

# Transport and Housing Bureau - Hong Kong

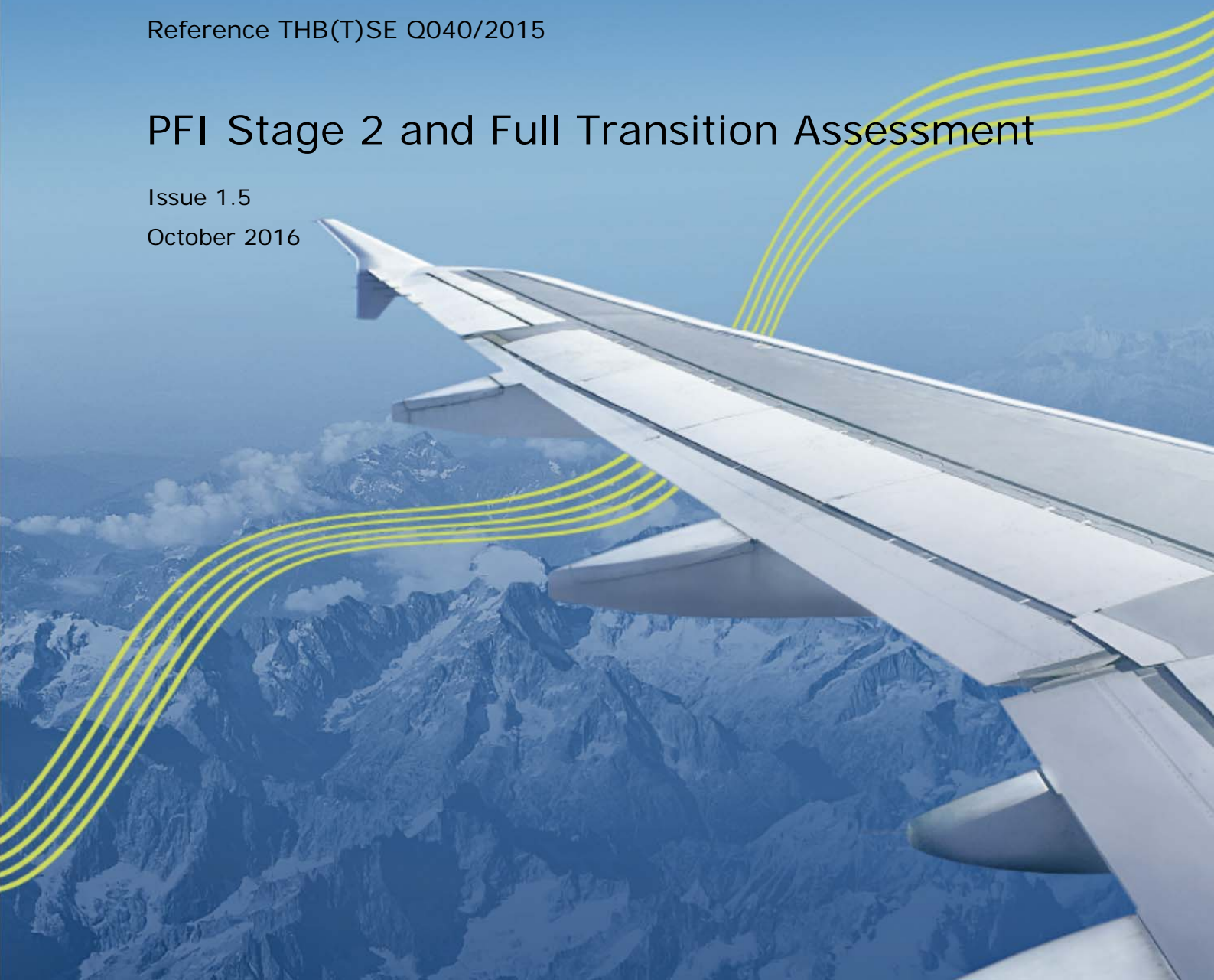
## Phased Transition Approach for Air Traffic Management System and Overall Transition Readiness for ATC Replacement System

Reference THB(T)SE Q040/2015

### PFI Stage 2 and Full Transition Assessment

Issue 1.5

October 2016



---

## Document Management

Publication details:

<b>Customer Relationship:</b>	<b>Chris Danner</b>
Title:	Client Relationship Manager Asia Pacific
Telephone no.:	+44 (0) 7920 503569
E-mail:	chris.danner@nats.co.uk

<b>Contract Delivery Manager:</b>	<b>Colin Smith</b>
Title:	Hd Solutions Strategy
Telephone no.:	+44 (0) 1489 444541
E-mail:	colin.smith@nats.co.uk

Issue:	Issue 1.5
--------	-----------

© NATS Ltd 2016

All rights reserved. No part of this document may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical photocopy, recording or otherwise without the prior permission of the Business Development Director, NATS.

The circulation of NATS Protectively Marked information outside NATS is restricted. Please do not redistribute this information without first obtaining NATS' permission. Every effort should be made to prevent any unauthorised access to this information and to dispose of it securely when no longer required. NATS is not a public body and therefore has no duty under the UK Freedom of Information Act (FOIA) and UK Environment Information Regulations (EIR) to release information. NATS does however appreciate that other organisations that receive NATS information could be subject to FOIA and EIR. With this in mind please do not release any NATS protectively marked information without prior consent from the author of the information and exemptions could apply.

## 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<sup>1</sup> 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

---

<sup>1</sup> 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.

INTENTIONALLY BLANK

## 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

<b>GLOSSARY .....</b>	<b>VII</b>
<b>TABLE OF CONTENTS .....</b>	<b>VIII</b>
<b>SECTION 1: INTRODUCTION.....</b>	<b>1</b>
1.1    DOCUMENT SCOPE .....	1
<b>SECTION 2: PFI AND FULL TRANSITION CONFIGURATION.....</b>	<b>2</b>
2.1    PFI HIGH LEVEL DESCRIPTION .....	2
<b>SECTION 3: ANALYSIS OF PFI STAGE 2 CONFIGURATION .....</b>	<b>4</b>
3.1    METHODOLOGY .....	4
<b>SECTION 4: RESULTS.....</b>	<b>5</b>
4.1    PFI 2 SUB CLAIM 1 (SCOPE AND PLANS) .....	5
4.2    PFI 2 SUB CLAIM 2 - 'PEOPLE' .....	6
4.3    PFI 2 SUB CLAIM 3 - 'PROCEDURES' .....	8
4.4    PFI 2 SUB CLAIM 4 - 'EQUIPMENT' .....	9
4.5    PFI 2 SUB CLAIM 5 - SAFETY PROCESSES .....	10
4.6    FULL TRANSITION SUB CLAIM 1 - SCOPE AND PLANS.....	11
4.7    FULL TRANSITION SUB CLAIM 2 - 'PEOPLE' .....	12
4.8    FULL TRANSITION SUB CLAIM 3 - 'PROCEDURES' .....	14
4.9    FULL TRANSITION SUB CLAIM 4 - 'EQUIPMENT' .....	15
4.10    FULL TRANSITION SUB CLAIM 5 - SAFETY PROCESSES .....	16
4.11    CAPACITY REDUCTION SCHEME (FULL TRANSITION) .....	17
<b>SECTION 5: CONCLUSION, OUTCOMES AND BEST PRACTICE</b>	
<b>RECOMMENDATIONS .....</b>	<b>18</b>
<b>REFERENCES .....</b>	<b>20</b>
<b>APPENDIX A – RECOMMENDATIONS FROM PHASE 1 REPORT (REF 1) .....</b>	<b>21</b>
<b>APPENDIX B – PREVIOUS RECOMMENDATIONS .....</b>	<b>25</b>
<b>APPENDIX C - PFI PHASE 2: CLAIM, ARGUMENT, EVIDENCE (CAE) STRUCTURED NOTATION.....</b>	<b>27</b>



## 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.

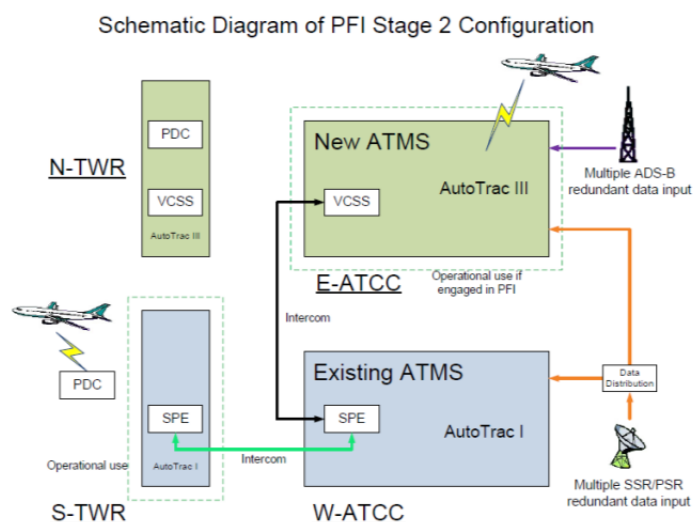


Figure 1

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

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

**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<sup>2</sup> is necessary.

---

<sup>2</sup> 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	<p>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.</p> <p>Complete – evidence is sufficient for CAE.</p>	Completed with sufficient evidence
2.2	Update on scheduled and completed training for technical staff	<p>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.</p> <p>Complete – evidence is sufficient for CAE.</p>	Completed with sufficient evidence
2.3	Briefing materials and briefing attendance record	<p>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.</p> <p>Complete – evidence is sufficient for CAE.</p>	Completed with sufficient evidence
2.4	Planning for operational staff deployment for PFI	<p>Complete – evidence is sufficient for CAE.</p>	Completed with sufficient evidence

## PFI Stage 2 and Full Transition Assessment

---

2.5	Planning for technical staff deployment for PFI	<p>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.</p> <p>Complete – evidence is sufficient for CAE.</p>	Completed with sufficient evidence
2.6	Pre-implementation meetings and resource	<p>Complete – evidence is sufficient for CAE.</p>	Completed with sufficient evidence
2.7	ATC user feedback and acceptability is collected	<p>Clear evidence that user feedback and confidence is being collected and tracked across different phases of training and shadowing.</p> <p>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.</p> <p>Complete – evidence is sufficient for CAE.</p>	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

## PFI Stage 2 and Full Transition Assessment

---

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	<p>System entry and contingency criteria are clearly defined in the referenced material.</p> <p>Complete – evidence is sufficient for CAE.</p>	Completed with sufficient evidence
4.7	Safety Case and SCARS for the engineered system aspects	<p>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.</p> <p>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.</p> <p>Complete – evidence is sufficient for CAE.</p>	Completed with sufficient evidence
4.8	Closure or mitigation for Problem Tracking Reports raised in PFI Stage 2.	<p>Review completed.</p> <p>Complete – evidence is sufficient for CAE.</p>	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	<p>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.</p> <p>Complete – evidence is sufficient for CAE.</p>	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	<p>ATMS Safety Case Report is sufficient for Full Transition noting the best practice recommendations for aligning build and safety case versions.</p> <p>Complete – evidence is sufficient for CAE.</p>	Completed with sufficient evidence
5.6	Implementation and Transition (I&T) Safety Case	<p>The I&amp;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.</p> <p>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.</p> <p>Complete – evidence is sufficient for CAE.</p>	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

## PFI Stage 2 and Full Transition Assessment

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

## PFI Stage 2 and Full Transition Assessment

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

**PFI Stage 2 and Full Transition Assessment**

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: <ul style="list-style-type: none"> <li>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</li> <li>ii. CAD has consolidated the engineering/technical documentation supporting equipment, staffing, procedures and mechanisms for data checking with defined follow-up actions recorded.</li> </ul>

INTENTIONALLY BLANK

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

