of each PFI session to ensure data integrity across the two 'live' systems is continuously monitored.	Closed – NATS is satisfied that: i. CAD has implemented respective supporting equipment, trained staff, as well as procedures to carry out on-going data integrity checks to monitor and maintain data integrity between the two "live" systems; and ii. CAD has consolidated the engineering/technical documentation supporting equipment, staffing, procedures and mechanisms for data checking with defined follow-up actions recorded.

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Appendix C - PFI Phase 2: Claim, Argument, Evidence (CAE) Structured Notation

Top Claim 0

The People, Procedures and Equipment for each stage of the planned Phase 2 PFI and the complete transition of N-TWR and the new ATCC (complete transition) are operationally ready.

This claim is addressed by the following arguments for the PFI Phase 2 and Full Transition:-

- The scope and related plan is known, agreed and communicated to relevant parties.
- The adequacy of the 'People', 'Procedures', 'Equipment' is demonstrated; and
- The application and completion of safety management processes.

Claim 1

The scope and plans of the PFI sessions and Full Transition are known, agreed and communicated to relevant parties, including any temporary traffic/capacity measures.

NOTE: Need to have confidence that all the relevant stakeholders involved with the PFI sessions and Full Transition understand the scope, plans, aims and arrangements. This includes reversion, fall back, contingency and temporary traffic arrangements. Issues raised and lessons learned actioned or mitigated from previous sessions (including Phase 1).

PFI 2 Evidence

1. Entry and Exit criteria (planned and unplanned)
2. PFI planning and program scheduling
3. Briefing materials and briefing attendance record
4. Pre-implementation processes per session
5. Evidence of Phase 1 lessons learning, issue tracking and closure
6. Adequate temporary traffic arrangements are in place for PFI if required

Full Transition Evidence

7. Entry criteria and contingency arrangements
8. Transition plan and programme scheduling
9. Briefing materials and briefing attendance record
10. Pre-implementation processes (e.g. final transition readiness review meeting)
11. Evidence of stakeholder communications including service impact
12. Adequate temporary traffic arrangements are in place for transition

Claim 2

'People' - The ATC, Engineering and all related roles for the PFI and Full Transition (including contingency) are sufficiently trained and available.

NOTE: Need to have confidence that the core Training and specific training/familiarisation for ATC and Engineering is planned and will be completed, and that required resources and fall backs are planned and available.

PFI 2 Evidence

1. Training for operational staff and training records
2. Training for technical staff and training records
3. Briefing materials and attendance record
4. Planning for operational staff deployment for PFI
5. Planning for technical staff deployment for PFI
6. Pre-implementation meetings and resource
7. ATC user feedback and acceptability is collected.

Full Transition Evidence

8. Training and experience levels for operational staff is recorded (including fall backs)
9. Training for technical staff and training records (including fall backs)
10. Briefing materials and attendance record
11. Planning for operational staff deployment
12. Planning for technical staff deployment
13. Pre-implementation meetings and resource
14. The W-ATCC and S-TWR contingency is resourced, monitored and maintained for the period of the warm standby.
15. ATC user feedback is collected and acceptability demonstrated

Claim 3

'Procedures'' - The ATC and Engineering procedures for the PFI and Full Transition (including contingency) are complete and available.

NOTE: Need to have confidence that the required procedures and instructions for ATC and Engineering are sufficient, complete and consistent for both PFI and Full Transition. (PFI includes pre-entry, entry to the session, operation during the session, exit/reversion from the session; Full Transition includes transition, fall back and contingency).

PFI 2 Evidence

1. ATC Procedures for operations and shadowing staff (including temporary instructions)
2. Engineering Procedures (including temporary instructions)
3. Procedures to cover steady state and fall backs

Full Transition Evidence

4. ATC Procedures for operational staff (including temporary instructions)
5. Engineering Procedures (including temporary instructions)
6. Procedures to cover steady state, fall backs and contingency

Claim 4

'Equipment'' - The engineered system can support the PFI and Full Transition (including contingency) operation.

NOTE: Need to have confidence that the ATMS and all related equipment are shown to support the operation sufficiently, that data presented will be accurate and timely, that voice communications (Ground-Ground and Ground –Air) are effective, that there is no negative interference when shadowing with the operations systems, that fall back, reversion and contingency arrangements are effective and that any system limitations/ shortcomings are known and mitigated.

PFI 2 Evidence

1. Entry and Exit criteria (planned and unplanned)
2. Safety Case and SCARS for the engineered system aspects
3. System Test Evidence for latest ATMS build
4. Evidence of the PFI configuration to enable shadowing, entry and exit from the session is understood including any limitations /shortcomings.
5. Closure or mitigation of Problem Tracking Reports raised since initiating PFI Stage 1

Full Transition Evidence

6. System entry criteria and contingency arrangements
7. Safety Case and SCARS for the engineered system aspects
8. Closure or mitigation for Problem Tracking Reports raised in PFI Stage 2.
9. System transition plan details migration to E-ATCC and N-TWR and maintaining availability of W-ATCC and S-TWR

Claim 5

The safety management processes to control hazards and risks have been applied and completed.

NOTE: Need to have confidence that the required safety management processes have been applied by relevant Subject Matter Experts, including the identification of hazards associated with the operation and that effective control measure and mitigations have been implemented to control the hazards and associated risks.

PFI 2 Evidence

1. ATMS Safety Case
2. New or amended SCARS Reports
3. Mitigations measures in place (e.g. procedures, instructions, training, resources)
4. Safety related Problem Tracking Reports are identified, prioritised and addressed.

Full Transition Evidence

5. ATMS Safety Case
6. I&T Safety Case
7. New or amended SCARS Reports/Transition Hazard Analysis
8. Mitigations measures in place (e.g. procedures, instructions, training, resources)

Annex D

Hong Kong Air Traffic Control Association supports full implementation of new ATMS

Mr Tommy Auyeung, President of the Hong Kong Air Traffic Control Association

The Hong Kong Air Traffic Control Association (HKATCA) today is glad to learn that the Transport and Housing Bureau (THB) has agreed to the Civil Aviation Department (CAD)'s planned full transition of the new Air Traffic Management System (ATMS) on 14 November, 2016. Our Association members and the other ATC staff will continue to offer with dedication round-the-clock air traffic control services in a safe and orderly manner to the public by using the new system.

We also noted that the THB's independent consultant had reviewed the issue on 27 October, during which a small number of workstations not used for direct communication with flights could not process some non-conventional flight plans, and considered that corresponding effective mitigating measures were in place and the risk of recurrence of the same situation was low. Hence, the independent consultant has decided to affirm his earlier assessment on the Department's readiness for full transition, i.e. it is ready to proceed with full transition in November 2016 as planned.

As a matter of fact, since June, the Phased Functional Implementation (PFI) has been conducted smoothly as planned in a safe, stable and reliable manner. After the 27 October incident, the final stage of PFI continued and the system has been working normally. Enhancement measures were put in place to tackle non-conventional flight plan data. ATC staff have also made significant progress in their competence and confidence in the operations of the new ATMS with the experience gained in the past two weeks by using the new ATMS to handle real time traffic. As such, the HKATCA concurred with the independent consultant's findings and recommendation.

To conclude, it is an urgent and imperative improvement project to upgrade to a new system so as to meet the growing regional air traffic demand in

future. In the early stage of the system transitional period, the number of arrivals and departures at Hong Kong International Airport during rush hours will be adjusted moderately in accordance with international practice. In addition, flow control measures will also be imposed to traffic overflying Hong Kong airspace. These measures are introduced to facilitate the ATC staff to accustom themselves to the new system and the associated new operating procedures. As one of the best ATC teams that acquired international recognition, we have been through a series of training and assessment before we could operate the new ATMS for the provision of air traffic control services to airspace users. Rest assured that HKATC will be able to live up to the general public's expectations and continue to safeguard the safety of our sky in the upcoming festive season with high air transport demand.

Annex E

Civil Aviation Department Electronics Engineers' Branch of Hong Kong Chinese Civil Servants' Association echoes the views in the assessment reports by independent consultant appointed by the Transport and Housing Bureau

By Ir Joseph Ho, Chairman of the Civil Aviation Department Electronics Engineers' Branch of Hong Kong Chinese Civil Servants' Association

The Transport and Housing Bureau announced today its agreement to the Civil Aviation Department to fully commission the new Air Traffic Management System (ATMS) next Monday (14 November). The reports by its independent consultant from the United Kingdom, NATS, one on the Full Transition and another one on the incident on 27 October, were also released. Our Association fully supports both the decision to launch the new ATMS and the comments in NATS' reports.

After the incident on 27 October, during which a small number of workstations not used for direct communication with flights could not process some non-conventional flight plans, CAD's electronics engineers quickly identified the root cause of the issue. In parallel, they literally worked day and night with the contractor to implement enhancement on the data processing and address the issue. As NATS pointed out in its report, the risk of recurrence of the same occurrence is assessed as low. NATS maintains their views that the new ATMS and Air Traffic Control (ATC) colleagues are ready for full commissioning.

In gist, NATS complimented CAD on the amount of professional work carried out to a detailed and achievable level in preparation for Full Transition and closure of all relevant recommendations including those from previous assessments. NATS confirmed that CAD has achieved a robust evidence based approach and was satisfied that CAD was ready to proceed with Full Transition as planned. NATS has cast their vote of confidence in the new ATMS and CAD colleagues. It also recognized the efforts and contribution undertaken by CAD's electronic engineers towards full implementation of the new ATMS.

As a team of professional engineers, we are committed to maintaining aviation safety. The new ATMS is designed to meet the latest international standards on technical, safety, ATC operational and maintenance requirements. CAD has conducted stringent tests on the new ATMS in accordance with international aviation safety management standards and established Government procedures, in order to ensure that the system operation is in full compliance with the contract conditions and safety management requirements.

In future, we will continue to upkeep the functionality and safety of the new ATMS. The advanced features of the new ATMS and CAD's professional ATC colleagues will be mutually complementary to further enhance the CAD's capability in air traffic management.

Incident Report on Air Traffic Management System (ATMS) Occurrence 27th October 2016

1. Introduction

1.1. Arising from a recent occurrence of the ATMS when some workstations entered into a "Display Degraded[1]" mode on the 27th October 2016[2] during a Phased Functional Implementation (PFI) session at East Air Traffic Control Centre (E-ATCC), THB have requested NATS to assess the course of actions undertaken in response to the occurrence, to advise on the safety and readiness of new ATMS, and to make relevant recommendations based on NATS' experience of similar system transitions. This report details the following aspects and consideration factors of the occurrence in turn:

a) The sequence of the event.
b) In the context of the specific event, did the associated operational and engineering reversion procedures adequately deal with the issue to maintain a safe air traffic service and minimise the operational impact?
c) In the context of the specific event, have CAD identified the root cause of the event and put in place appropriate revisions to the systems and training to ensure that this event will not re-occur?
d) In the wider context, should this event have occurred after Full Transition, would the system have been sufficiently robust to continue to provide a safe service with managed impact on service provision?
e) In the light of this event, are there recommendations that NATS would make to support CAD's full commissioning of the new ATMS?

2. Sequence of the Event

2.1 During the Full E-ATCC PFI session on 27 October 2016, a full team of frontline operational and engineering staff were manning respective positions of the new ATMS (Autotrac 3 or AT3) at E-ATCC handling all 3 ATCC functional streams, viz. approach/departure (APP/DEP), terminal (TMC) and area (AREA) with AT3's North Tower (N-TWR) in parallel operation mode. Concurrently, South Tower (S-TWR) and West Air Traffic Control Centre (W-ATCC), served by the existing ATMS, were respectively providing operational aerodrome control and parallel ATC operations to support the PFI session with capability of instant reversion to W-ATCC according to the pre-defined PFI reversion process and criteria for all planned and unplanned completion of PFI[3] to ensure seamless ATC operations.

[1] Workstation "Display Degraded" indicates a data mismatch has been detected and contained by disabling the associated software processing thread in the workstation only. Other threads running simultaneously in the workstation remain unaffected. "Display Degraded" mode is not a system crash, but is an automated system strategy in AT3 as per system design to contain potential system issues at affected workstation whilst preserving data integrity and continuing a safe ATC service.

[2] All times in Hong Kong local time.

[3] A previous unplanned reversion was called during the PFI on 27 September 2016 when an inbound flight declared emergency due to engine failure. Reversion to W-ATCC operation was initiated per pre-defined PFI reversion process and criteria and completed without impact on safety or ATC operations.

2.2 Noting that the bi-annual China International Aviation and Aerospace Exhibition would be held in Zhuhai, a Flight Data Operator (FDO) concerned attempted to input some "non-routine" command / scenario data into the new ATMS primarily for information of frontline colleagues.

2.3 At 10:23, a flight plan (FPL) for an airshow practice flight (not entering HK Flight Information Region - HKFIR) in association with the Zhuhai Airshow was received and rejected by AT3 and as per system design, channelled into its Problem Message Queue (PMQ)[4]. The PFI commenced at 10:33. At 11:29, the FDO retrieved a rejected FPL from the PMQ for review and noted that the FPL had departure aerodrome, route, destination aerodrome fields all indicating Zhuhai airport, which was unusual. In an attempt to recover the FPL, the FDO first deleted the route field entry but the change was rejected by AT3. In a second attempt, the FDO revised the FPL route to go directly to a navigation route fix called ROMEO ("direct to ROMEO"). It should be noted that ROMEO is not a route fix within HKFIR. The change was applied and the FPL was processed by the system.

2.4 This unusual FPL, though processed, did not indicate entry into HKFIR, and was followed subsequently by 3 controller positions[5] in Terminal Stream assigned to process the FPL for flight planning purpose entering into "Display Degraded" mode automatically. These positions were not involved in providing active control of aircraft. This is an automatic protection mechanism by system design to contain the data mismatch at these positions, whereby all executive control positions with radar display used for direct communication with flights were operating normally as usual at all times.

2.5 In recognition of multiple workstations entering into "Display Degraded" mode and in consideration of on-going parallel operation at W-ATCC with full operations/engineering team and instant reversion capability, the PFI managers (one each from operations and engineering), in accordance with pre-defined PFI reversion process and criteria[6], initiated the reversion procedure at 11:35 notwithstanding the availability of Fallback System as well as the Ultimate Fallback System (UFS) running in parallel in the background in addition to the normal operation of the Main System. The reversion was completed safely and successfully at 11:41. While AT3 was under shadowing operations, spare positions in the AT3 were logged on, per standing instruction, in an attempt to recover from the degraded workstations and a similar issue was observed.

2.6 With the presence of a full operations/engineering team, as part of the testing, shadowing operations commenced at E-ATCC at 12:08 using ATMS Fallback System and "Display Degraded" at the workstations concerned was observed as expected. At 12:30, the UFS was used to continue with shadowing operations and to further confirm all of the workstations were functioning normally without workstation "Display Degraded" as expected. The shadowing operations completed at 13:00.

[4] "Problem Message Queue" (PMQ) is AT3's repository of problematic FPLs detected with syntactic or semantic errors for manual processing.

[5] Currently, there are about 50 controller working positions in E-ATCC and N-TWR.

[6] The PFI reversion process with entry/exit criteria was reviewed by NATS in its Phase 2 study.

NATS Observation 1 – NATS noted a good engineering practice of new ATMS architecture design and contingency provision in its Main System, Fallback System and UFS. There is no provision of UFS in the existing ATMS. NATS also noted that provisions are available for the Main System itself to handle multiple scenarios of failure, which are not available in the existing ATMS.

Moreover, the Main System and Fallback System are exactly the same in terms of hardware and software design. Thus, the Fallback System, by offering contingency provisions, can cater for multiple hardware problems, e.g. overheating and failure of circuit boards and the design was such that it responded in the same manner as the Main System to the "non-routine" command/scenario data, as expected.

On the other hand, the UFS is different from the Main System and Fallback System in terms of software and hardware design and therefore did not encounter the same problem. The testing conducted in E-ATCC, after reversion of operations to W-ATCC, is a good demonstration and confirmation to ascertain the response of the new ATMS Fallback System and the UFS with expected results tallied with the design of the system in ensuring the continued provision of ATC service.

Moreover, the Main System, Fallback System and UFS were stable. No system crash was observed at all times.

2.7 In parallel, CAD and the on-site engineer of the new ATMS Contractor (the Contractor) investigated the issue by collecting data logs while leaving the system in its then present state to facilitate testing/investigation. The concerned FPL causing the issue was positively identified (see Section 4).

2.8 At 14:15, a de-briefing session was held to inform CAD staff who had participated in the PFI in that morning about what had happened, cause of the occurrence, decision for reversion to existing ATMS, system designed protection mechanism available, immediate workaround, follow-up fix, and a Question & Answer (Q&A) session to provide as much information to the CAD staff as available on hand.

NATS Observation 2 – CAD had undertaken significant and stringent system testing. However the specific scenario that occurred during the PFI had not been identified as part of testing and procedure design. NATS has experienced similar issues with flight planning data causing system inconsistencies during both system transitions and normal operations in UK. Even with all reasonable efforts and endeavours, there could still be possibilities to have set-backs of this type during introduction of a new system. This underlines the importance of contingency, transition and fallback provisions, procedures, and associated training that were duly covered in Phase 2 Study. Moreover, new ATMS design to have “Display Degraded” mode to contain a data mismatch at the workstation level, without causing system or workstations crash, is obviously an improvement over the existing ATMS to preserve data integrity and ensure a safe ATC service.

3. Effectiveness of System Reversion from PFI

3.1 As detailed within the NATS' PFI Stage 2 and Full Transition Assessment (Phase 2 Study – see Reference 1), in preparation for PFI and Full Transition, CAD has established a framework of evidence that the people, procedures, equipment, and safety management processes for each stage of the PFI and Full Transition are operationally ready. This scope includes the following specific PFI criteria that are related to the occurrence:

a) Operational entry and exit criteria were established for both planned and unplanned occurrences (CAE Ref 1.1)
b) Both engineering and operational ATC Staff are adequately briefed (CAE Ref 1.3, 2.1, 2.2, 2.3)
c) ATC Procedures are in place for staff participating in live and parallel operations (including temporary instructions) (CAE Ref 3.1)
d) Engineering Procedures (including temporary instructions) are in place to cover steady state and fallbacks (CAE Ref 3.2 & 3.3))
e) System entry and exit criteria (planned and unplanned) are in place (CAE Ref 4.1)
f) System Test Evidence for ATMS build is in place (CAE Ref 4.3)
g) There is evidence of the PFI configuration to enable parallel operations, entry and exit from the session is understood, including any limitations/shortcomings (CAE Ref 4.4)

3.2 Phase 2 Study details the evidence provided against these areas by CAD in its overall finding, NATS confirms that CAD has achieved a robust evidence based approach and is satisfied that "CAD is ready to proceed with Full Transition as planned, well supported by clear entry and success criteria, robust fallback contingency measures if needed, and with demonstrated operational readiness in the areas of planning, people, procedures, equipment and safety management processes, that together evidence safe implementation of the new ATMS."

NATS Observation 3 – CAD's exit criteria, fallback procedures and transition out of PFI to normal operations, as reviewed and agreed by NATS in the Phase 2 study, worked as intended and allowed CAD to smoothly and safely transition out of PFI and assume continuous operations without any safety or operational impacts. The de-briefing session with the staff involved is a good practice as part of overall communications and staff engagement.

4. Fault Identification and Resolution

4.1 Following the occurrence, CAD immediately forwarded relevant system records and system logs plus relevant observation documents to the Contractor for urgent investigation and rectification. The following are findings and proposed remedial actions by the Contractor:

a) The immediate cause – that it was the route data deemed invalid by the system in the unusual FPL as determined by CAD was confirmed.

b) The root cause –the occurrence was confirmed to be in the FPL posting logic for flight planning function. An explanation of the mechanism leading to the occurrence is given in Appendix 1.

4.2 With the root cause positively identified, the Contractor has already worked out a software fix and successfully tested at their factory confirming that the same issue will not recur. The fix has also been verified in Hong Kong for all such unusual FPL scenarios with satisfactory results.

4.3 The implementation of the fix is to handle the data mismatch for HKFIR entry time before applying the posting logic. In case of no HKFIR entry time, posting logic based on HKFIR entry time would not be applied. The FPL concerned will be displayed at the auxiliary screen of the ATMS (which is next to the radar screen) for reference by the air traffic controller(s) and flight planner(s) concerned, i.e. the FPL data checking has been improved to handle such situations.

NATS Observation 4 – CAD together with the Contractor have been able to quickly identify the root cause and recreate the occurrence. NATS is satisfied that enhancement measures including the software fix and procedural changes have been implemented and verified to both solve and avoid the recurrence.

5. Potential Impact if the Issue of "Display Degraded" Had Occurred After Full Transition

5.1 If the same FPL issue causing display degrade had occurred after Full Transition without the new fix, based on established procedures, the concerned FDO would immediately retrieve the problematic FPL, of which the route field content had been modified and applied just before the workstation had entered into "Display Degraded" mode. The FDO could quickly remove the problematic FPL using his own workstation. After the FPL is deleted, affected workstation(s) with "Display Degraded" would be rebooted to resume normal operations.

5.2 NATS' assessment is that the impact of the issue should it occur after Full Transition would be minor with no safety concern because:

a) There was neither system "outage" nor system "crash". The Main System, Fallback System and UFS[7] of the new ATMS kept operating normally.
b) Only 3 out of some 50 controller positions showed "Display Degraded" and these positions are used for flight planning rather than controlling flights. All other positions in E-ATCC and N-TWR remained fully operational without affecting safety.
c) Each of the concerned positions could resume normal operation after deletion of the concerned FPL and the workstations were re-booted afterwards. The recovery process can be completed within 15 minutes with minimal operational

[7] There are multiple backup hardware and software modules with the Main System, and the same for Fallback System. The UFS would be used for operation only when the hardware and software of both Main System and Fallback System fail simultaneously. It is noted that the backup ATMS system for existing ATMS system has not been used for operation since its commissioning.

impacts and without the need to switch to Fallback System or UFS. This has been verified by a drill based on established procedures on 30 October 2016.

6. *Review Framework*

6.1 The framework applied for the NATS review of this occurrence has been based on key elements of existing NATS processes, in accordance with safety management system, and experiences of investigating similar incidents (including those for Flight Data Processing systems). These include:

a) System Fallback and Recovery;
b) Incident Management;
c) Problem Tracking / Investigation; and
d) Problem Fix delivery and testing.

6.2 With the objective of satisfactory resolution of the issue, minimisation of risks and the viability of Full Transition, the following areas and the relevant procedures / documents / records have been the focus of NATS' review:

a) Technical details (Equipment) – the problem system data, mechanism leading to the issue and system behaviour;
b) The circumstances leading to the issue (Environment);
c) Operation details (People and Procedure) – the sequence of events, the decision and execution of reversion, potential operational impacts, contingency and fallback readiness;
d) The relevant processes and adequacy followed up by CAD in the investigation of the incident (Procedure);
e) Effectiveness of the fix, workarounds and further enhancement to prevent recurrence of same or similar issues from a system, operational and procedural perspective (Equipment, People and Procedure); and
f) Management and handling of the incident and its potential impact on the continuation of PFI and Full Transition.

NATS Observation 5 – The actions and activities undertaken by CAD, both during and subsequent to the occurrence to manage and resolve the situation are considered satisfactory, effective and on par with those of NATS.

7. Communication

7.1 NATS places importance on open and accurate reporting, and for this reason asks all external communication to be directed through official channels. NATS notes CAD has undertaken substantial efforts in communicating with staff at all levels with an aim to conveying clear and accurate factual information on the occurrence in a timely and effective manner. With the cause leading to the issue positively identified and demonstrated to operational colleagues (the FDOs in particular), CAD had immediately provided a briefing on details of what had happened and cause of the occurrence on 27 October 2016, reversion decision, built-in system protection mechanism, and upcoming fix to colleagues who had participated in the PFI on 27 October 2016.

7.2 A separate briefing session was provided to engineering and system maintenance staff on 28 October 2016. An e-mail was also sent to all operational staff on 29 October 2016. Besides, operational staff participating in subsequent live traffic handling was also briefed on the related details.

7.3 CAD has issued a Press Release on 28 October 2016 to promulgate a correct and accurate message on the course of action, cause of the occurrence, and forthcoming actions. NATS is satisfied with the effective communication by CAD to appraise its staff and media/public on details pertinent to the occurrence.

8. NATS Summary and Recommendations

8.1 In the course of the assessment work, NATS has reviewed the evidence and the information provided by CAD and come up with five observations as shown in the previous sections. Given the complexity of an ATMS, even with all reasonable efforts and endeavours, there could still be possibilities for an issue as experienced by CAD on 27 October 2016, as NATS' own experience could attest. NATS has observed good practice by CAD in system fallback provisions, incident management, containment of data mismatch, and recovery arrangements in the areas of people, procedures, and equipment. The five observations by NATS were summarised as follows:

a) NATS noted a good engineering practice of new ATMS architecture design and contingency provisions in its Main System, Fallback System and UFS to cater for multiple failure scenarios, which are more advanced than the existing ATMS. The Main System, Fallback System and UFS were stable. No system crash was observed throughout the occurrence;
b) NATS underlined the importance of contingency, transition and fallback provisions, procedures, and associated training by CAD that were previously assessed by NATS as effective and satisfactory. NATS noted the enhancement feature for new ATMS to contain the data mismatch which preserves data integrity and ensures a safe ATC service;
c) NATS noted that the occurrence was well-managed by CAD professionals in accordance with pre-defined PFI reversion procedures ensuring safe, smooth and effective ATC service;
d) NATS considered the investigation on the root cause and implementation of enhancement measures, including effective software fix and procedural changes

by CAD and the Contractor were efficient and effective. NATS is satisfied that the occurrence reported was satisfactorily resolved; and

e) NATS is satisfied with and impressed by CAD's overall management of the occurrence, including in particular the dissemination of information to internal and external parties, which is on par with NATS.

8.2 NATS has had direct experience of flight planning issues impacting both NATS' system transitions and live operations, arising from issues related to FPL format / data as well as issues within the core processing. On the occasions these have occurred during live operations, NATS has experienced high levels of traffic delay. To avoid disclosing piecemeal or isolated information to external parties that may cause unnecessary confusion, NATS has experience in treating information collected from occurrence of similar nature and in preserving its confidentiality until completion of investigation.

8.3 Noting the adverse impact of inaccurate information reaching the media/public through unofficial channels, despite all endeavours by CAD including issuing of circulars / reminder emails, it is suggested that CAD might consider to further reduce that risk by reiterating staff responsibility with regards to external communications, including information provided to social media, as appropriate.

8.4 On the basis of the evidence provided to NATS, CAD's handling on the occurrence was considered effective and the reversion procedure was conducted and completed as designed (as reviewed and agreed by NATS in its Phase 2 Study) resulting in no impact to safety and ATC operations. This is largely due to the clarity of the entry and exit criteria for PFI, and the level of staff training to support an instant reversion.

8.5 Considering that software fix and workarounds are already in place, the risk of recurrence of the same occurrence is assessed as low. Based on NATS experience, NATS would recommend CAD to take the following further steps before Full Transition:-

Minimising the likelihood of further FPL issues

a) Undertake testing to build confidence of the fix for this specific issue.

b) For non-conventional FPLs[8] that normally enter into the PMQ requiring manual processing, carry out testing to verify if manual amendment on those FPLs would cause no issues to AT3.

Minimising the impact of any future FPL issues

c) Enhance procedures and practice for FDOs to remove the problematic FPL once it is detected.

d) Review and refine the reversion and backup plan to cater for different scenarios/faults.

[8] Non-conventional flight plans involving:

- re-entrant flight – a flight that takes off and lands at same airport
- multiple-point flight – a flight passes through multiple navigation route fixes
- slow aircraft – a helicopter or small propeller-driven aircraft that flies by visual flying rules
- flights with duplicated identifiers – each flight with FPL under process by the system should have a unique identifier
- incomplete flight plan – a flight plan with missing information in its data field(s)

8.6 The CAD responses including actions to each of the recommendations are detailed at Appendix 2.

9. Conclusion

9.1 In conclusion, upon review of the occurrence, and CAD's responses to each of the NATS' recommendations, NATS is satisfied that CAD has implemented all actions arising from the recommendations, some of which bear the benefit of a wider and general coverage to other potential issues. NATS also find that CAD's actions are also supported by documentary evidence. Considering the nature of the occurrence, that corresponding effective mitigating measures have been in place and the event-tested reversion, NATS is confident that the issue as reported has been satisfactorily resolved, and NATS' assessment on CAD's readiness for Full Transition as previously concluded in Phase 2 Study remains unchanged.

References

1. Phased Transition Approach for Air Traffic Management System and Overall Transition Readiness for ATC Replacement System - PFI Stage 2 and Full Transition Assessment (Issue 1.5, October 2016)

Appendix I – Mechanism of flight strip posting logic leading to the occurrence

(a) A posting logic based on FIR entry time had been activated through system adaptation. Therefore, to determine when and where to post a FPL to controllers, AT3 required the FIR entry time to make the decision.

(b) The concerned FPL did not indicate any entry to HKFIR, which caused the FPL to be placed into the PMQ by the system. Subsequent manual amendment of the FPL also did not rectify the issue. Therefore, no FIR entry time could be determined by the system. The FPL posting logic at the workstation detected a data mismatch. As a result, when the concerned FPL was posted to the respective flight planning workstations, the protection mechanism was immediately triggered to protect the workstation from crashing with a "Display Degraded" shown onto the screen.

(c) All Executive Control positions, directly communicating with flights, were operating normally at all times, and with no safety and operational impacts due to the occurrence.

(d) As the amended FPL passed the format checking at the time and so no warning/error popup was displayed at the time of executing the FPL amendment. It is confirmed that the Main System, Fallback System, and UFS were working normally and stable as per system design with the issue occurred at flight planning workstation level only.

(e) As the concerned FPL was only required to be processed by the affected workstations, other positions not required to process the FPL were not affected by the occurrence.

Appendix 2 – NATS Recommendations & CAD Responses

ID	NATS Recommendation	CAD Comment/Response	Status
REC 1	• Undertake testing to build confidence of the fix for this specific issue.	• As an established practice, the fix developed by Contractor has undergone various tests including the factory testing at their factory at Marlborough, functional tests, on-site verification tests in Hong Kong and normal ATC operations (NATCO) so as to build confidence that the fix could successfully address the identified issue.	Closed
REC 2	• For non-conventional FPLs that normally enter into the PMQ requiring manual processing, carry out testing to verify if manual amendment on those FPLs would cause no issues to AT3.	• A thorough and structure review were conducted to trace the problematic FPLs from the PMQ of new ATMS. These problematic FPLs were fed into the AT3 for manual amendments at PMQ and it was confirmed that such actions did not cause any problem to AT3. The above-mentioned review was made during the subsequent PFI sessions with satisfactory results.	Closed
REC 3	• Enhance procedures and practice for FDOs to remove the problematic FPL once it is detected.	• Procedures have been enhanced and practice/briefing was conducted for FDOs to remove the problematic FPL once it is detected.	Closed
REC 4	• Review and refine the reversion and backup plan to cater for different scenarios/faults.	• The reversion and backup plan were reviewed and refined to cater for different scenarios/faults. Such review was conducted with documents updated.	Closed

Annex G

Cathay Pacific and Dragonair fully support the new air traffic management system

Date: 29 Oct 2016

Cathay Pacific and Dragonair fully support the implementation of the new Air Traffic Management System (ATMS) by the Civil Aviation Department (CAD), which the airlines believe is instrumental to strengthening Hong Kong's status as one of the world's leading aviation hubs.

The airlines are confident that the CAD will successfully enhance operational efficiency as a result of the new system, which will be of considerable benefit to the long-term development of Hong Kong.

Furthermore, Cathay Pacific and Dragonair have full faith in CAD's professionalism and are certain that it will uphold the highest standards for flight safety. The airlines look forward to working closely with both CAD and the Transport and Housing Bureau (THB) in the successful implementation of the new system.

Annex H

Hong Kong Airlines Supports the Implementation of New ATMS

Date: 2016-10-29

Hong Kong Airlines (the "Company") welcomes any initiative which is beneficial for strengthening Hong Kong's status as a premier international aviation hub. We support the implementation of the new Air Traffic Management System (ATMS) by the Civil Aviation Department (CAD) which is believed to create a positive impact on Hong Kong's economic development in line with the region's long-term economic growth.

Aviation safety has always been the top priority of the Hong Kong aviation industry and the authorities. Hong Kong Airlines is confident that the new ATMS will enhance the efficiency of air traffic control operations. We will continue to fully cooperate with the Transport and Housing Bureau and the CAD to ensure the successful launch of the new ATMS.

Annex I

CAD responds to media enquiries on new ATMS

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In response to media enquiries today (November 19) on the new Air Traffic Management System (ATMS), a spokesman for the Civil Aviation Department (CAD) said:

The operation of the new ATMS has been smooth in general since its full commissioning on November 14. On November 15 afternoon, the position of an departing aircraft was not displayed temporarily on the radar screen of one workstation in the new Air Traffic Control (ATC) Centre and there was a brief occurrence of split tracks (showing two flight tracks of the same aircraft on the screen). Through radar screen updates, the aircraft position was shown again automatically within 12 seconds. The allegation made by a source in a Chinese-language newspaper today that the position of an aircraft "resurfaced after some 20 to 30 seconds" was not factually correct. During the process, radar screen display of all other workstations were operating normally in the new ATC Centre.

As a matter of fact, the phenomenon of aircraft positions temporarily not displayed on the radar screens was also observed occasionally in the ATMS elsewhere. It is a common practice for the ATMS developers to address the issue in their system design. In Hong Kong, no matter the air traffic controllers (ATCOs) use the old or the new ATMS, they can retrieve the position of an aircraft immediately or avoid split tracks by choosing an appropriate radar signal through the main system in accordance with established operation procedures. This procedure is called switching to the "bypass mode" (in case of the old ATMS) or "local mode" (in case of the

new ATMS). There are long established guidelines on how to tackle relevant scenarios for all ATCOs to follow. The allegations quoted by the newspaper that "ATCO could not get hold of the aircraft position" or that "the phenomenon will have profoundly impacted on the daily operations" were unfounded. Moreover, the same set of aircraft information is available to the workstations operating in the "bypass mode" or "local mode". There is no question of putting extra pressure on the ATCOs.

The CAD has been in close communications with the President of the Hong Kong Air Traffic Control Association and the Chairman of the Civil Aviation Department Electronics Engineers Branch of Hong Kong Chinese Civil Servants' Association. They both understood the situation on November 15 and supported the management of the CAD. They acknowledged that there is a set of clear guidelines for frontline officers to follow. They considered it reasonable for the CAD management to remind the ATCOs to switch to "local mode" in order to address the issue in case of recurrence. They believed that the ATCOs who have all undergone professional training are capable to handle this kind of known phenomenon.

The new ATMS, with sophisticated design, adopted multi-radar tracking system to enhance the precision of aircraft position. It may take a bit longer occasionally for synchronisation. Sometimes, radar signals may be affected by different external factors (for instance aircraft transponder is busy or has radio communication problems, the reception of radar signals is interfered by external factors, terrain or obstacles etc.). Even if the aircraft is following a standard flight path, there is still a possibility that its position cannot be displayed temporarily or there are split tracks on the radar screen.

According to the guidelines issued by the International Civil Aviation Organisation (ICAO) and the European Organisation for the Safety of Air Navigation (EUROCONTROL), the position of an aircraft displayed on the

radar screen should be updated at an interval of not more than five seconds. The CAD has adopted an update rate of four seconds. On November 15, the position of the aircraft concerned appeared after two to three updates (within 12 seconds), even without the need to switch to "local mode".

In conclusion, the phenomenon mentioned above is a relatively minor occurrence, in relation to local external factors, that requires further optimisation of the ATMS in the light of operational experience. The overseas independent consultant of the Transport and Housing Bureau from the United Kingdom, National Air Traffic Services (NATS), has confirmed that the CAD's new ATMS is safe, stable and reliable, and that the CAD is ready for the full commissioning of the new ATMS. According to the experience of NATS, given the complexity of an ATMS, even with all reasonable efforts and endeavours, there could still be possibilities to have set-backs during introduction of a new system. To safeguard aviation safety, the CAD has laid down procedures for trained and professional ATCOs to handle different situations. It is normal and in accordance with international practice that the new ATMS needs some time to optimise its performance and suit the local operating environment. The CAD will continue to closely monitor the operations of the new ATMS with a view to bringing further improvements to it.

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