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Study Report on Selected Safety Issues for Staffing ATC Operations

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Abstract

This report presents a study of good practice on selected safety issues for staffing Air Traffic Control (ATC) Operations. The study focuses on the following selected staffing issues: degraded systems operations, workload extremes, night work, Single Person Operations (SPO), position handover, and On-the-Job Training (OJT). The aim when addressing these issues was to obtain a description of the hazards and prevention and mitigation strategies.

Keywords

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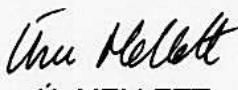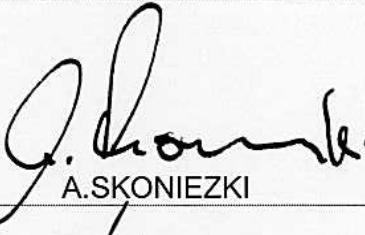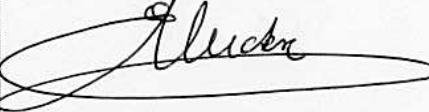
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APPENDICES

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EXECUTIVE SUMMARY

The lessons learned from the fatal accidents that occurred in the beginning of the century highlighted concerns and issues related to staffing in Air Traffic Control (ATC) units, i.e. Single Person Operations (SPO), staffing during all operations, and position handover. In the Strategic Safety Action Plan (SSAP) developed by EUROCONTROL as a response to the Linate and Überlingen accidents, a specific work package was identified to address issues on adequate levels of staffing, which has led to this study on selected safety issues for staffing ATC Operations. The referred work package has been approved by the Provisional Council to be continued and fully delivered under the European Safety Programme for Air Traffic Management (ATM) under its Activity Field 5, 'Safety Management Enhancement'.

The purpose of this study was to review practices and trends for the staffing in ATC Operations that focused on the following safety critical issues:

1) Staffing in degraded systems operations.
2) Staffing during workload extremes.
3) Staffing during night work.
4) Single Person Operations (SPO).
5) Position handover.
6) On-the-Job Training (OJT).

The aim when addressing these safety critical issues was to obtain a description of the potential hazards and their appropriate prevention and mitigation strategies. The study focuses on staff working in current operations (e.g. Air Traffic Controllers (ATCOs), supervisors, On-the-Job Training Instructors (OJTIs), flight data, and in general ATM staff occupying an operational position in the Ops room). Excluded are engineers and technicians who interact with live operational equipment. Although it was acknowledged that these categories are important, their inclusion was considered outside the scope of this study. The staffing issues were investigated in the ATM domain as well as related industries.

Section 1, 'Introduction', presents the concept of staffing in ATC Operations, the approach, chosen scope, and outlines the structure of the report.

Sections 2 to 7 cover the six staffing issues. Each of these sections outlines the hazards associated with safe staffing, provides appropriate prevention and mitigation strategies, and ends with a mitigation summary.

Section 8, 'Interaction between the six issues', describes the context in which hazards may occur and appropriate prevention and mitigation strategies.

Section 9, 'Summary and Conclusions', provides the overall summary and main conclusions from the study.

Appendices 1 to 8 provide information on the methodological approach, case studies from ATM and consolidated information from related industries in relation to the six staffing issues.

A list of references, a glossary of terms, a list of the abbreviations and acronyms used in this document, and a list of the contributors to its development are also provided.

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1. INTRODUCTION

1.1 Background

The growing traffic, technological changes and commercial pressures makes staffing the ATC Operations complex and challenging. To maintain a safe, orderly and expeditious flow of traffic, it is important to staff operational positions safely and to withstand commercial pressure avoiding unnecessary risks. This may require certain safety buffers to cope with expected and unexpected variances (e.g. people, technology, organisation, contextual).

The lessons learned from fatal accidents that occurred in the beginning of this century highlighted concerns and issues related to staffing in ATC units, i.e.

- Single Person Operations (SPO)[1],
- staffing during all operations,
- position handover.

In the Strategic Safety Action Plan (SSAP) developed by EUROCONTROL organisation as a response to the Linate and Überlingen accidents, a specific work package was identified to address issues on staffing, which has led to this study. The referred work package has been approved by the Provisional Council to be continued and fully delivered under the European Safety Programme for ATM under its Activity Field 5, 'Safety Management Enhancement'.

1.2 Staffing Concept

Staffing in ATM is defined as resourcing ATC Operations with competent (see 'EUROCONTROL Safety Regulatory Requirement 5 – ESARR 5' [2002][2]) staff at all required operational positions to provide a safe, orderly and expeditious flow of traffic within the capacity declared by the Air Traffic Service (ATS) unit, including periods of known or unknown workload extremes and/or degraded system operations. This implies the following requirements of the staff involved:

- to have an appropriate mix of experience,
- to be fit for duty,
- to be legally qualified,
- to be motivated (see 'ESARR 3' – EUROCONTROL, 2000[3]).

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[1] See Section 5 for definition.
[2] ESARR5 competence is taken to mean possession of the required level of knowledge, skills, experience and, where required, proficiency of English, to permit the safe and efficient provision of ATM services.
[3] ESARR3 – 5.2.1: ATM service provider shall ensure that staff are adequately trained, motivated and competent for the job they are required to do. In addition, to be properly licensed if so required.

Note: Safe staffing may simply be to staff all operational positions required to be open at any one time. Whereas, unsafe staffing is when not all operational positions are staffed to the right level when required.

Factors that impact staffing are summarised in Figure 1.

The overall hazards associated with staffing in ATM are:

- **Over- and under-staffing**: Not enough staff to handle properly the traffic, leading to safety occurrences including accidents. Over-staffing may lead to boredom and hence distraction. Also staff may be needed for other tasks.

- **Traffic variation**: High-traffic volume may fall into periods when humans are not at their biological peaks. This is influenced by factors such as length of duty and when the peak volume occurs in regard to circadian rhythm.

- **Competency/recency**: Competency to open required sectors or to combine certain sectors and recency for controllers, in particular part-time controllers.

- **Lack of redundancy due to Single Person Operations (SPO)**: Lack of available redundancy for normal and degraded operations.

- **Teamwork**: The quality and efficiency in the different mix of positions, right mix of people and coordination between sectors including the extent of cooperation and assistance available and provided within the team.

- **Overconfidence**: Controllers 'can do' mentality i.e. the mentality to do the job whatever the circumstances.

- **Fit for duty**: (fatigue, drugs, alcohol, medical). Awareness of fitness for duty state. Balancing personal and professional life and scheduling free time.

- **Health**: The impact of working shift overtime and the nature of the job on the individual.

- **Loss of job satisfaction**: caused by over- or under-staffing, dropping traffic, rosters or management and social issues.

These hazards may vary depending on the different configurations of operational positions (number of working positions required), type of traffic, pattern of traffic, Letter of Agreements (LoAs) and local procedures. The overall outcome could be the same but it is apportioned on different causes depending on en-route, approach, and tower environments.
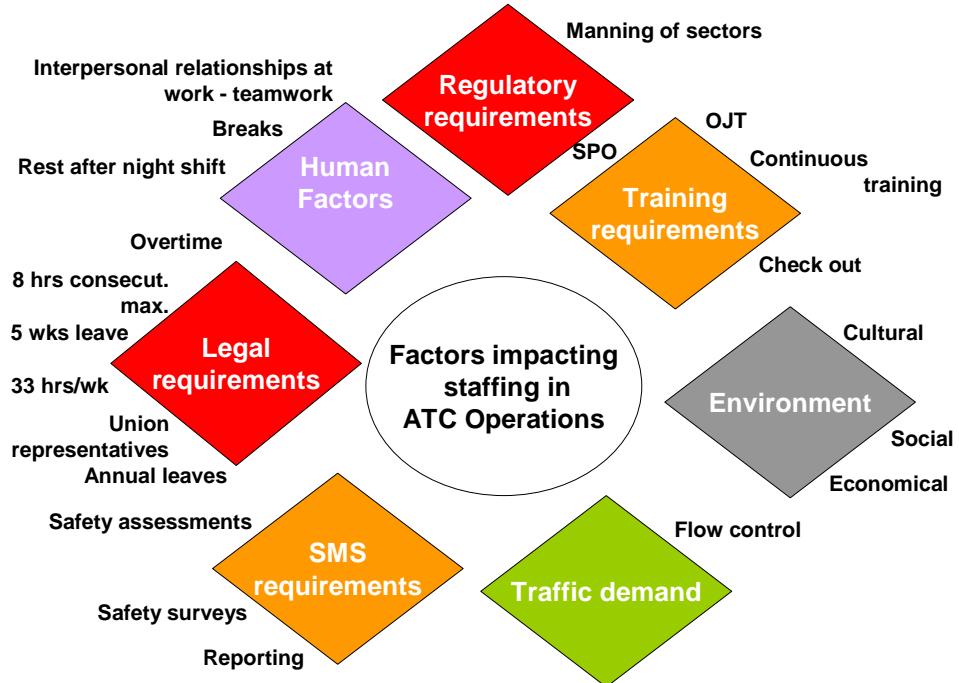
Figure 1: Factors impacting staffing

1.3 The Purpose of the Study

The study focuses on the following selected staffing issues:

1. Degraded systems operations.
2. Workload extremes.
3. Night work.
4. SPO.
5. Position handover.
6. OJT.

The idea when addressing these issues was to obtain a description of the hazards and prevention and mitigation strategies.

The study reviews practices and trends including:

a) Methodology, concepts, approaches, and tools.

b) Issues/hazards that may arise and the related prevention and mitigation strategies in place.

c) Examples / case studies of good practices in ATM, especially relating to different operating environments.

1.4   The Scope of the Study

The study focuses on staff working in current operations (e.g. ATCOs, technical supervisors, OJTIs, data specialists and operational supervisors). Excluded are engineers and technicians who interact with live operational equipment. It is acknowledged that these categories are important, but their inclusion is considered outside the scope of this study.

The staffing issues are investigated in the ATM domain as well as related industries.

The study includes content from the EUROCONTROL deliverables reporting on the 'Managing Shiftwork in European ATM' study ('Literature Review' and 'Shiftwork Practices', 2004a & b).

1.5   Duration and Planning

The study lasted six months, from September 2005 to March 2006.

1.6   Data Collection Approach

To ensure that the range of potential issues was identified, it was decided to use a parallel approach. This implied that data on the six staffing issues was sought by the following approaches:

1) Approaching ATM through the following:

    a. Interviews with Air Navigation Service Providers (ANSPs) and International Federation of Air Traffic Controllers Associations (IFATCA), and with the Danish Air Traffic Controller Association (DATCA). Nine ANSPs were approached for data collection, using a data collection template for semi-structured interviews.

    b. The data collected through the interviews was examined by operational and research experts associated with the project. The collected data was evaluated for their relevance, analysed, categorised, and served as a basis for generating the identification of hazards and prevention and mitigation strategies related to the six staffing issues. Where the interview data was found to be incomplete, these hazards and prevention/mitigation strategies were expanded on by the project group based on sound operational experience.

       Appendix 1 outlines the data collection approach employed for ATM. Appendices 2 to 7 provide case studies and useful reference material from ATM.

2) Identify industries that are considered comparable to ATM, and approaching these by interviews and, to some extent, literature searches. To obtain information about the related industries, interviews were

conducted with the police department, and an emergency ward in Oslo, Norway. In addition, a meeting was arranged with a Norwegian rostering expert from the medical field. Even though shipping was not identified as 'a related domain', an interview was also conducted with Sydney port authority, as it was assumed to provide valuable data.

Appendix 8 contains an overview of the method utilised for selection of relevant related industries.

1.7 Structure of the Report

The report is structured as follows:

- Sections 2 to 7 cover the six following staffing issues:
  - o Section 2: Staffing in degraded system operations,
  - o Section 3: Staffing during workload extremes,
  - o Section 4: Staffing during night work,
  - o Section 5: SPO,
  - o Section 6: Position handover, and
  - o Section 7: OJT.

  Each section outlines:

  - o The hazards associated with the respective topics and safe staffing.

  - o Appropriate prevention and mitigation strategies to cope with the hazards that are clustered into the following dimensions/categories: people, equipment, and procedures. These dimensions are widely recognised as general components of the ATM system.

  - o Mitigation summary highlighting key strategies for staffing an operational unit in relation to each topic.

- Section 8 explores the interaction between the staffing issues and attempts to make coherent connections between them, i.e. explores the hazards and prevention/mitigation strategies associated with night work, SPO, handover, and OJT in high/low-workload situations and normal/degraded operating conditions.

- Section 9 provides a summary of the contents of this report and draws the main conclusions from the study.

- The appendices include some information on the methodological approach, case studies from ATM, an overview of the information from related industries in relation to the six staffing issues and a mapping of tools/guidelines available from EUROCONTROL on the six staffing issues.

1.8   Use of the Report

It was explained earlier in this report that the purpose of it is to highlight a range of hazards and prevention and mitigation strategies related to the six staffing topics covered. The list provided, however, is not exhaustive or prescriptive.

The contents of this report can be used, where appropriate, as a checklist for supervisors and safety managers in ANSPs, and can then be adapted to the context of the local environment.

The report content provides information to derive practical material e.g.:

- checklists,
- training and awareness material,
- safety risk assessment material.

2. DEGRADED SYSTEM OPERATIONS

2.1 Introduction

The conditions that operational staff face can be considered as either within or outside the limits of what constitutes 'normal operating conditions'. Conditions 'outside' these limits can be classified as degraded system operations.

Degraded system operations include both:

- predictable conditions: outside normal operating conditions, e.g. routine maintenance and identified degraded modes of operation for which a contingency plan is foreseen.

- unpredictable conditions: e.g. system malfunctions for which there is no contingency plan.

2.2 Hazards

- **Staff awareness and preparedness**: Staff might be unaware of and unprepared for degraded operations both under predictable and unpredictable conditions. The impact is that supervisors and controllers' workload, particularly cognitive workload, may be affected.

- **Staff understanding**: Staff may not understand the technical implications of the system degradation, which may involve possible unknown scenarios. For example, it might be difficult to remember how to work with the fall-back system.

- **Suitably qualified staff**: The right number and mix of staff to work the positions may not be available.

- **System opacity**: System alerts are inadequate. A challenge for individual(s) to become aware of the level of degraded mode of the system.

2.3 Prevention and Mitigation Strategies

People

- **Backup staff available**: Adequate access to operational and technical backup staff.

- **Cyclical refresher training**: Training (including simulator training) for operational staff on understanding the impact of and response required in all types of degraded modes.

- **Holistic risk assessment**: Planning for predictable degraded mode should include risk assessment on a holistic basis rather then separate assessments of fragmented areas.

- **Culture of empowerment**: Develop a culture of empowerment to deal with issues not covered in checklists and contingency plan. Clarify roles of all operational staff for these situations. Consider assigning operational command authority to a position/person where appropriate.

Equipment (including tools)

- **Standardise system components**: The system components (i.e. same interface, functionality) should be available at all operational positions.

- **Contingency plan and checklist**: A contingency plan and checklist for operational staff on degraded modes should be available at operational positions. A contingency plan should make provision for supervisory intervention, especially during planned degraded modes. If no supervisor is available, procedures should exist in the contingency plan to support the controller.

Procedures

- **Checklists**: Use the checklists to implement the contingency plan.

- **Coordination between departments**: Clear procedures on coordination and communication between the relevant departments (e.g. operations and engineering) during degraded modes (planned or unplanned).

- **Managing capacity**: Adapt capacity to match actual staff levels and degraded mode(s).

- **System safety assessment methodology**: Use safety assessment methodology such as extensive system assessment/testing prior to commissioning new software versions.

- **Adjacent units**: Notify adjacent units of major planned degraded modes. Consider involving adjacent units in the contingency plans to manage the risks associated with degraded modes (planned or unplanned).

2.4   Mitigation Summary

- Working in planned degraded modes should require an assigned supervisor who is appropriately trained and procedures designed to support operational staff.

- A culture of empowerment should be developed to deal with issues not covered in checklists and contingency plans. Roles of all operational staff for these situations should be clarified. Assigning operational command authority to a position/person where appropriate should be considered.

- There should be adequate access to operational and technical support.

- ▪ Training (including simulator training) for operational staff should include understanding the impact of and response required in all types of degraded modes.

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3. WORKLOAD EXTREMES

3.1 Introduction

Controller's workload in this context refers to cognitive workload. It is generally agreed that controller's workload is a subjective and individual response by a controller to given task load situation, and that either personal factors (e.g. skill, experience, stress) or contextual factors (e.g. time pressure, noise, stressors, distraction, organisational change issues) can all influence workload.

The greatest staffing challenge during workload extremes[4] (that is in high/low-workload situations) is matching available workforce to the current traffic level. A mismatch between the two can impact controller fatigue, and perhaps even jeopardise safety. However, it is clear that the high-workload situation is not the only one for concern; low-traffic periods carry their own risks (e.g. reduced vigilance and therefore possible failure to notice critical events).

3.2 Hazards

- **Demand exceeds expectation**: This will only be an issue in situations where the controller/unit is working at capacity. Sustained excess demands may require greater intervention.

- **Suitably qualified staff**: The right number and mix of staff to work the positions now required may not be available.

- **In-flight emergency**: An in-flight emergency will increase the workload (cognitive and physical) of both the individual and the unit.

- **Workload**: Extended low workload impacts on an individual's arousal states (see Section 8).'

- **Fatigue**: Fatigue from continuously working at one's cognitive limits.

3.3 Prevention and Mitigation Strategies

People

- **Procedure design strategies exhausted**: Whenever the procedure design strategies are exhausted then strategies to match the workforce with workload extremes are needed, e.g. increase operational positions and/or decrease traffic.

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[4] It should be noted that this topic was not considered as relevant for all ANSP organisations, i.e. if traffic situation represents medium to low.

- **Active operational supervision**: Supervisors should manage staff based on individual and/or team performance limits at a given moment in time, taking into account time on position, duration of shift, and workload context.

- **Supervisor should manage the time leakage**: There should be enough ATCOs to cover the peak and a shift schedule should be built which prevents staff surplus when the peak is over (managing time leakage). Supervisor should be aware of other resources that are available to call in at short notice. Supervisor should manage his/her operational staff to the minimum required and should be aware of staff on additional tasks which can be tasked in the Ops room if need be.

- **Staffing level**: Define minimum staffing levels and observe them.

- **Stand-by staff**: Staff on stand-by should be within easy reach of a unit.

- **OJT training**: Supervisor should consult the OJTI to decide how much OJT (if any) should take place when there is peak workload (see Section 7).

- **Environment**: Minimise or eliminate environmental distractions during peak workload.

- **Refresher training**: Training should include simulations at a higher level of traffic i.e. 120% of expected peak and emergency training on in flight emergency responses for operational staff.

- **Workload**: Recognise that low workload has its own hazards. Consider approving extra curricula activity to manage this situation.

- **Fatigue management** : Monitor against ATCO fatigue.

Equipment (tools)

- **Traffic prediction tools**: Appropriate traffic prediction tools should be available - in particular for tactical workload management.

- **Actual workload measurement tool**: Appropriate actual workload measurement tool for supervisors should be available.

- **Support tools**: Consider introducing support tools to improve vigilance during low workload e.g. system alarms.

Procedures

- **During the peaks**: Traffic levels should be timely managed and coordinated with relevant stakeholders.

- **Traffic prediction tools**: Make use of appropriate traffic prediction tools.

- **Monitoring workload and performance limits**: Supervisors should monitor the workload and performance limits for all staff in their area of responsibility, and take appropriate action as necessary.

- **Procedures**: Management should review recurring peaks in terms of impact on existing LoAs and procedures.

3.4 Mitigation Summary

- Management should review recurring peaks in terms of impact on existing LoAs, rostering schedules and procedures.

- Minimum staffing level arising from daily and seasonal traffic variations should be respected. That is only allow staffing to fall below these minimums when a requisite reduction in capacity is implemented or when anticipated traffic levels are below expectations.

- Supervisors should be trained to monitor staff workload and assess individual and/or team performance limits at a given moment in time, taking into account time on position, duration of shift, and workload context.

- Recognise that low workload has its own hazards; to manage this consider approving extra curricula activity.

- Consider introducing support tools to improve vigilance during low workload e.g. system alarms.

- Traffic prediction tools and actual workload measurement tools should be utilised.

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4.   NIGHT WORK

4.1   Introduction

"It is common knowledge that work efficiency during the night is not the same as during the day" (as cited in van den Heuvel, Fletcher, Paradowski, and Dawson, 2003, p. 8). There are several staffing aspects related to night work. Traffic levels differ during the night. Staff have biological challenges concerning performance and vigilance. Night work, from a staffing perspective, is usually part of a shiftwork system where staff have to rotate through shifts including night shifts in order to meet the task demand. For further information regarding the effects of shiftwork during night work see EUROCONTROL, 2004a.

A summary report on fatigue management in AirServices Australia can be found in Appendix 2.

4.2   Hazards

- **Suitably qualified staff**: The right number and mix of staff to work the positions now required may not be available. Smaller pool of staff to select from (controllers who may not work at night, controllers not fully rated, etc.) Lack of competency / recency to handle situations that occur at night and infrequently.

- **Traffic levels**: Low-traffic levels can lead to reduced vigilance, i.e. loss of concentration and risk of not reacting (in time). High-traffic levels may lead to stress.

- **Tiredness[5]**: Tiredness, especially during early morning build-up.

- **Fatigue**: Fatigue may induce loss of situational awareness that may lead to safety occurrences.

- **Night shift paralysis**: A temporary but incapacitating paralysis known as 'night-shift paralysis' appears to be a special form of sleep paralysis that occurs when night workers manage to maintain a state of wakefulness despite considerable pressures to sleep.

- **Staff efficiency measures**: Reduced staff due to costs.

- **Ergonomic factors**: Reduced levels of illumination and environmental noise i.e. lights/sound.

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[5] Fatigue is defined as the exhaustion of mind or body resulting from labour or exertion. Tiredness is defined as the feeling an individual has in relation to their fatigue level.

4.3 Prevention and Mitigation Strategies

People

- **Roster design**: Roster design should reflect fatigue risk management principles.

- **Risk mitigation**: Utilise risk mitigation process for staff replacement and staff management.

- **Education**: Educate individuals (including during refresher training) creating awareness of health and lifestyle issues.

- **Rest facilities and napping**: Make use of rest facilities including for strategic naps. Various studies have also demonstrated that napping might improve objective performance and alertness, and decrease feelings of sleepiness. It is recommended to authorise and encourage napping as a strategy to reduce fatigue-related problems. It should however be noted that performance might also be degraded in the period immediately after waking up (i.e. 'sleep inertia'). 'Immediate' is relative, in that this can last from a few minutes to several hours. In addition, the successfulness of napping is largely dependent on individual factors (e.g. factors like motivation, age, and also the roster itself). Findings indicate that a ten-minute nap does not involve sleep inertia effects (van den Heuvel *et al.*, 2003). In general, however, the research findings regarding naps and sleep inertia are somewhat contradictory and limited, and it can be concluded that napping appears to be a useful strategy, but this issue is complex and requires more research to determine appropriate napping strategies for various circumstances.

Equipment (tools)

- **Rest facilities**: Provide rest facilities.

- **Water dispensers**: Provide water dispensers in or near Ops room.

- **Support tools**: Consider introducing support tools to improve vigilance during night work e.g. system alarms.

Procedures

- **Managing rest facilities**. Develop processes for managing the use of rest facilities including for strategic naps.

- **Ops room environment**: Provide a mentally stimulating environment for night shift – stimulating sound/light activities.

- **Supervisor absence**: In the absence of a supervisor, supervisor type duties during night shift should be allocated.

- **Breaks**: The management of breaks should include break frequency, length and rotation considerations. To maintain vigilance and alertness,

research recommends incorporating frequent breaks. (However, refer also to handover/takeover issues where frequency is discouraged.) (van de Heuvel *et al.*, 2003).

- **Staff/capacity management**: Supervisor should collapse and de-collapse sectors in response to unexpected demand (lower or higher). Supervisor should also call in additional staff if required (e.g. in response to negative weather forecast or unscheduled demand). Collapsed sectors should be co-located wherever possible.

4.4 Mitigation Summary

- Strategies should be adopted to mitigate the effects of sleepiness and fatigue. Staff should relieve each other at appropriate times, have frequent breaks (and possibly naps) but with due regard to inherent hazards associated with the handover/takeover process itself, and rotate between positions.

- Rest facilities should be available, and backup staff should be close.

- Supervisor should collapse and de-collapse sectors in response to unexpected demand (lower or higher). Supervisor should also call in additional staff if required (e.g. in response to negative weather forecast or unscheduled demand). Collapsed sectors should be co-located wherever possible.

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5.   SINGLE PERSON OPERATIONS

5.1   Introduction

In the context of this study, it is recognised that there are two types of Single Person Operations (SPO) in ATM:

- position staffed by a single person (sector operated by one person),
- an Ops room staffed by a single person,

for a given laps of time during a 24-hour period.

SPO can either be planned (design conditions) or unplanned (it is considered an unmitigated hazard).

This report does not advocate SPO and only aims to summarise hazards and prevention/mitigation associated with SPO should they exist. However, it is recommended that a detailed risk/safety assessment is carried out prior to deciding on the implementation of SPO.

Appendix 3 provides a case study of the application of SPO in AirServices Australia. Appendix 4 includes IFATCA view on SPO.

5.2   Hazards

Position staffed by a single person

- **Task load**: Task load too high, which leads to having to perform concurrent tasks.

- **Distraction**: Unexpected occurrences may distract ATCO's attention.

- **Lack of redundancy**: Staff incapacitation in case of workplace incidents/accidents, illness, toilet relief. Operational imperative of the replacement of staff involved in aviation incident/accident.

- **Threats and errors**: Non-detection of threats and non-recognition of an error.

- **Team interaction**: Decreased team interaction, which means that passing on wisdom is reduced - degrading collective wisdom and potentially affecting competency in the long term.

Ops room staffed by a single person

- **Task load**: Task load too high, which leads to having to perform concurrent tasks.

- **Distraction**: Unexpected occurrences may distract ATCO's attention.

- **Lack of redundancy**: Staff incapacitation from workplace incidents/accidents, illness, and toilet relief. Operational imperative to replace staff involved in aviation incident/accident.

- **Fatigue**: The individual fatigue is not detected.

- **Fitness for duty**: The individual fitness for duty is not detected.

- **Threats and errors**: Non-detection of threat and non-recognition of an error.

- **Competency**: Unnoticed proficiency / competency degradation.

- **Team interaction**: Lack of transfer of wisdom (loss of mentoring capability), degrade collective wisdom due to less team interaction. Nobody to check up with.

5.3 Prevention and Mitigation Strategies

It is considered that the prevention and mitigation strategies are applicable to both SPO situations (position staffed by a single person and an Ops room staffed by a single person).

For prevention and mitigation strategies related to the people category a distinction is made between for planned (design conditions) or unplanned (it is considered an unmitigated hazard) SPO.

People

Planned SPO

- **Contingency plan**: Have a contingency plan should the SPO staff member become unavailable at short notice.

- **Competency assessment**: Regular competence assessment and stringent recency requirements.

- **Training**: SPO performed in simulated training environment.

- **Fatigue factors**: Train operational staff to be aware of fatigue issues.

Unplanned SPO

- **Response**: Appropriate measurements should be taken to alleviate the SPO situation as soon as possible.

- **Contingency plan**: Have a contingency plan, should the remaining ATCO become unavailable at short notice.

- **Training**: SPO performed in simulated training environment.

Equipment (tools)

- **SPO concept and system design**: Appropriate system design should be in place.

- **Equipment**: Standardised functionality of the equipment.

Procedures

- **Risk management approach**: Risk management approach to developing standardised procedures for SPO. Equally, within the unit safety case, contingency plans should be developed for planned and unplanned SPO. Traffic levels are a key element to include in this risk assessment.

- **Standardised procedures**: Standardised procedures throughout all sectors.

- **Operational supervision concept**: Operational supervision concept that supports SPO.

- **Just culture**: A legal and corporate framework should be adopted that supports a just culture for incident reporting. This is particularly important for Ops room staffed by a single person as there is little understanding of the rationale to report and follow up on occurrences to ensure lesson learned[6].

5.4 Mitigation Summary

Prior to making a decision to introduce SPO, a risk assessment should be undertaken to validate the decision (see ESARR 4 – EUROCONTROL, 2001[7]). Equally, within the unit safety case, contingency plans should be developed for unplanned SPO.

Furthermore, prior to implementing SPO, it is recommended that:

- an operational supervision concept that supports SPO should be developed.

- the system design supporting the SPO concept should be verified.

- operational staff should be specifically trained to transition between two into one and one into two where relevant.

- operational staff should be trained in relevant human factors issues e.g. threat and error management training.

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[6] This is in itself is not a mitigation but a unit culture issue which could identify future mitigation.

[7] ESARR 4 requirement 5.1.c) specifies that an ATM service provider shall ensure that hazard identification as well as risk assessment and mitigation are systematically conducted for any changes to those parts of the ATM System and supporting services within his/her managerial control, in a manner which addresses the three different types of ATM elements (human, procedures and equipment), the interactions between these elements and the interactions between the constituent part under consideration and the remainder of the ATM System.

- a legal and corporate framework should be adopted that supports a just culture for incident reporting.

6. POSITION HANDOVER

6.1 Introduction

"… just because I have told someone, they may still not know what I know" (Cumming & Bradbury, 2003, p. 3). Position handover can be defined as "the accurate reliable communication of task-relevant information across shift changes, thereby ensuring continuity of safe and effective working" (Lardner, 1996, p. 3), or as "the requirements needed for the safe transfer of the understanding of the operational situation from one team/person to another team/person". In ATC, shift handover can be triggered for instance by the end of a given controller's shift, or by 'bandboxing' (in which sectors are combined for operational reasons). Controllers generally spend a fair amount of time (out of regulation as well as necessity) on the process of handing over to ensure that the incoming controller has an adequate overview not only of the traffic situation but also the control strategies of the outgoing controller.

Appendix 5 provides an example of the elements of a handover checklist.

6.2 Hazards

- **Information exchange**: Inadequate exchange of information being passed to the new shift, e.g. incorrect assumptions/expectations.

- **Reliability of information**: Information is distorted during successive handovers. For example, different teams may interpret/apply certain procedures in a different way.

- **Disregard for procedures**: Not following the checklist or procedures.

- **Checklist complacency**: Omitting items on checklist when using checklists routinely.

- **Distraction**: Errors are introduced; vigilance is compromised.

- **Simultaneous handovers same sector**: Everybody on the same sector hands over to someone else at the same time. The result is that everyone is new on the sector.

- **Simultaneous handovers several sectors**: Staff working on several sectors hands over to other staff at the same time. The result is that everyone is new on a number of sectors.

6.3 Prevention and Mitigation Strategies

People

- **Handover time**: Allow sufficient time for handover.

- **Training**: Handover should be practised during all phases of training including refresher training.

- **Roster design**: Time for position handover should be built into the roster.

- **Availability and preparedness**: Operational staff should make themselves available and prepare for the takeover (e.g. familiarisation with new procedures, environment, weather, expected demand, work plans, etc.) prior to approaching the operational position.

- **Workload and information transfer**: Where available supervisor should be responsible for determining timing. All handover/takeovers should be conducted at a time when doing so will not compromise the information transfer (i.e. during demand troughs). Supervisor may monitor transfers in complex situations.

- **Staff assessment**: Operational staff assessment should include handover process on a regular basis.

Equipment (tools)

- **Checklist(s)**: Checklist(s) should be available at all operational positions.

- **Handover form / briefing note**: Standardised handover form should be available to describe critical information e.g. weather, facilities, staffing, and equipment status.

- **Reminders**: Consider introducing support tools to provide reminders to the controllers (e.g. bleep).

Procedures

- **Follow checklist**: As a routine task, operational staff should follow the checklist. A 'uniform' way of working for all members having the same endorsement which should reduce the problems where teams have distinctly different ways of working.

- **Handover form**: The handover form should be completed.

- **Signing off/in procedure**: Signing off and signing in procedure should be in use to acknowledge that everything is done.

- **Adjacent operational positions**: Avoid simultaneous handover of adjacent operational positions.

- **Number of handovers**: Where possible minimise the number of handovers (need to compromise between need for regular breaks and need to minimise hazardous activity like a handover/takeover).

- **Sector opening**: Minimise the number of handovers before/after sector opening (e.g. when sectors are collapsed or de-collapsed). All handovers/takeovers should be conducted at a time when doing so will not compromise the information transfer.

6.4 Mitigation Summary

- Operational management should develop checklists for handover and takeover procedures (crosschecks, readouts).

- Staff should follow a pre-determined checklist and complete the handover form.

- Staff should be trained to conduct handovers and to be aware of the hazards associated with the handover process.

- All handover/takeovers should be conducted at a time when doing so will not compromise the information transfer.

- Operational staff assessment should include handover process on a regular basis.

- Simultaneous handover of adjacent operational positions should be avoided.

- Where possible the number of handovers should be minimised (need to compromise between need for regular breaks and need to minimise hazardous activity like a handover/takeover).

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7.   ON-THE-JOB TRAINING

7.1   Introduction

On-the-Job Training (OJT) is defined as the integration in practice of previously acquired job-related routines and skills under the supervision of a qualified On-the-Job Instructor (OJTI) in a live traffic situation (ESARR3).

OJT has long been recognised as critical in the training of an ATCO and of a major consequence in his/her overall formation. The EUROCONTROL deliverable 'Air Traffic Controller training at Operational Units' (1999) provides recommendations and guidelines for the organisation and conduct of ATCO Unit training. It proposes the introduction of a structured approach to Unit training with a transition phase (after basic institutional training), a pre-OJT phase, using global and analytical simulations and the OJT phase where the emphasis is on student coaching. This section deals with the OJT-related staffing issues.

Appendix 6 provides a copy of an article from EUROCONTROL Hindsight newsletter on safety occurrences during periods of OJT.

7.2   Hazards

- **OJTI judgement**: OJTI misjudges when to take or hand over control.

- **Vigilance and distraction**: Missing critical events because the OJTI is not actively participating in what is going on and OJTI assumes that the trainee is more skilled then he/she really is or OJTI is distracted by an event.

- **Mental fatigue**: The mental workload to maintain situational awareness and check on the student/trainee's situational awareness is high and may lead to fatigue when no or little intervention from the OJTI is required.

- **OJTI's coaching competence**: Trainee training is inadequate or incomplete.

- **Number of trainees in the Ops room**: The system is potentially exposed to more errors because there are too many trainees at the same time in the Ops room.

- **Number of trainees in the system**: Active controller proficiency declines because too many trainees in the system are taking available console time.

- **Simulator training**: Trainee arrives in the live environment not yet ready for the live environment due to insufficient or lack of simulator training. Potentially too many issues for the OJTI to deal with.

- **Simulator versus real operation**: An unmanaged mismatch between the simulator exercise timing and the time on the position in the real operation. Trainees loose their concentration after the same duration they are used to in the simulator.

- **Change of instructors**: Trainee has become programmed to what his/her previous OJTI expected. New OJTI has different expectations especially during a shift. Handover issue (both the position and the trainee's status).

- **Roster plans**: Not enough time is rostered to allow OJTI and student/trainee to brief for duty and debrief the sessions. This leads to insufficient preparation and distractions during the end of shift when debriefings are conducted on the shift. Also the staffing/roster may be planned such that the OJTI and trainee 'cover' two operational positions.

7.3 Prevention and Mitigation Strategies

People

- **Ratio OJTI to student**: As far as practicable, have a single OJTI or a small group of OJTIs allocated to a student (from the pedagogical and organisational point of view).

- **Number of OJT sessions in Ops room**: Restrict number of OJT sessions in Ops room at any one time to avoid trainees in adjacent positions.

- **Number of OJT students/trainees in the system**: Restrict total number of OJT students/trainees in the system at any one time.

- **OJTI training**: OJTI training should include extensive training in 'active monitoring', awareness of distraction issues and in the art of intervention.

- **Trainee's proficiency level**: All trainees should reach a required proficiency level prior to plugging into a 'live' position.

- **Training issues**: Some training issues identified in the live environment should be resolved off-line e.g. in simulator environment.

- **Supervisor**: Where possible a supervisor should be available during OJT to manage the environment.

- **OJTI change**: Avoid changing OJTI during the OJT session.

- **Duration of OJT session**: The OJT trainee/student should be exposed progressively to training sessions of a duration similar to session lengths expected in the live environment. This should also be controlled from the OJTI's viewpoint as it is hard to maintain concentration and situational awareness while observing a trainee, especially for a prolonged amount of time.

- **Roster planning**: It should be clearly stated that OJTI is responsible only for the trainee and his/her performance and should be planned in roster to work on the same single position as a trainee.

Equipment (tools)

- **Pre-OJT or unit training simulator**: Organisations should attempt to utilise the highest fidelity simulator available.

- **Position ergonomics**: Ergonomics of the position should be such that it allows the instructor to easily observe all aspects of the position. Appropriate tools should be readily available for the OJTI to enable him/her to intervene rapidly.

- **Checklist and progress list**: A checklist and progress list for communication between OJTIs about trainees.

Procedures

- **Standardised checklist and progress lists**: Ensure that OJTIs use standardised checklist and progress lists.

- **OJTI training**: ESARR5.2.1.8 states that before granting an air traffic controller authorisation to provide operational training as an OJT instructor, ensure that the applicant has:
  - a minimum of two years experience in the rating discipline in which he/she will instruct;
  - a minimum of six months experience in the rating on the specific sector or operational position on which the instruction will be given;
  - completed an appropriate OJTI course and passed any associated assessments required.

- **Assessment of OJTI's competence**: Ensure regular assessment of OJTI's competence in the instructing role (see EU ATCO Licensing Directive 26/2006 Article 11[8]).

- **OJT sessions**: Avoid *ad hoc* OJT, i.e. OJT should be formalised, planned, structured, and integrated with employee orientation (see ESARR 5[9]).

- **Roster plans**: Provide an operational roster allowing OJT to give adequate briefing and debriefing times to OJTI and student/trainee.

- **Review of OJT programme**: Regular review of OJT programmes to ensure adequacy and relevance.

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[8] EU ATCO Licensing Directive 26/2006 Article 11 'Conditions for maintaining rating and keeping endorsements valid – The instructor endorsement shall be valid for a renewable period of 36 months.'

[9] ESARR5: 5.2.1.10 requires operational units to have approved unit training plans. 5.2.2.3: Unit(s) have approved unit training plans by the Designated Authority, which detail the processes by which a student and/or a trainee air traffic controller is trained to meet the required standards to meet the objective of providing a safe air traffic control service. 5.2.2.10: An air traffic controller at his/her unit(s) whose competence is in doubt complies with any conditions imposed upon him/her by the designated authority.

7.4 Mitigation Summary

- The number of OJT sessions in Ops room at any one time should be restricted to avoid trainees in adjacent positions.

- OJTI training should include extensive training in 'active monitoring', awareness of distraction issues and in the art of intervention.

- All trainees should reach a required proficiency level prior to plugging into a 'live' position.

- Ergonomics of the position should allow the instructor to easily observe all aspects of the position. Appropriate tools should be readily available for the OJTI to enable him/her to intervene rapidly.

- The OJT trainee should be progressively exposed to training sessions of a duration similar to session lengths that expected in the live environment.

- *Ad hoc* OJT should be avoided, i.e. OJT should be formalised, planned, structured, and integrated with employee orientation.

- Operational roster should be provided, which allow OJT to give adequate briefing and debriefing times to OJTI and student/trainee. This should also be controlled from the OJTI's viewpoint as it is hard to maintain concentration and situational awareness while observing a trainee, especially for a prolonged amount of time.

8. INTERACTION BETWEEN THE SIX ISSUES

8.1 Introduction

When analysing the interaction between the six issues, the following two approaches have been taken into consideration:

- **Across dimensions**: When describing the ATC operational work situation in terms of different working/environmental modes, two dimensions appear:

  - high-workload versus low-workload situations,
  - normal versus degraded operating conditions.

  The remaining four topics (SPO, night work, position handover, and OJT), were explored in relation to how they are affected by high/low workload (e.g. sector complexity) in combination with normal/degraded working conditions.

- **Individual impact analysis**: Each topic was assessed individually in relation to its impact on each of the other topics.

The following paragraphs describe the outcome of the analysis for both approaches.

8.2 Across Dimension Analysis

When describing the ATC operational work situation in terms of different working/environmental modes, two dimensions appear:

- high-workload versus low-workload situations,
- normal versus degraded operating conditions.

Staffing during workload extremes and staffing in degraded systems operations, under either nominal (e.g. routine maintenance) or non-nominal (malfunction) conditions, can be considered as implicit in the two dimensions above, and thus serve as a framework to consider the remaining topics, i.e. SPO, night work, position handover, and OJT. Each of these four topics was explored in relation to how they are affected by high/low workload (e.g. sector complexity) in combination with normal/degraded working conditions. Four quadrants are apparent as illustrated in Figure 2.

High-workload situations

Normal operational conditions ──────── Degraded operational conditions

Low-workload situations
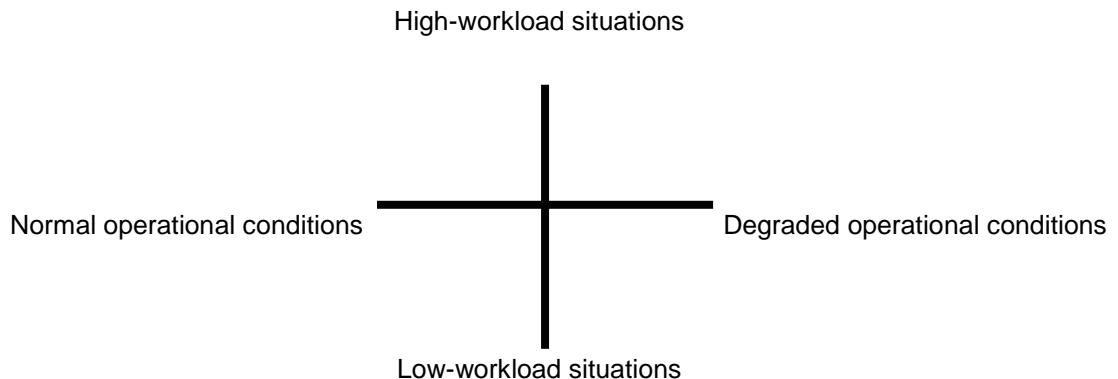
Figure 2: Organisation of the staffing issues

The aim of addressing the four issues on the two dimensions, 'high/low-workload situations' and 'normal/degraded operational conditions' was to explore under what circumstances (where in the quadrants) the staffing issues are considered as problematic and where they are not. To achieve this the data providers[10] needed to describe the circumstances that give rise to risks and possible mitigation strategies. An important factor was to clearly describe and define any relevant contextual conditions. These factors would be the task demands and workforce variables in a unit/organisation (see Figure 1).

Table 1 indicates how to interpret the colours in Figure 3.

Table 1: Colour coding for diagrams shown

Level of risk	Colour copy	Black & white copy
Hazardous/problematic	Red	Black
Some hazardous/problematic areas	Red/green stripes	Grey/black stripes
Non hazardous / unproblematic	Green	Grey

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[10] Data providers refer to the data and judgement provided by the nine ANSPs interviewed.
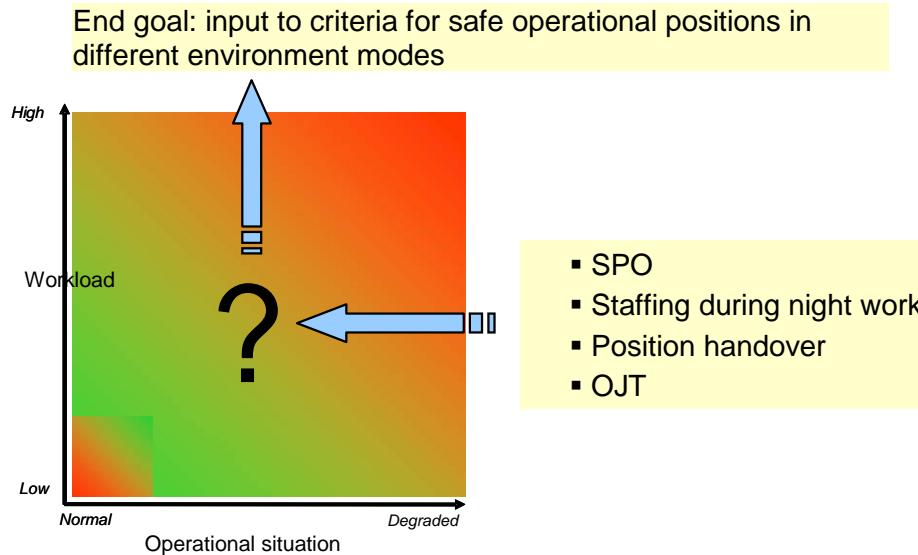
Figure 3: An illustration of a likely risk picture for the staffing issues (green colour: not considered as hazardous; red colour: considered as hazardous)

SPO, night work, position handover, and OJT were assumed to be of a different nature and thus associated with different hazards and prevention/mitigation strategies depending on the 'status' of the two dimensions. It was considered that:

- SPO might be less hazardous in low-workload conditions and normal operating conditions, but might compromise safety in high-workload conditions or degraded operating conditions;

- the overall staffing requirements and its associated hazards and mitigation approaches during night would be different depending on whether the level of workload is high or low, or whether the operating conditions are of a normal or degraded nature;

- the nature of the handover and the hazards/mitigation approaches for ensuring safe handover would be different depending on whether the workload situation is high or low, and/or on whether the operating conditions are normal or degraded;

- the nature of OJT, and the hazards/mitigation approaches for the training would most likely depend on whether workload is high or low, and on whether the operating conditions are normal or degraded; however, a qualified controller indeed needs to be able to manage both of these situations, so the trainee will need controlled exposure to such situations; deciding when such exposure is appropriate and low risk is the challenge.

The following paragraphs present the respective four staffing issues and will include hazards associated with the different operating situations, and the

appropriate prevention and mitigation strategies suggested to cope with these hazards.

8.2.1 Night Work

Night Work is examined under the dimensions of workload extremes and normal/degraded modes. The hazards associated with night work are magnified by various combinations as follows:

- in all degraded conditions;

- in normal conditions when combined with high-workload situations;

- in very low workload situations (normal and degraded);

- where main peaks happen at night, the individual is more at risk due to his/her circadian rhythm.
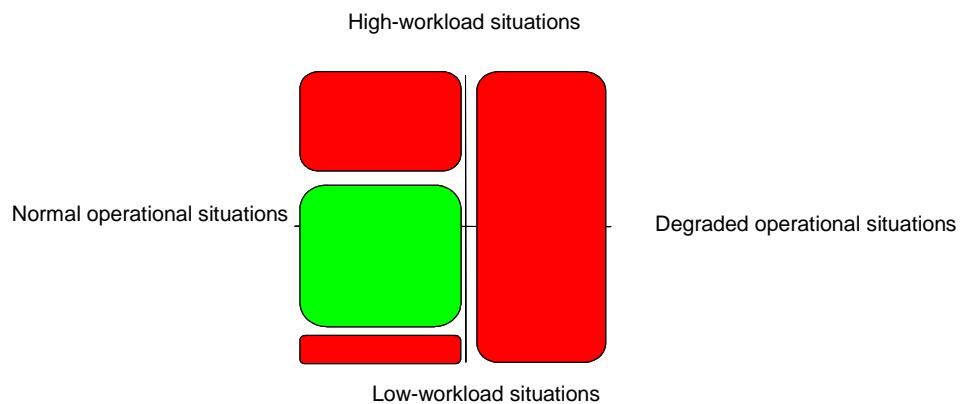
Figure 4: Situations considered as hazardous (red colour/black in non colour-printed copy) /non hazardous (green colour/ grey in non colour-printed copy) for night work

In addition to the prevention and mitigation strategies listed in Section 4, the following practices are highlighted for the different situations:

Normal situations / high workload
▪ Consider traffic flow management or other filtering techniques (e.g. re-routing to an adjacent sector).
▪ Consider calling in additional staff.
Degraded situations / high workload
▪ Supervisors should be on duty.
▪ Consider traffic flow management or other filtering techniques (e.g. re-routing to an adjacent sector).
▪ Consider calling in additional staff.

Normal situations / low workload
▪ Consider collapsing positions where possible. ▪ Allowing breaks ▪ Consider approving extra curricula activity ▪ Consider allowing napping.
Degraded situations / low workload
▪ In planned degraded situations supervisors should be on duty e.g. to manage impact of work plans. If no supervisor is available, procedures should exist in the contingency plans to support the controller. ▪ Consider calling in additional staff if required. ▪ Planned degraded situations should be rostered for.

8.2.2   SPO

SPO are examined under the dimensions of workload extremes and normal/degraded operations. The following situations may induce hazards during SPO:

▪ all unplanned degraded conditions,
▪ normal conditions when combined with high-workload situations,
▪ very low workload situations due to low vigilance or low state of arousal.
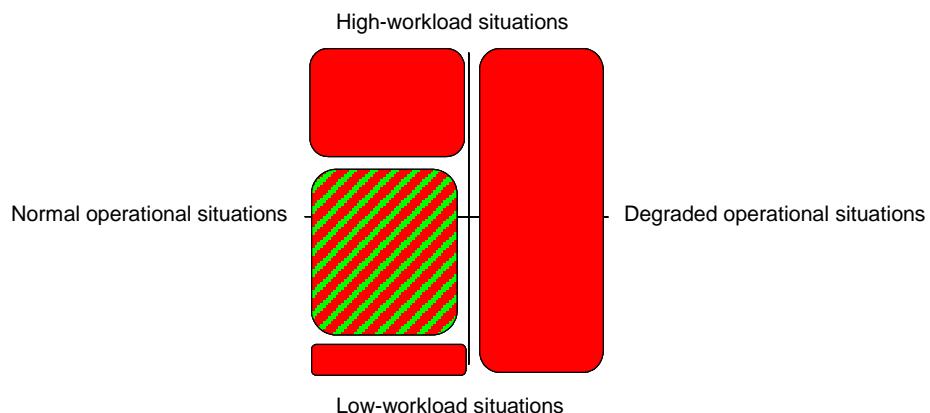
Figure 5: Situations considered as hazardous (red colour) / non hazardous (green colour) for SPO

In addition to the prevention and mitigation strategies listed in Section 5, the ones below are suggested for the different situations:

Normal situations / high workload	
Position staffed by a single person	An Ops room staffed by a single person
- Consider traffic flow management or other filtering techniques (e.g. re-routing to an adjacent sector). - Should workload increase unexpectedly and uncontrollably, backup staff should be available on call-in within reasonable time limits to ensure the safe continuation of service.	- Consider traffic flow management or other filtering techniques (e.g. re-routing to an adjacent sector) - Should workload increase unexpectedly and uncontrollably, backup staff should be available on call-in within reasonable time limits to ensure the safe continuation of service. - In the case of an aircraft emergency or any other incident/accident it is unlikely that staff could be called in quickly enough to assist in the increased workload. Procedures should be in place to support the operational staff and this procedure should be subject to a risk management approach. Staff should be trained on these procedures.
Degraded situations / high workload	
Position staffed by a single person	An Ops room staffed by a single person
- Consider traffic flow management or other filtering techniques (e.g. re-routing to an adjacent sector). - Guidance procedure on managing the most critical issues – such situations should be simulated during refresher/emergency situations. - Managed by staff management including re-assignment of duties (combining and de-combining positions, or calling in additional staff). If unable to do either, supervisor may provide support services (e.g. coordination) temporarily pending arrival of additional staff.	- Consider traffic flow management or other filtering techniques (e.g. re-routing to an adjacent sector). - Guidance procedure on managing the most critical issues – such situations should be simulated during refresher/emergency situations. - Crisis management plans and procedures should be developed and should be put in place to support the single controller.

Normal situations / low workload	
Position staffed by a single person	An Ops room staffed by a single person
▪ Consider introducing support tools to improve vigilance. ▪ Consider approving extra curricula activity to manage the situation. ▪ Consider bandboxing the position if operationally feasible.	▪ Consider introducing support tools to improve vigilance. ▪ Consider approving extra curricula activity to manage the situation.
Degraded situations / low workload	
Position staffed by a single person	An Ops room staffed by a single person
▪ Supervisor should consider using this opportunity to provide mentoring support. ▪ Procedures should be in place to support the operational staff and these procedures should be subject to a risk management approach. ▪ Guidance procedure on managing the most critical issues – such situations should be simulated during refresher/emergency situations.	▪ Procedures should be in place to support the operational staff and this procedure should be subject to a risk management approach. ▪ Guidance procedure on managing the most critical issues – such situations should be simulated during refresher/emergency situations.

8.2.3 Position Handover

Position Handover is examined under the dimensions of workload extremes and normal/degraded operations. The following situations are considered hazardous during handover:

- high workload and degraded conditions;
- normal operating conditions when combined with high workload;
- normal operating conditions with very low levels of workload (low vigilance);
- degraded situations and during an emergency.
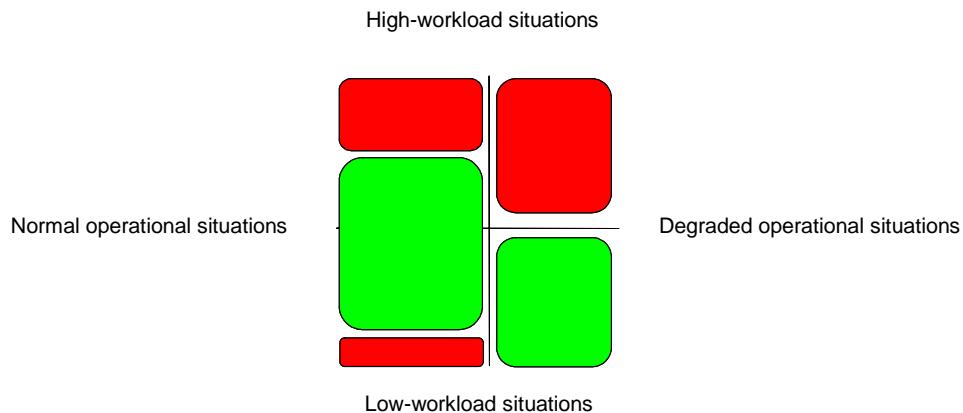
Figure 6: Situations considered as hazardous (red colour) / non hazardous for position handover

In addition to the prevention and mitigation strategies mentioned in Section 6, the ones below are suggested for the different situations:

Normal situations / high workload
▪ All handovers/takeovers should be conducted at a time when doing so will not compromise the information transfer (i.e. during demand troughs).
▪ Consider monitoring the handover/takeover.
▪ The length of the handover/takeover will also vary and should take the time required (not necessarily the rostered time).
▪ Consider requiring the handing-over controller to remain to answer any queries and verify handover.
▪ Training in handover situations.
Degraded situations / high workload
▪ Consider requiring the handing-over controller to remain to answer any queries and verify handover.
▪ Handover/takeover should not be done during an emergency or degraded situation until the emergency or degraded situation is stabilised. However, the supervisor may wish to make a controller swap because of performance management issues. In the case of critical incidents – Critical Incident Stress Management (CISM) procedures may be recommended.
▪ All handovers/takeovers should be conducted at a time when doing so will not compromise the information transfer (i.e. during demand troughs).
▪ Consider monitoring the handover/takeover.
▪ The length of the handover/takeover will also vary and should take the time required (not necessarily the rostered time).

Normal situations / low workload
▪ Where possible minimise the number of handovers. ▪ Avoid unnecessary handovers e.g. smoking breaks.
Degraded situations / low workload
▪ Handover/takeover of a position should not be done during an emergency or degraded situation until the emergency or degraded situation is stabilised. However, the supervisor may wish to make a controller swap because of performance management issues. In the case of critical incidents – CISM procedures may be recommended.

8.2.4   OJT

OJT is examined under the dimensions of workload extremes and normal/degraded operations. The following situations are considered hazardous during OJT:

- degraded operating conditions, particularly if this situation is combined with high workload;

- normal operating conditions if workload is high;

- normal operating conditions if workload is low and student requires little or no intervention.
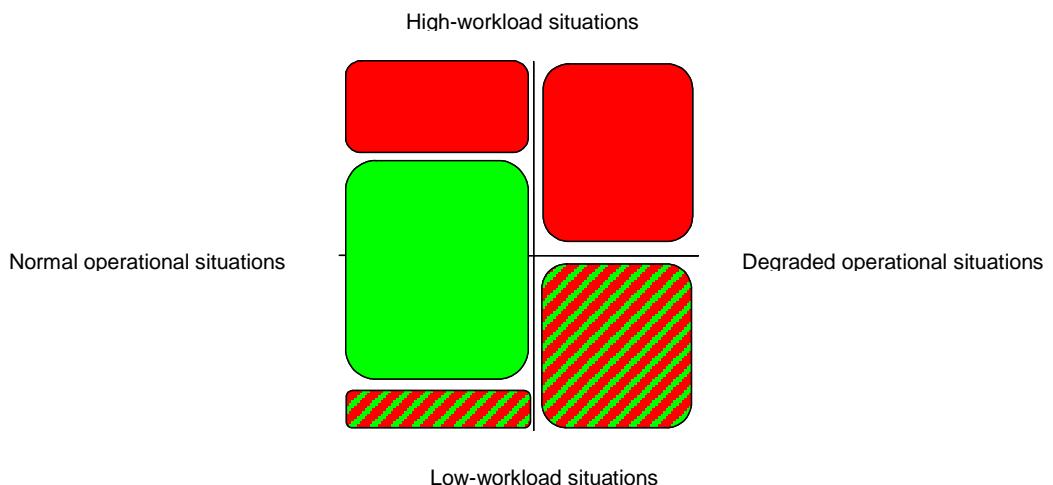

**Figure 7: Situations considered as hazardous (red colour) /
non hazardous (green colour) for OJT**

In addition to the prevention and mitigation strategies listed in <u>Section 7</u>, the ones below are suggested for the different situations:

Normal situations / high workload
▪ The OJTI's assessment of the trainee's and his/her own capability should determine whether or not to allow the trainee to continue in the service delivery role (as opposed to monitoring the OJT) under the supervision of the OJTI.
▪ A supervisor may remove a trainee from active control in deference to the circumstance. At no time should a supervisor insist that the trainee needs to stay in position under supervision (this is only at the discretion of the trainer).
▪ Use simulator to get trainee to a minimum standard prior to training commencing in the operational environment, and use simulator to provide trainee with workload that approaches (or exceeds) the live environment (where the live environment for one reason or another fails to deliver high (normal) workload.
▪ Build up student's capability in the operational environment by following a unit training plan.
Degraded situations / high workload
▪ The OJTI's assessment of the trainee's and his/her own capability should determine whether or not to allow the trainee to continue in the service delivery role (as opposed to monitoring the OJTI) under the supervision of the OJTI.
▪ A supervisor may remove a trainee from active control in deference to the circumstance. At no time should a supervisor insist that the trainee needs to stay in position under supervision (this is only at the discretion of the trainer).
▪ Use simulator to get trainee to a minimum standard prior to training commencing in the operational environment, and use simulator to provide trainee with workload that approaches (or exceeds) the live environment (where the live environment for one reason or another fails to deliver high (normal) workload.
▪ Run a contingency training session for all students and OJTI in simulators.

Normal situations / low workload
▪ It is not always possible to combine positions because the trainee is not receiving training in all positions at once. This may lead to additional staffing requirements during low-workload situations (to keep other positions (normally combined) open.
▪ Low workload provides opportunities for the OJTI to use the time on position for teaching purposes, which helps to maintain arousal for both participants.
▪ Positions combined wherever possible to ensure that the trainee is properly challenged and maintains concentration.
Degraded situations / low workload
▪ Whether or not trainee is permitted to continue working under supervision will depend on the competence achieved to date and the degree of degradedity. This assessment is usually made by the OJTI but may include advice from the supervisor if one is present.

8.3 Individual Impact Analysis

8.3.1 Introduction

A further analysis has been carried to understand more fully the impact of each issue on each other and how they interact.

Table 2 illustrates this with further explanation provided in the following paragraphs.

Table 2: Impact analysis of six topics

	Degraded Ops	Workload extremes	Night work	SPO	Position handover	OJT
Degraded Ops		1	2	3	4	5
Workload extremes			6	7	8	9
Night work				10	11	12
SPOs					13	14
Position handover						15
OJT						

8.3.2   Degraded Operations Impact

Workload extremes (1)

Degraded operations have a high impact on workload extremes. When identifying degraded operation, the impact of the degradation on the traffic load needs to be carefully assessed and adequate mitigation strategies derived.

Night work (2)

Degraded operations have a low impact on night work. If no SPO are planned, there is no special bearing of night work on degraded modes.

SPO (3)

Degraded operations have a medium/high impact on SPO. The impact of degraded operations on SPO needs to be carefully assessed so as to verify whether SPO is safely acceptable.

Position handover (4)

Degraded operations have a low/medium impact on position handover depending on the information available (e.g. manual correlation) and workload. Position handover procedures in degraded operations should be defined and practised during e.g. refresher training.

OJT (5)

Degraded operations have a medium impact on OJT. There are possibly two ways to look at this issue:

1. Degraded systems as an interference to OJT.
2. Degraded systems as they should be practised during training.

In the first case the issue should be addressed in the OJT guidelines, e.g. should the training continue or the OJTI take over. In the second case there is a need to train on degraded operations (simulators are good at simulating degraded operations) and in the last stages of training and provided the trainee has the required theoretical knowledge, the OJT could continue in a degraded operation environment.

8.3.3   Workload Extremes Impact

Degraded operations (1)

Workload extremes have a high impact on degraded operations. In high-workload situations this is more critical. When identifying degraded operations, the impact of the degradation on the traffic load needs to be carefully assessed and adequate mitigation strategies derived.

Night work (6)

Workload extremes have a medium to high impact on night work. Should extreme high workload occur during night this would impact the staffing levels (due to fatigue etc.). In low workload there is a risk of reduced vigilance, and boredom.

SPO (7)

Workload extremes have a high impact on SPO. Extreme high workload during night may prevent SPO being a safe staffing option. A safety assessment should verify that SPO is safe in relation to traffic levels. In low workload the impact on SPO is lower and less hazardous.

Position handover (8)

Workload extremes have a high impact on position handover. Position handover procedures should envisage this situation, i.e. where it may become impossible for the handing-over team to communicate. The handover should then be performed by the taking-over team which could for instance plug into the Radiotelephony (R/T) and follow the traffic until such point that the team is confident it can take over and so inform the handing-over team. This should be practised in simulation.

In low workload there is low impact; however, it is important to stress the need to stick to procedures.

OJT (9)

Workload extremes have a medium/high impact on OJT. Although a very tricky issue, this is just an OJT issue in relation with the trainees' development status as well as the OJTI's capability to take over should it be required.

In low workload there is low/no impact on OJT.

8.3.4 Night Work Impact

Degraded operations (2)

Night work has a low impact on degraded operations. If no SPO planned, there is no special bearing of night work on degraded modes.

Workload extremes (6)

Night work has a medium to high impact on workload extremes. Should extreme high workload occur during night this would impact the staffing levels (due to fatigue etc.). In low workload, there is a risk of reduced vigilance, and boredom.

SPO (10)

Night work has a medium/high impact on SPO depending on the traffic levels.

When performing a safety assessment for the introduction of SPO careful attention should be given to the characteristics of night work including boredom and fatigue further depending on the number hours to be worked in a row.

Position handover (11)

Night work has low/medium impact on position handover. As such (i.e. not combined with other issue(s)) there is no specific interaction that has not already been noted in the report.

OJT (12)

Night work has low impact on OJT. There is an observed danger of letting trainees self-train during night shifts.

8.3.5 SPO Impact

Degraded operations (3)

Single Person Operations (SPO) have a medium/high impact on degraded operations. The impact of SPO when potential degraded operations situation occurs needs to be carefully assessed so as to verify whether SPO are safely acceptable.

Workload extremes (7)

SPO have a high impact on workload extremes. Extreme high workload during night may prevent SPO being a safe staffing option. A safety assessment should verify that SPO are safe in relation to traffic levels. In low workload the impact on SPO is lower and less hazardous.

Night work (10)

SPO have a medium/high impact on night work depending on the traffic levels.

When performing a safety assessment for the introduction of SPO careful attention should be given to the characteristics of night work including boredom and fatigue further depending on the number hours to be worked in a row.

Position handover (13)

SPO have a low impact on position handover. There is no specific issue related to this interaction that has not been mentioned earlier in the report.

OJT (14)

SPO have a low impact on OJT. There is no specific issue related to this interaction that has not been mentioned earlier in the report.

8.3.6 Position Handover Impact

Degraded Operations (4)

Position handover has a low/medium impact on degraded operations depending on the information available (e.g. manual correlation) and workload. Position handover procedures in degraded operations should be defined and practised during e.g. refresher training.

Workload Extremes (8)

Position handover are impacted by workload extremes. Position handover procedures should envisage this situation, i.e. where it may become impossible for the handing-over team to communicate. The handover should then be performed by the taking-over team which could for instance plug into the Radiotelephony (R/T) and follow the traffic until such point that the team is confident it can take over and so inform the handing-over team. This should be practised in simulation.

In low workload there is low impact; however, it is important to stress the need to stick to procedures.

Night work (11)

Position handover has a low/medium impact on night work. As such (i.e. not combined with other issue(s)) there is no specific interaction that has not already been noted in the report.

SPO (13)

Position handover has a low impact on SPO. There is no specific issue related to this interaction that has not been mentioned earlier in the report.

OJT (15)

Position handover has a medium impact on OJT. It is important that roles are defined and agreed between trainee and OJTI, i.e. is the position handover part of the training session and the trainee should carry it out, or is it not the case and the OJTI will take care of that.

8.3.7 On-the-Job Training Impact

Degraded operations (5)

OJT has a medium impact on degraded operations. There are possibly two ways to look at this issue:

1. Degraded systems as an interference to OJT.
2. Degraded systems as they should be practised during training.

In the first case the issue should be addressed in the OJT guidelines e.g. should the training continue or the OJTI take over. In the second case there is

a need to train on degraded operations (simulators are good at simulating degraded operations) and in the last stages of training and provided the trainee has the required theoretical knowledge, the OJT could continue in a degraded operation environment.

Workload extremes (9)

OJT has a medium/high impact on workload extremes. Although a very tricky issue, this is just an OJT issue in relation with the trainees' development status as well as the OJTI's capability to take over should it be required. In low workload there is low/no impact on OJT.

Night work (12)

OJT has a low impact on night work. There is an observed danger of letting trainees self-train during night shifts.

SPO (14)

OJT has a low impact on SPO. There is no specific issue related to this interaction that has not been mentioned earlier in the report.

Position handover (15)

OJT has a medium impact on position handover. It is important that roles are defined and agreed between trainee and OJTI, i.e. is the position handover part of the training session and the trainee should carry it out, or is it not the case and the OJTI will take care of that.

9. SUMMARY AND CONCLUSIONS

9.1 Introduction

This section provides an overview of all the mitigation strategies summaries provided in Sections 2 to 7. In addition, some general guidance is provided on how the information in this report can be used in training and safety assessment.

9.2 Mitigation Summary Overview

The following paragraphs provide an overview of the mitigation summary highlighted for each of the six topics

Degraded system operation

- Working in planned degraded modes should require an assigned supervisor who is appropriately trained, and procedures designed to support operational staff.

- A culture of empowerment should be developed to deal with issues not covered in checklists and contingency plans. Clarify roles of all operational staff for these situations. Consider assigning operational command authority to a position/person where appropriate.

- There should be adequate access to operational and technical support.

- Training (including simulator training) for operational staff should include understanding the impact of and response required in all types of degraded modes.

Workload extremes

- Management should review recurring peaks in terms of impact on existing LoAs, rostering schedules and procedures.

- Minimum staffing level arising from daily and seasonal traffic variations should be respected. That is only allow staffing to fall below these minimums when a requisite reduction in capacity is implemented or when anticipated traffic levels are below expectations.

- Supervisors should be trained to monitor staff workload and assess individual and/or team performance limits at a given moment in time taking into account time on position, duration of shift, and workload context.

- Recognise that low workload has its own hazards; to manage this consider approving extra curricula activity.

- Consider introducing support tools to improve vigilance during low workload e.g. system alarms.

- Traffic prediction tools and actual workload measurement tools should be utilised.

Night work

- Strategies should be adopted to mitigate the effects of sleepiness and fatigue. Staff should relieve each other at appropriate times, have frequent breaks (and possibly naps) but with due regard to inherent hazards associated with the handover/takeover process itself, and rotate between positions.

- Rest facilities should be available and backup staff should be close.

- Supervisor should collapse and de-collapse sectors in response to unexpected demand (lower or higher). Supervisor should also call in additional staff if required (e.g. in response to negative weather forecast or unscheduled demand). Collapsed sectors should be co-located wherever possible.

SPO

Prior to making a decision to introduce SPO, a risk assessment should be undertaken to validate the decision (see ESARR 4[11]). Equally, within the unit safety case, contingency plans should be developed for unplanned SPO.

Furthermore, prior to implementing SPO, it is recommended that:

- an operational supervision concept that supports SPO should be developed;

- the system design supporting the SPO concept should be verified;

- operational staff should be specifically trained to transition between two into one and one into two where relevant;

- operational staff should be trained in relevant human factors issues e.g. threat and error management training;

- a legal and corporate framework should be adopted that supports a just culture for incident reporting.

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[11] ESARR 4 requirement 5.1.c) specifies that an ATM service provider shall ensure that hazard identification as well as risk assessment and mitigation are systematically conducted for any changes to those parts of the ATM System and supporting services within his/her managerial control, in a manner which addresses the three different types of ATM elements (human, procedures and equipment), the interactions between these elements and the interactions between the constituent part under consideration and the remainder of the ATM System.

Position handover

- Operational management should develop checklists for handover and takeover procedures (crosschecks, readouts).

- Staff should follow a pre-determined checklist and complete the handover form.

- Staff should be trained to conduct handovers and to be aware of the hazards associated with the handover process.

- All handover/takeovers should be conducted at a time when doing so will not compromise the information transfer.

- Operational staff assessment should include handover process on a regular basis.

- Simultaneous handover of adjacent operational positions should be avoided.

- Where possible the number of handovers should be minimised (need to compromise between need for regular breaks and need to minimise hazardous activity like a handover/takeover).

OJT

- The number of OJT sessions in Ops room at any one time should be restricted to avoid trainees in adjacent positions.

- OJTI training should include extensive training in 'active monitoring', awareness of distraction issues and in the art of intervention.

- All trainees should reach a required proficiency level prior to plugging into a 'live' position.

- Ergonomics of the position should allow the instructor to easily observe all aspects of the position. Appropriate tools should be readily available for the OJTI to enable him/her to intervene rapidly.

- The OJT trainee should be progressively exposed to training sessions of a duration similar to session lengths that are expected in the live environment.

- *Ad hoc* OJT should be avoided i.e. OJT should be formalised, planned, structured, and integrated with employee orientation.

- Operational roster should be provided, which allow OJT to give adequate briefing and debriefing times to OJTI and student/trainee. This should also be controlled from the OJTI's viewpoint as it is hard to maintain concentration and situational awareness while observing a trainee, especially for a prolonged amount of time.

Night work, SPO, handover, and OJT in different operating conditions

Recommendations when considering night work, SPO, handover, and OJT in different operating conditions, i.e. high-workload versus low-workload situations and normal versus degraded operating conditions are summarised in Table 3.

Table 3: Recommendations when considering night work, SPO, handover, and OJT in different operating conditions

	NORMAL + HIGH	DEGRADED + HIGH	NORMAL + LOW	DEGRADED+ LOW
Night work	Consider traffic flow management or other filtering techniques (e.g. re-routing to an adjacent sector). Consider calling in additional staff.	Supervisors should be on duty. Consider traffic flow management or other filtering techniques (e.g. re-routing to an adjacent sector). Consider calling in additional staff.	Consider collapsing positions where possible. Allowing breaks. Consider approving extra curricula activity Consider allowing napping.	In planned degraded situations supervisors should be on duty e.g. to manage impact of work plans. If no supervisor is on available, procedures should exist in the contingency plans to support the controller. Consider calling in additional staff if required. Roster for planned degraded situations.

	NORMAL + HIGH	DEGRADED + HIGH	NORMAL + LOW	DEGRADED+ LOW
SPO	**Common recommendations for SPO Position/Ops Room** Consider traffic flow management or other filtering techniques (e.g. re-routing to an adjacent sector). Should workload increase unexpectedly and uncontrollably, backup staff should be available on call-in within reasonable time limits to ensure the safe continuation of service. **Additional recommendations for SPO Ops room** In the case of an aircraft emergency or any other incident/accident it is unlikely that staff could be called in quickly enough to assist in the increased workload. Procedures subject to risk management approach. Staff should be trained on these procedures.	**Common recommendations for SPO Position/Ops room** Consider traffic flow management or other filtering techniques (e.g. re-routing to an adjacent sector). Guidance procedure on managing the most critical issues – such situations should be simulated during refresher/emergency situations. Crisis management plans and procedures should be developed and be put in place to support the single controller **Additional recommendations for SPO position** Managed by staff management including re-assignment of duties (combining /de-combining positions, calling in additional staff). If unable to do either, supervisor may provide support services.	**Common recommendations for SPO Position/Ops room** Consider introducing support tools to improve vigilance. Consider approving extra curricula activity to manage the situation. **Additional recommendations for SPO position** Consider bandboxing the position if operationally feasible	**Common recommendations for SPO Position/Ops Room** Procedures should be in place to support the operational staff and this procedure should be subject to a risk management approach. Guidance procedure on managing the most critical issues – such situations should be simulated during refresher/emergency situations. **Additional recommendations for SPO position** Supervisor should consider using this opportunity to provide mentoring support.

	NORMAL + HIGH	DEGRADED + HIGH	NORMAL + LOW	DEGRADED+ LOW
Handover	All handovers/takeovers should be conducted at a time when doing so will not compromise the information transfer (i.e. during demand troughs). Consider monitoring the handover/takeover. The length of the handover/takeover will also vary and should take the time required (not necessarily the rostered time). Consider requiring the handing-over controller to remain to answer any queries and verify handover. Train handover situations	Consider requiring the handing-over controller to remain to answer any queries and verify handover. Handover/takeover should not be done during an emergency or degraded situation (may wish to make a controller swap because of performance management issues). In the case of critical incidents – CISM procedures maybe recommended. All handovers/takeovers should be conducted at a time when doing so will not compromise the information transfer (i.e. during demand troughs). Consider monitoring the handover/takeover. The handover/takeover should take the time required.	Where possible minimise the number of handovers. Avoid unnecessary handovers, e.g. smoking breaks.	Handover/takeover of a position should not be done during an emergency or degraded situation until the emergency or degraded situation is stabilised. However, the supervisor may wish to make a controller swap because of performance management issues. In the case of critical incidents – CISM procedures may be recommended.

	NORMAL + HIGH	DEGRADED + HIGH	NORMAL + LOW	DEGRADED+ LOW
OJT	The OJTI's assessment of the trainee and his/her own capability should determine whether or not to allow the trainee to continue in the service delivery role under the supervision of the OJTI. A supervisor may remove a trainee from active control in deference to the circumstance. At no time should a supervisor insist that the trainee needs to stay in position under supervision (this is only at the decision of the OJTI). Use simulator to get trainee to a minimum standard prior to training commencing in the operational environment, and use simulator to provide trainee with workload that approaches (or exceeds) the live environment. Build up student's capability in the operational environment by following a unit training plan.	The OJTI's assessment of the trainee and his/her own capability should determine whether or not to allow the trainee to continue in the service delivery role under the supervision of the OJTI. A supervisor may remove a trainee from active control in deference to the circumstance. At no time should a supervisor insist that the trainee needs to stay in position under supervision (this is only at the decision of the OJTI). Use simulator to get trainee to a minimum standard prior to training commencing in the operational environment, and use simulator to provide trainee with workload that approaches (or exceeds) the live environment. Run a contingency training session for all students and OJTI in simulators.	It is not always possible to combine positions because the trainee is not receiving training in all positions at once. This may lead to additional staffing requirements during low-workload situations. Low workload provides opportunities for the OJTI to use the time in the position for teaching purposes, which helps maintain arousal for both participants. Positions combined wherever possible to ensure that the trainee is properly challenged and maintains concentration.	Whether or not trainee is permitted to continue working under supervision will depend on the competence achieved to date and the degree of abnormality. This assessment is usually made by the OJTI but may include advice from the supervisor if one is present.

9.3 Conclusions

The purpose of this report was to highlight a range of hazards and prevention and mitigation strategies relevant to the selected six topics for staffing an ATC Operations. The study served to identify information to derive practical material, for instance:

- checklists,
- training and awareness material for controllers,
- safety risk assessment material.

The information provided is not exhaustive or prescriptive. The information in the report can be used, where appropriate, as a checklist for supervisors, and safety managers in ANSPs, and adapted to the context of the local environment.

ANSPs are invited to:

- assess their own practices related to the findings of the report and update these where appropriate.

- share their best practices in the framework of Safety Improvement Sub-Group (SISG). This will serve to improve further enhancements of cumulative sharing knowledge at EUROCONTROL organisation level. This exchange of information should be reflected in work of SISG and developed products and processes

- use the content of the report in training for supervisors, controllers and safety personnel. It is considered that the work produced in this report is valuable to supervisors, safety assessors, and roster designers. Therefore, the contents of the report may be adapted locally and generated into suitable communication and awareness material.

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APPENDIX 1: DATA COLLECTION APPROACH FOR ATM

An interview guide/template was developed for the structured interviews with a number of ANSPs (see list of contributors), IFATCA and DATCA. This covered the following main features:

- Description of the current general staffing situation.

- Addressing the six safe staffing issues in terms of hazards and prevention and mitigation strategies.

- Interrelationship between the additional relevant information: This included e.g. case studies, guidelines, and tools.

- The six issues were explored in relation to each other: The six staffing issues do not seem to be mutually exclusive. By organising the issues according to their concerns and constructs (in a framework or model) it is possible to explore their relations. The topics were thus organised in the following way:

  When describing the ATCO work situation in terms of the different working/environmental modes, two dimensions appear:

  - high-workload versus low-workload situations,
  - normal versus degraded operating conditions.

  These two dimensions then served as a framework for the consideration of the remaining topics – night work, SPO, handover, and OJT.

Note: Further details on data collection approach, and interview details are available on request.

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APPENDIX 2: CASE STUDY, ROSTER GUIDELINES FOR FATIGUE MANAGEMENT IN AIRSERVICES AUSTRALIA

In a report on fatigue management within AirServices Australia (Allen, 2004), a set of rostering guidelines aiming to reduce and maintain acceptable fatigue levels are proposed[12]. These are summarised in the following:

- All rosters should be evaluated by the use of software tools specifically developed for assessing predictions of fatigue (e.g. Fatigue Audit InterDyne (FAID) - see below). In addition, staff should be provided with the opportunity to report potential fatigue instances by the use of a self-reporting system.

- High-quality sleep is best achieved between 10 pm and 8 am, and this period should be rostered off regularly.

- Consecutive shifts are generally not recommended, but if unavoidable, there should not be more than two, and must not be more than three consecutive shifts that influence the normal sleep period.

- At least two days off should be rostered frequently – at least every second cycle. Single days off should be avoided.

- Two days off should be rostered before night shift.

- There should be a regular pattern for rostering both within and between shift cycles. However, do not group together shifts that influence normal sleep hours).

- Morning shift should not start before 6 am unless this in unavoidable in order to avoid an additional night shift for managing the morning traffic.

- Extra duty shifts affecting normal sleep hours should be evenly distributed.

Some strategies to manage fatigue are listed in Flight Safety Australia (2005):

1. *Identify factors/hazards contributing to fatigue*: Factors that contribute to fatigue must be identified. Roster design should be considered, e.g. shift duration, sufficient rest between shifts, mental/physical demands involved in the work, and time of day (night work). Methods for identifying factors might include e.g. inspection of rosters, consulting staff, consulting health/safety representatives, analyse incident reports, and conduct safety audit.

2. *Assess risks associated with these hazards*: Involves calculation of consequences and likelihood + consequences for each risk. Factors that

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[12] It should be noted that the author points out that some of the guidelines might be contradictive, and they should be read in the context of the entire set of recommendations made in the report.

should be considered when assessing the risks associated with fatigue are e.g. time of day (night work), shift duration, opportunities to recover from fatigue, the frequency of the situation involving fatigue, the number of fatigued staff, the skills/experience of fatigued staff, the duration of fatigue.

3. *Decide on control measures to minimise the risk level to manage exposure to fatigue*: Since it is impossible to choose the ideal solution, i.e. remove the factors contributing to fatigue like night work and extended working hours, alternatives to decrease fatigue exposure must be defined. This involves: limit shiftwork to tasks that must be performed at night, minimise the need for administrative work at night, schedule later start hours for the morning shift, schedule low-risk work at night, schedule highly complex tasks outside night shifts. Examples of administrative tools to be used to manage fatigue are e.g. sufficient supervision in high-fatigue periods (i.e. night), contingency plans for fatigued staff, effective emergency responses, formal procedures for hazardous work in high-fatigue periods (i.e. night), and job rotation.

4. *Implement the control measures*: Involves development of procedures, informing the staff about the control measures, train and prepare the staff on fatigue issues (e.g. causes, impact, appropriate mitigation), and supervision of the correct use of the control measures.

5. *Monitor/review the effectiveness of the control measures*: Involves consideration of whether they have been implemented according to plan, whether they are working, and whether there are any problems. Review the process frequently.

It should also be noted that an Australian Software Company (InterDynamics) has developed a tool for AirServices Australia, "Fatigue Audit InterDyne (FAID)", which is a program that produces a fatigue index. This index is based on a number of factors related to fatigue (shift duration, breaks, timing of shifts and breaks, prior work history, biological limitations related to sleep and recovery) (FAID User Guide, 2005). Validation studies have also indicated high predictive validity of the FAID model, in the sense that the model "would accurately indicate the effects of specific hours-of-work schedules on measures such as sleepiness, fatigue, performance and sleep latency" (Fletcher, 2004, p.5).

APPENDIX 3: CASE STUDY, SPO IN AIRSERVICES AUSTRALIA

In 1992, AirServices Australia made a significant change to the way it structured its sector control service. As well, it also began a conscious program of reducing staff at many of its towers

Until 1992, each sector was, for a significant period of each day, manned by two people – one looking after the 'procedural' elements and the other responsible for providing a radar service and a communication service. The 'procedural' controller was regarded as being the controller in charge and therefore holding 'Command Authority'.

The change was made after considerable analysis of the potential issues (i.e. hazards). This was undertaken before AirServices had implemented a formal Safety Management System (SMS) and many of the processes followed were subsequently incorporated in AirServices Australia's SMS. The staff changes were also made as a prelude to introducing a future Air Traffic Management system known as 'The Australian Advanced Air Traffic System (TAAATS)' – using Eurocat 2000 technology.

The result of these changes was the emergence of Single Person Operations (SPO) – i.e. a single air traffic controller became responsible for managing all aspects of air traffic management for a particular volume of airspace or at a particular aerodrome. The situation was slightly different for en-route, approach and tower environments.

En-route environments

Each controller now responsible for a separate volume of airspace essentially works in isolation of those that may be around him/her. In a fully automated environment, there is not even any opportunity for interaction because the majority of coordination is automatically managed by the 'machine'. Nevertheless, it is not entirely as bad as one may expect because depending on workload, there are some limited opportunities for interaction with a neighbouring controller.

In a larger centre, and as the workload recedes, volumes of airspace are usually progressively combined until a single controller is ultimately responsible for vast tracts of airspace perhaps stretching halfway across continental Australia. At the same time, the next controller (also responsible for a vastly increased expanse of airspace) may be physically located a whole aisle away. Typically, this is the situation at night (with a couple of exceptions).

Approach environments

In the larger en-route centres that also provide approach services, one such controller may ultimately be responsible for all of the approach airspace around a major capital city airport and be sitting quite remotely from other SPO controllers in the room. Typically, this is the scenario at night.

In the smaller terminal control units providing an approach service, it is still a single controller, but now that controller is also the sole person on duty in that terminal control unit.

Tower environments

The reduction in staff in towers – particularly the smaller ones – also created situations where there are now a number of towers around the country which at various times during the day, are manned by a single controller. This scenario may be because the other controller is on a break or, there is simply no other controller needed and therefore none is rostered.

In the larger capital city towers (which are also equipped with a variety of surveillance technologies), the traffic/workload (even on a night shift) still requires at least two controllers. However, in the smaller regional and general aviation towers (usually where there is no radar or other surveillance technology available – yet), there is only a need for a single person – and at night, many of these towers are simply closed leaving the airspace as a Mandatory Broadcast Zone (MBZ) which is uncontrolled (i.e. no Air Traffic Control service is provided).

The following hazards are identified for SPO:

Single Person Operations (SPO) give rise to a number of issues – some of which may give rise to a near-term safety hazard and others which may contribute to a longer-term safety hazard. Clearly, these hazards will need to be mitigated to maintain the safety of the air navigation system in such higher-productivity circumstances. As well, there are also issues relating to the welfare of the controller.

Typical (but not necessarily exhaustive) safety hazards needing mitigation are:

1. Controller loss of confidence in decisions in the absence of a 'sounding board';

2. Unnoticed or mismanaged errors or threats;

3. Unexpected workload (for example from unscheduled additional traffic; adverse weather impacting on 'normal' operations; facility failure leading to additional unfamiliar task load; etc.);

4. Unnoticed reduction in controller's competence;

5. Reduced opportunity for mentoring (passing on wisdom);

6. Controller does not recognise having reached limit of capacity/competence;

7. Tunnel vision in circumstances where the controller is responsible for a large volume of airspace or a large aerodrome;

8. Loss of standardisation;

9. Emergence of untested or unapproved techniques;

10. Insufficient system knowledge to recognise operational impact of system degradation.

Typical (but not necessarily exhaustive) occupational health and safety hazards which may need mitigation are:

11. Incapacity from a medical event or an accident;

12. Unrecognised or unacknowledged fatigue or medical unfitness (for duty);

13. Psychological stress – 'it all depends on me' and perhaps a feeling of inadequacy;

14. Adverse reaction to isolation – particularly in remote locations;

15. Staff security is compromised;

16. Long-term medical fitness.

The following mitigation actions are suggested:

The hazards identified above (referring to the same numbers, i.e. mitigation number 1 corresponds to hazard number 1 etc.) may be mitigated by the following:

1. **Culture**: Controllers are encouraged to discuss hypothetical scenarios; there is provision for solo tower and Terminal Control Unit (TCU) controllers to communicate with each other or from the console and the practice is actively encouraged.

    Supervision: An experienced operational supervisor (floor walker) is available and can be called upon for advice.

    Centre design: Sector consolidations are managed in such a way as to congregate remaining controllers in close proximity to each other.

    Training: Rostered regular training days to provide an opportunity for information and anecdote exchange as well as refresher training in those elements not frequently or regularly encountered or exercised.

2. **Training**: Training in threat and error management.

    Systemic: A Normal Operations Safety Survey (NOSS) programme is implemented in accordance with the ICAO Recommended Practice.

    Supervision: Supervisors are provided with technical training and hence an operational understanding of the various sectors for which they are responsible.

    Performance management regime: A robust performance management regime (incorporating regular/frequent competency assessment and proficiency improvement episodes) is implemented.

3.   **Contingency**: Contingencies plans have been designed and are appropriately implemented as necessary.

     Training: Controllers are provided with regular and appropriately targeted Refresher training.

     Knowledge: Controllers are provided with regular opportunities to refresh their knowledge and their knowledge retention is regularly tested.

4.   **Performance management regime**: A robust performance management regime (incorporating regular/frequent competency assessment and proficiency improvement episodes) is implemented.

5.   **Performance management regime**: A robust performance management regime (incorporating regular/frequent competency assessment and proficiency improvement episodes) is implemented. It is the proficiency improvement activity that replaces the mentoring that occurred when working alongside another experienced controller.

6.   **Performance management regime**: A robust performance management regime (incorporating regular/frequent competency assessment and proficiency improvement episodes) is implemented.

     Supervision: Supervisors are provided with technical training and hence an operational understanding of the various sectors for which they are responsible. They also liaise regularly with the check controllers and thus have a good understanding of the capabilities of their charges.

     Culture: Controllers are encouraged to discuss hypothetical scenarios – particularly as these may relate to circumstances that are perceived as being a 'stretch' for the controller. In this way the controller is forced to confront the hypothetical possibility that they may need to seek assistance. Furthermore, having sought the assistance it is provided in a non-judgmental fashion.

7.   **Human factors training**: Controllers are provided with specific training in maintaining situational awareness and taught techniques for ensuring acquisition of a complete 'picture'.

     Procedural: Before considering coordination for automation, its impact on potentially reducing situational awareness is tested and, if necessary, mitigated. Perhaps the coordination is not automated providing a 'heads up' that captures the controllers' attention regarding the relevant issue.

8.   **Performance management regime**: A robust performance management regime (incorporating regular/frequent competency assessment and proficiency improvement episodes) is implemented. During the check, the assessor will identify and correct non-standard practices.

     Supervision: Supervisors are provided with technical training and hence an operational understanding of the various sectors for which they are

responsible. They also liaise regularly with the check controllers and thus have a good understanding of the standardisation issues to be on the lookout for.

9. **Performance management regime**: A robust performance management regime (incorporating regular/frequent competency assessment and proficiency improvement episodes) is implemented. During the check, the assessor will identify and correct any untested or unapproved techniques.

    Supervision: Supervisors are provided with technical training and hence an operational understanding of the various sectors for which they are responsible. They also liaise regularly with the check controllers and thus have a good understanding of the types of inappropriate techniques to be on the lookout for.

10. **Performance management regime**: A robust performance management regime (incorporating regular/frequent competency assessment and proficiency improvement episodes) is implemented. During the check, the assessor will probe the assessee for their system knowledge as a part of measuring their level of competence.

    Training: Rostered regular training days to provide an opportunity for information and anecdote exchange as well as refresher training in those elements not frequently or regularly encountered or exercised.

11. **Medical standards**: An appropriate set of medical standards enshrined in legislation will reduce the likelihood of incapacity due to illness.

    Fatigue management: Will assist in mitigating the possibility of an accident travelling to/from the workplace.

12. **Education**: Controllers need to develop an awareness and a willingness to identify when they are unfit for duty.

    Just culture: This will reduce the motivation to not self-report.

13. **Performance management regime**: A robust performance management regime (incorporating regular/frequent competency assessment and proficiency improvement episodes) is implemented. A controller who is subjected to regular competency assessment will have a good appreciation of their competence. The performance management system therefore needs to be valid and reliable – and without any form of bias (positive or negative).

    Supervision: Having an experienced supervisor available will reduce the psychological stress.

    Centre design: Sector consolidations are managed in such a way as to congregate remaining controllers in close proximity to each other – and hence a possibility for some peer support.

14. **Employment screening**: It is important that appropriate people are selected for work in isolated areas. Some people are simply better at acclimatising themselves to such situations than others.

15. **Security mitigators**: All locations must be provided with adequate security. This is an issue whether the person is male or female.

16. **Fatigue management**: Long-term medical fitness is related to roster design and hence an effective Fatigue Rich Management System (FRMS) is vital. Education of both staff and their families should be a feature of such a FRMS.

   Drug and alcohol policy: Long-term medical fitness is also related to a person's consumption of drugs and alcohol. An appropriate workplace policy in this regard (including education) will have long term benefits to all.

The future of SPO

Single Person Operations (SPO) are really a product of the emergence of vastly improved technology. The rate of technology improvement is not expected to abate and thus we can expect SPO to become the norm rather than the exception. However, overall system design (i.e. technology and the human participant) will require ever more vigilant and exhaustive testing against real operational issues and responses thereto.

It behoves us, therefore, to make a concerted effort at considering the human elements of system design. Indeed, ICAO has published a Human Factors Manual specifically targeting this issue.

APPENDIX 4: IFATCA VIEW AND POLICIES ON SINGLE PERSON OPERATIONS

Introduction

Shrinking federal budgets and commercial pressures from privatisation are producing a global drive for increased efficiencies in the Air Navigation Systems (ANS) of the world. Consequently, Air Navigation Service Providers (ANSPs) are looking to find increased productivity from ATCOs. Member associations with staff shortages and those where the ANS is still developing may find themselves facing similar pressures. As a result, employers are using a number of different labour practices in an effort to increase the number of aircraft movements handled per person and/or reduce number of staff required to run the system. Because these practices may affect the health and safety of the ATCOs and the safety of the system, IFATCA must monitor their implementation and effect. It should be noted that this Paper reflects the realities of the ATCOs' working environment and does not mean that IFATCA endorses the use of Single Person Operations (SPO).

Discussion

SPO are defined by IFATCA as those periods of time when an operational ATC unit is providing service with only one person present on staff, that being the ATCO. A 1996 study into Air Traffic Control by Transport Canada noted:

> "Running an operation at its most efficient staffing levels usually means that very little surplus staff is tolerated. Unfortunately, in a safety-critical working environment, redundancy in system components is a requirement, including the human side of the system."

It is clear that in case of SPO, the redundancy of the human element is missing and therefore procedures need to be in place in the event of a failure of that element whether due to illness, fatigue or overloading.

These procedures should limit the levels and duration of traffic to an amount safely handled by a lone ATCO and should also deal with the possibility of the ATCO becoming unable to perform his/her duties. Procedures should be in place not only for the SPO unit but also for neighbouring units that may be affected. Because traffic may increase unexpectedly or uncontrollably, backup staff should be available on call-in within reasonable time limits to ensure the safe continuation of service. But it should be noted that in the case of an aircraft emergency, it is unlikely that staff could be called in quickly enough to assist in the increased workload. This is a risk that ANSPs and their customers must be willing to take if they use SPO.

SPO of longer duration do not allow the taking of normal meal and relief breaks. It should be noted that as a result of their research, the United Kingdom has recently regulated that: "...no operational duty shall exceed a

period of two hours without there being taken during or at the end of that period a break or breaks totalling not less than thirty minutes." IFATCA also has policies on maximum working hours.

Effects on ATCOs

What becomes apparent from the above discussion on the effect to the system is that the SPO also affects the personal wellbeing of the ATCO. As a minimum, he/she may be unable to take a meal or relief break for extended periods. IFATCA policies on night shifts, working hours and breaks are a good indication that this is an undesirable situation. Until a recent arbitration, Canada used SPO to staff night shifts of up to eight hours. The arbitrator ruled that this was an unreasonable length of time for an ATCO to work alone and ordered a minimum of two staff for any duration longer than three hours.

Further, the ATCO has no medical assistance in the event that he/she falls ill or is injured. Labour law in many jurisdictions requires that there be one employee present at all times who is trained in basic first aid. The use of SPO would require each ATCO have this training and be able to apply first aid on him/herself. The ATCO has no assistance should his/her unit be subject to unlawful interference. Fatigue may influence the controller's abilities. The 1996 Transport Canada study noted that: "...sustained vigilance for prolonged periods of time is demanding... and leads to decreased alertness and low motivation."

Each of the above factors can increase both the fatigue and the level of stress felt by the ATCO in the course of his/her shift, both of which have been found to be detrimental to health and well being. Further information on the resulting effects of SPO and current IFATCA policy on work and rest schemes, stress, fatigue and pregnancy is available.

Four-Eye Principle

Another aspect of SPO is the lack of the Four-Eye Principle (4EP). 4EP is defined as the situation where an active controller is accompanied by another appropriately qualified controller whose function includes that of a safety net by monitoring the same working area as the active controller.

IFATCA Policy

'Implementation of 4EP shall be strongly encouraged both through ANSPs and regulators. Individual ATCOs shall not be held liable for incidents or accidents resulting solely or in part from the non-implementation of the 4EP safety net'. Practically speaking one can conclude that SPO can be tolerated in a Unit that is on standby e.g. during night curfew.

Conclusions

SPO eliminate redundancy in the human element of the ANS system. This can lead to a failure of the whole system should the traffic demand on the ATCO exceed his/her abilities or would he/she fall ill. SPO may be detrimental to the

well-being of the ATCO by reducing his/her ability to take normal breaks while at the same time increasing the level of stress and fatigue under which he/she is operating. For these reasons, the use of single controller shifts should be strongly discouraged. Where providers choose to use SPO, they - not the ATCO - must bear the responsibility for the resulting risk to the system.

IFATCA POLICY

Rostering Single Person Operations (SPO) shall be avoided. In the unlikely event of unavoidable SPO appropriate measurements shall be taken to ensure that the SPO situation will be alleviated as soon as possible. Until such time measures shall be taken to mitigate all impacts of SPO such as: traffic regulation, provide breaks, informing neighbouring ATC units. Procedures shall be in place to implement such measures in an efficient way, not increasing the workload of the ATCO.

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- *SPO Slice with Proportional openings (Neering The Controller)*, 2003.

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APPENDIX 5: CASE STUDY: GOOD PRACTICE ON HANDOVER

HANDOVER/TAKEOVER OF OPERATIONAL POSITION

Origin: EUROCONTROL Hindsight newsletter Issue No1 – 15 October 2003

The problem

A number of ANSPs have expressed concerns about safety occurrences associated with the handover/takeover process of operational ATC positions.

It is acknowledged that the vast majority of handovers take place without any problems, and only a very small proportion are flawed. Therefore, the level of normal human reliability has already been reached and potential mitigations should be targeted at the other system elements procedures (checklists) and/or equipment.

The Safety Improvement Sub-Group (SISG) secretariat has investigated, analysed and summarised the existing good practice approaches used by some ANSPs. Some recommendations are provided below:

Before handover

- A handover produces a workload of its own. Careful consideration to the timing should be given.

- If it is likely that the sector will be split shortly after the handover, consider splitting it before the handover.

- Simultaneous takeover of all the sector positions (for example both radar and planner) should be avoided.

- Do not short cut the existing good practice during low-vigilance periods.

- The handing-over controller should tidy up the working position prior to the handover.

- A handover should be commenced only after all the initiated actions for resolving the potential conflicts or recovering from actual conflicts are accomplished.

During handover

- Avoid distracting controllers during handover.

- Use checklists with the sequence of actions to be performed by both handing-over and taking-over controllers.

- The taking-over controller should ensure that he/she has been able to assimilate all information relevant to a safe handover and should accept

responsibility only after he/she is completely satisfied that he/she has a total awareness of the situation.

- Use mnemonic reminders within the checklist like 'check REST before going to rest' (see <u>table below</u>).

- Please, note that there is an important logic behind the REST sequence, building consecutively the situational awareness for (1) environment frame work (2) environment of operations (3) operations.

After a handover

- It is specifically important that the handing-over controller should remain available for few minutes following the handover, particularly in dynamic traffic situations, to provide clarifications/assistance regarding any points which may subsequently arise.

- Other controllers on the sector should only impart additional information after a handover is complete.

R	Restrictions	Examples: flow restrictions, TSA, danger, prohibited and other special status airspace.
E	Equipment	Examples: Status, maintenance, ground-ground communications, air-ground communications, navigation, surveillance, radar filters, radar source, type of surveillance sources integration if multiple, strip printers, workstations, information systems.
S	Situation	Examples: Weather (fog, snow, hail, visibility, low/high pressure, CB turbulence, CAT, winds, etc.), staffing, configurations (sectors, runways, taxiways, adjacent sectors etc), strips, holding.
T	Traffic	Examples: All under control, expected, military, VIP, aerial activity, non compliant with ATM regulations (RVSM, RNAV, 8.33, ACAS, etc.), VFR flights, clearances and instructions given.

Note: Case studies on handover practices from ANSPs are available on request.

APPENDIX 6: SAFETY OCCURRENCES DURING OJT

Origin: EUROCONTROL Hindsight Newsletter Issue No2 – January 2006

The problem

- According to a recent report 10% of the analysed safety occurrences are associated with the 'controller-under-training' situation.

- This fact alone does not give sufficient indication of the scale of the problem, unless statistics are made available to establish the relationship between the total number of sector hours and the number of sector/hours during On-the-Job Training (OJT) for a specified time period.

- Independent of the above argument some ANSPs are concerned by an increasing trend in such events.

- While 'lack of attention from the instructor' was reported as 'infrequent to none' during the first ten minutes of an OJT session, it was reported as 'significant' during the second hour in working position.

Potential explanations

- Insufficient awareness by the instructors of the level of competence of the student or trainee they are supervising.

- The instructor allowing the situation to develop for the purpose of training.

- Distraction of the instructor.

- An unmanaged mismatch between simulator exercise timing (often between 45 minutes and one hour) and the time on the position (often two hours).

- General inconsistency between the *ab initio* and OJT programmes in terms of level of knowledge and skills required to start off.

- General inconsistency between the simulator and start of process in terms of:
  - change of instructors;
  - change in system support provided by the simulator facility and the operational system;
  - specific operational environment not known to the needed level of detail;
  - unrealistic simulation environment, including aircraft performance and coordination procedures.

- In general, humans are not good at monitoring tasks and the OJTI's role demands a high degree of monitoring.

Potential solutions

The On-the-Job-Training Instructor (OJTI) is responsible for the safety of the ATC service being provided under supervision. Therefore consider:

- Identifying needs for and implement improvements in the selection and training of the OJTI.

- Clearly defining and documenting the roles and responsibilities of the OJTI and implementing them in the OJTI training programme.

- Limiting the time on the OJT position.

- Providing refresher training on coaching techniques and error recovery to OJTIs on a regular basis.

- Introducing a regular meeting forum for the OJTIs for exchanging lessons learned and good practices and for supporting drafting the respective unit/ANSP training plan.

- Making arrangements for sharing situational awareness and the plan of work between the OJTI and trainee.

- Detailing when and how to take over control from the trainee, including the take-over of communication, by using the appropriate switch/pedal to activate the transmitter.

- Detailing the procedure for the handover/takeover of the position, including introducing appropriate checklists.

- Ensuring that the OJTI is briefed on the level of proficiency of the student/trainee.

- Developing a competence scheme for OJTIs.

- Ensuring that the ANSP has a procedure to provide assurance that students and trainees are appropriately trained and licensed.

- Limiting the number of permitted OJTIs per trainee.

- Restricting simultaneous OJT on more than one position of a sector or more than one adjacent sector.

- Incremental increase of complexity in the training programme - defining training phases and communicating the objectives and progress of the phase, including strong and weak points.

- Introducing the practice of briefings and debriefings between the OJTI and trainee.

- Reviewing the training programmes to ensure that they reflect the knowledge and skills required for:

  - collision avoidance,

- emergency situations.

- Ensuring smooth transition from simulator to OJT, including:

  - sufficient simulator time;
  - training in emergency and unusual situations;
  - identical system support;
  - simulation environment as close as possible to the operational environment.

- The possibility for OJTI and student to be able to use simulation facilities during OJT so that certain experiences occurring with live traffic can be repeated in a simulated environment in order to maximise the lessons learned.

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APPENDIX 7: SUMMARY - EUROCONTROL GUIDELINES/TOOLS RELATED TO TOPICS

Safe Staffing Topic	Deliverables – tools/guidelines from EUROCONTROL
Degraded modes	- Guidelines for Controller Training in the Handling of Unusual/Emergency Situations (HRS/TSP-004-GUI-05) - Guidelines for Refresher Training for Air Traffic Controllers (HRS/TSP-004-GUI-04)
Workload extremes	- A Tool for the Assessment of the Impact of Change in Automated ATM Systems on Mental Workload (HRS/HSP-005-REP-03)
Night work	- Fatigue and Sleep Management: Personnel strategies for decreasing the effects of fatigue in air traffic control - Literature Review
Position handover	- Guidelines for Controller Training in the Handling of Unusual/Emergency Situations (HRS/TSP-004-GUI-05) - Guidelines for Refresher Training for Air Traffic Controllers (HRS/TSP-004-GUI-04) - Hindsight – Issue No1 - Web-based training on factors dealing with handovers/takeovers for ATCOs
OJT	- Air Traffic Controller Training at Operational Units (HRS/TSP-05.4000-GUI-01) - ATCO Development Training – OJTI Course (HRS/TSP-004-GUI-06) - ATCO Development Training – OJTI Refresher Course (HRS/TSP-004-GUI-01) - Hindsight - Issue no2

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APPENDIX 8: DATA COLLECTION APPROACH AND LESSONS LEARNED FROM RELATED INDUSTRIES

Domain Selection Framework

A framework was developed that listed candidate domains and the ATM staffing relevant criteria on which they needed to match. The development of the framework made it possible to identify specific domains that were believed to be similar to ATM on relevant features. The selection of domains (related industries) was thus based upon a methodology developed to avoid a more intuitive and thus probably biased process.

The domain selection framework was originally developed for the shiftwork study, and a detailed description of the approach can be found in EUROCONTROL (2004b). For the shiftwork study, the domain selection framework indicated that the Medical Emergency Room personnel, together with the airlines and the police would make good subjects for data collection on best practices for shiftwork. As the relevant features of the domain selection framework defined for the shiftwork study are also relevant for staffing issues (e.g. features like effort and stressors involved in the work), it was decided to elaborate on the framework developed for this study, rather than developing a framework that excluded these features. In addition to the existing features, the following features were included:

- SPO;

- handover;

- night work;

- OJT;

- workforce characteristics (is the operative team comprised of staff performing different or same tasks?);

- legal requirements in relation to staffing (tight vs. loose);

- whether the following are relevant and associated with any risks:

  - over/under-staffing;

  - high-traffic volume falls into periods when humans are not at their biological peaks;

  - professional pride and/or 'can do' mentality;

  - part-time controller recency;

  - whether SPO is considered a risk.

The framework is presented in Table 2. The different domains are listed on the top. The shift and staffing relevant features are listed down at the left side. The evaluation of similarity with ATM for each of the other domains was scored

within the grid. Note that not all of the features could be scored. The different regulations for the different domains in different countries or organisations are hard to obtain. The same can be said about the organisational factors affecting shiftwork.

For some of the features (the ones originally developed for the shiftwork study), different values (ranging from -3 to +3) were used and given as indications of degree of similarity with ATM ('0' indicated perfect similarity, and '3' indicated total absence of similarity, with '+' indicating that ATM had more of the feature relevant to the domain in question, and '−' indicating that ATM had less of the feature relevant to the domain in question). For an easier analysis the similarity was coded by means of different shades of grey. Thus, the brighter grey the more similar to ATM the cell is, and the darker grey, the more different. However, this coding does not consider the priority of the features. The staffing specific features can be classified as either 'similar' or 'different' from ATM, so the rating of these features was obtained through the use of 'V'= similar to ATM, and 'X'=different from ATM, rather than a scale ranging from -3 to +3. The colour coding applied the same logic as for the shiftwork study.

Police and medical emergency were selected as the most relevant domains.

Table 4: Domain selection framework

Domain Selection Framework		Railway Control Centre	Emergency Dispatchers	Medical Emergency Room	Road Transport Centre	Fire Station	Military	Meteor-ologist	Oil	Airlines	NPP	Police	Shipping	Harbour
Shift work issues														
Predictability		+3	+1	+1	+1	0	0	+3	+1	+2	+3	+1	+2	
Avoiding unwanted consequence – Safety														
• Others		0	-1	-1	-1	-1	-1	-1	-1	0	0	-1	-1	
• Self		0	-1	0	-2	+3	+3	-2	+1	+2	+2	+2	+1	
Effort														
Mental	• Skills	-1	-1	0	-1	0	+1	-1	-1	0	-1	-1	-1	
	• Rules	-1	0	0	0	0	+1	-2	-1	0	+1	0	0	
	• Knowledge	-2	-1	0	-2	-2	-2	-1	-1	-1	-1	-1	-1	
• Physical		0	0	+2	0	+2	+3	0	0	+1	0	+2	+1	
• Variation		-2	-2	0	-2	0	0	-2	-2	0	-3	0	-1	
Stressors	Physical conditions	+1	0	+2	0	+2	+2	0	0	+1	-2	+1	+1	
	Balancing the demands of home and work	0	0	0	0	0	+2	0	+1	+2	0	+1	+2	
	Job design	-1	-1	0	-1	0	+1	-1	+1	0	-2	0	-2	
	Relationships in organisation	+1	0	0	-1	+1	0	0	0	0	0	0	0	
	Work organisation and conditions	0	0	0	0	0	+2	+1	0	0	0	0	0	
Level of Expertise		-1	-1	0	-2	-2	-2	0	-1	0	0	-2	-1	
Shift work rosters type: Continuous or conti-systems (24/7) *= weeks on/off		X	X	X	X	X	X*	X	X*	X	X	X	X*	
Selected domains				x							x		x		
Staffing issues														
Single person operation		V/X	X	X	X	X	V	X	V	X/V	X	X	V/X	V
Handover		V	V	V	V	V	V	V	V	X	V	V	V	V
Night work		V	V	V	V	V	V	V	V	V	V	V	V	V
On-the-job training		V/X	V	V	?	V	V	V	V/X	V	V	V	V	V
Work force characteristics:														
• **Different roles**		V	V	V	X/V	V	V	X	V	V	V	V	V	X
Legal requirements: tight vs. loose		?	Tight		?	Tight	Loose	Loose	Loose	Tight	Tight	Loose	Tight	Loose
Risks:														
Human aspects														
- Over- and under-staffing		X	V	V under	?	X	V	V under	V/X	X	V under	V under	X	X
- High traffic volume falls into periods when humans are not at their biological peaks.		X	V/X	V	X	V	X	X	X	V	X	V	X/V	X
- Professional pride and/or a 'can do' mentality.		X	X	V	X	X	V	X	X	V/X	X	V	X	X
- Part time controllers recency		X	V/X	V	?	V	X	V	X	V	V	V	V	V
Operational risks														
- SPO – Is it considered a risk?		V/X	V	V	V	V	V	V	X	V	V	V	V	X
Level of similarity with ATC (no of compl.overlap)		2	6	9	3	7	9	7	5	6	7	10	6	6
Selected domains				x								x		

The following informants provided input to the data needed for the development of the domain selection framework in relation to the staffing issues (for informants on the shiftwork issues see EUROCONTROL, 2004b):

- *Railway:* Ann Britt Skjerve, Ife.

- *Emergency dispatchers*: staff coordinator for emergency (113) Fredrikstad hospital.

- *Medical emergency rooms*: Oslo Legevakt: Anne Cathrine Nore.

- *Road Transport Centre*: Salvatore Massau/Magnhild Kaarstad, Ife.

- *Fire station*: Fredrikstad fire departement: Brannmester Sture.

- *Military*: Jan Heimdal, Ife.

- *Meterologist*: Meterological Institute.

- *Oil*: Lars Åge Seim, Ife.

- *Airlines*: Pilot, SAS: Per Julius Helweg.

- *NPP*: Helena Broberg, Ife.

- *Police*: Norwegian Police academy: Svein Dahl.

- *Shipping*: Ole Breimo, previous captain http://www.bergesen.no/lwp/wcm/connect/BWG/BW+Gas/Company/Offices/#.

- *Harbour*: Paal Waage: http://www.ohv.oslo.no/cgi-bin/ohv/imaker?id=2452&visdybde=2&aktiv=2452.

Data Collection Approach

To obtain information about the police an interview was conducted with the police department in Oslo, Norway.

The data obtained from the interview with the emergency ward in Oslo, Norway, in relation to the shiftwork study (EUROCONTROL, 2004b), was also used as a relevant data source.

A new interview with focus on the staffing issues specific for the present study was also conducted with the same emergency ward.

In addition, a meeting was arranged with a Norwegian rostering expert.

Even though shipping was not identified as 'a related domain', an interview was also conducted with Sydney port authority, as it was assumed to provide valuable data.

An additional source of information for the related domains (i.e. medical and police) was published documents and papers on staffing that were mainly found on the Web.

Note: **Any relevant information from the related industries about any of the six topics studied has been integrated in the main body of this document. Detailed information on data collected from related industries is available on request.**

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GLOSSARY

Air Traffic Management (ATM): The aggregation of ground-based functions (comprising variously ATS, ASM, ATFM) and airborne functions required to ensure the safe and efficient movements of aircraft during all appropriate phases of operations.

Air Traffic Management Organisation (ATMO): An organisation that has the management of aircraft either in flight or on the manoeuvring area of an aerodrome vested in it and which is the legitimate holder of that responsibility.

Air Traffic Services (ATS): A generic term meaning variously, flight information service, alerting service, air traffic advisory service, ATC service (area control service, approach control service or aerodrome control service). (ICAO Doc 9569 Definitions)

Breaks: The time in a shift when an individual or group of individuals is not at the workplace. This includes meal breaks, rest breaks, relief breaks and all other forms of workplace release from work for recuperation purposes.

Hazard: A potentially unsafe condition.

Licence: An ATC Licence indicates the qualifications of a controller and includes a record of his/her competence at a particular unit together with his/her medical classification.

Mitigation strategies: Steps taken to control or prevent a hazard from causing harm and reduce risk to a tolerable and acceptable level.

Operational staff: The staff working in the operational environment of ATS comprising ATCOs, flight data assistants, flow managers, operations room supervisors and ATS support staff.

Rating/endorsements: An authorisation entered on or associated with a license and forming part thereof, stating special conditions, privileges to be exercises. Reference ICAO Doc 9569 Definitions.

Risk: The combination of the probability or frequency of occurrence of a defined hazard and the magnitude of the consequences of the occurrence.

Rostering: The allocation of human resources in order to ensure service for the scheduled working hours in accordance with legal and local procedures.

Safety: Freedom from unacceptable risk of harm.

Stand-by duty: A period during which, by prior management, controllers are required to be available to report at their workplace with the intention of providing an ATC service.

Team: In ATS a group of two or more persons who interact dynamically and interdependently with assigned specific roles, functions and responsibilities.

Time leakage: Unaccountable loss of time from working shift time. It is assumed that the regulatory number of weekly hours will always be accommodated in the rosters, independent of the roster cycle in use. However, this assumption does not reflect reality because duties cannot be perfectly fitted into an existing roster in a way that adheres to the working conditions/regulations and at a time that fully meets the requirements in terms of regularity in the number of working hours. Effective time for breaks is assumed to be 100%, although breaks are rarely spread evenly and leave and sickness and other staff absences are not spread evenly over the year. Thus time leakage will lead to the need to have additional staff cover.

Unit training plan: A plan that details the processes by which student ATCOs and/or trainee ATCOs are trained. Additionally, the plan should detail the standards which will enable the objective of providing a safe air traffic control service to be met.

ABBREVIATIONS AND ACRONYMS

(Malta) ACC	(Malta) Area Control Centre
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATCO	Air Traffic Controller *(US)* / Air Traffic Control Officer *(UK)*
ATM	Air Traffic Management
ATMO	Air Traffic Management Organisation
ATS	Air Traffic Services
CAA	Civil Aviation Authority/Administration
CHPR	Centre for Human Performance Research
CISM	Critical Incident Stress Management
DAP/SAF	Directorate ATM Programmes, Safety Enhancement Business Division *(since Summer 2006 merged with DAS/HUM into new DAP/SSH)*
DAP/SSH	Directorate ATM Programmes, Safety, Security and Human Factors Division *(EUROCONTROL Headquarters, formerly split in two divisions: DAP/SAF and DAS/HUM)*
DAS/HUM	Directorate ATM Strategies, Human Factors Management Business Division *(since Summer 2006 merged with DAP/SAF into new DAP/SSH)*
DATCA	Danish Air Traffic Controllers Association
EATM	European Air Traffic Management
EUROCONTROL	European Organisation for the Safety of Air Navigation
ESARR	EUROCONTROL Safety Regulatory Requirement *(SRC)*
FAID	Fatigue Audit InterDyne
FRMS	Fatigue Rich Management System
IAA	Irish Aviation Authority

IANS	Institute of Air Navigation Services *(EUROCONTROL, Luxembourg)*
ICAO	International Civil Aviation Organisation
IFATCA	International Federation of Air Traffic Controllers' Associations
IFE	Institute for Energy Technology *(Norway)*
LFV	Luftfartsverket *(Swedish CAA)*
LoA	Letter of Agreement
MBZ	Mandatory Broadcast Zone
NOSS	Normal Operations Safety Survey
OJT	On-the-Job Training
OJTI	On-the-Job Training Instructor
Ops room	Operations room
SISG	Safety Improvement Sub-Group
SPO	Single Person Operations
SMS	Safety Management System
SRC	Safety Regulation Commission *(EUROCONTROL)*
SSAP	(European) Strategic Safety Action Plan
TAAATS	The Australian Advanced Air Traffic System
TCU	Terminal Control Unit

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