SAFETY ASSESSMENT REPORT

ON

INDEPENDENT APPROACHES TO PARALLEL INSTRUMENT RUNWAYS

AT

HELSINKI – VANTAA AIRPORT

Final Version 1.2

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DOCUMENT DESCRIPTION

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Safety Assessment on Independent Approaches to Parallel Instrument Runways

Helsinki – Vantaa Airport

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Abstract

Increasing demand and capacity needs at Helsinki – Vantaa airport has led to the decision that a new Independent Parallel Approach procedure shall be developed and implemented.

A Safety Assessment - covering a Functional Hazard Assessment (FHA) and Preliminary System Safety Assessment (PSSA) - has been performed in compliance with ESARR4: Risk Assessment and Mitigation in ATM. The present report provides the results of the performed assessments.

Keywords

Safety Assessment	Independent Approaches to Parallel Instrument Runways
FHA	Procedure Assurance Level (PAL)
PSSA	Safety Objectives and requirements

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1.2	27 March 2006	Final proofreading and editorial corrections	All

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EXECUTIVE SUMMARY

The report at hand presents the results of a safety assessment (FHA/PSSA) performed on the proposed procedure for operating independent parallel approaches at Helsinki-Vantaa Airport.

The FHA and PSSA have been performed in accordance with the EUROCONTROL Safety Assessment Methodology (SAM) and the related guidance material: Safety Assessment of ATM Procedures (SAAP).

The FHA identified 3 hazards as follows:

1. **Wrong application of independent parallel approach procedure**

   - the procedure is executed incorrectly

   Severity classes ranging from 1 to 3 for the identified hazard effects with the worst credible effect having a severity 3.

2. **Wrong application of missed approach procedure**

   - the missed approach procedure is executed incorrectly

   Severity classes ranging from 1 to 4 for the identified hazard effects with the worst credible effect having a severity 3.

3. **Wrong conditions**

   - the criteria for operating the procedure are not satisfied

   Severity classes ranging from 1 to 3 for the identified hazard effects with the worst credible effect having a severity 3.

Based on the identified hazards and hazard effects, a number of safety objectives have been derived.

The PSSA has proposed a set of safety requirements to be implemented to ensure that the hazard effects are controlled, reduced or eliminated. Furthermore, the PSSA has allocated a ***PAL3*** to the procedure giving the development effort to be applied during the further procedure development process supporting that the risk of the procedure stays at acceptable safety levels and safety requirements are satisfied.

The united results of the FHA and PSSA indicate relatively clearly that the procedure safely can be further developed and implemented pending Finavia development of certain criteria (e.g. contingency procedures and procedures for activation/termination etc).

A final decision will have to be made at the end of the implementation phase (SSA implementation report) whether transfer into operation and/or operations can be performed.

1 INTRODUCTION

As the number of operations at Helsinki – Vantaa Airport is expected to grow over the years, the possibility of operating independent parallel approaches on runways 04L/R and 22L/R has been considered to accommodate capacity needs. An independent parallel approach procedure has been developed by the Air Navigation Service provider in Finland – Finavia - in compliance with ICAO Doc 9643 "Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (SOIR)" [ref. 3].

The new independent parallel approach procedure has been the subject for a Safety Assessment, FHA and PSSA which are presented further in this report.

1.1 Scope of the Document

The document has the following content:

Section 2: Safety Assessment Initiation

This section describes the starting point for the Safety Assessment and provides background information relating to Helsinki – Vantaa Airport together with a short description of the system, the operational environment and the regulatory framework connected to the new procedure.

Section 3 Safety Assessment Methodology

This section provides a brief presentation of the applied Safety Assessment Process and Methodology to introduce the results in the following sections.

Section 4: Results of the Functional Hazard Assessment

This section describes the essential outputs of the FHA sessions leading to the derivation of the Safety Objectives.

Section 5: Results of the Preliminary System Safety Assessment

This section describes the essential outputs of the PSSA sessions leading to the definition of the Safety Requirements.

Section 6: Conclusion

This section outlines the conclusions of the performed FHA and PSSA sessions.

Appendices: The appendices contain the detailed and supporting information relating to the description of processes, methodology descriptions and basis, detailed FHA and PSSA results etc.

2 SAFETY ASSESSMENT INITIATION

2.1 Introduction

This section provides information related to the planned implementation of the independent parallel approach procedure and about Helsinki – Vantaa Airport in order to create a common understanding of the procedure and the environment in which it will be implemented. Note, however, that the detailed system description, operational environment description and assumptions are contained in Appendix D.

2.2 Helsinki – Vantaa Airport

Helsinki - Vantaa airport can cater for 12-13 million passengers per year. The airport is open 24 hours a day throughout the year. The airport handles around 50% of the total number of domestic passengers per year and around 88% of all international passengers in Finland. In 2004, the total number of landings at the airport was 86,276 (commercial aviation 83,143, general aviation 452, military aviation 1,027 and other 1,654).

The number of operations per year is approximately 220,000. The annual increase in number of passengers amounts to 5% and the annual increase in operations to 2%.

The maximum number of operations (take-offs and landings) currently stands at 76 an hour, of which 40 can be incoming aircraft and 36 departing aircraft. On weekdays Helsinki – Vantaa handles between 550-600 operations a day and about 400 a day at weekends.

Helsinki – Vantaa's third runway, 04L/22R, has given the airport greater overall capacity, but specially during the peak hours demand is still greater than what is available. In particular, demand during the busiest hours of the afternoon has increased more than expected.

In 2004 the airport, therefore, initiated a scheme to improve runway efficiency and capacity. The idea was that by overhauling its air traffic control procedures, the airport could switch from dependent parallel approaches to using independent parallel approaches on the two parallel runways: 04L/22R and 04R/22L. The application of independent parallel approaches will increase the arrival capacity to 48 per hour and thus satisfy the peak hour demand.

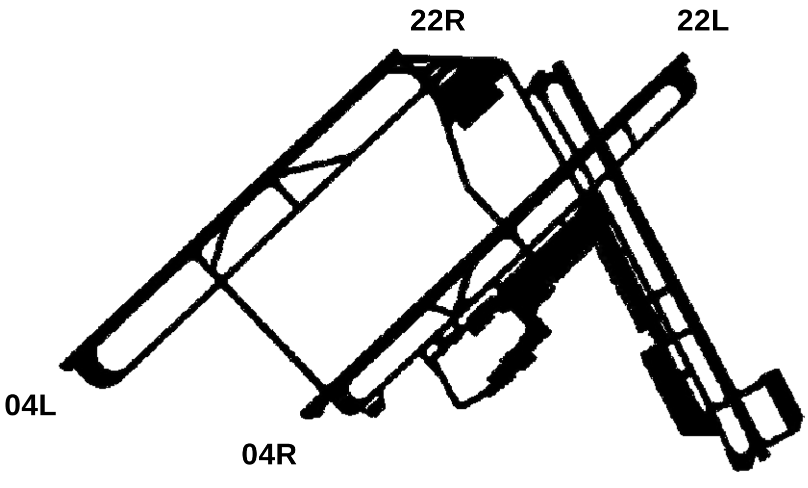


Figure 2-1: Helsinki – Vantaa layout

2.3 The Independent Parallel Approach Procedure

The procedure designers at Finavia have developed a procedure for independent approaches to parallel instrument runways.

The complete procedure description can be found in “Independent approaches to parallel instrument runways – EFHK procedures” [ref. 4 (+ *draft version enclosed in Appendix R*)]. In brief, the procedure description provides the working procedures when operating simultaneous approaches to the parallel instrument runways 04L/R and 22L/R.

It is assumed that the ICAO procedure as described in Doc 9643 is acceptably safe. The safety assessment as described has been restricted to the local implementation of such procedure. Thus, the baseline for the performed safety assessment is the Finavia procedure including any noted deviations.

The procedure developed by Finavia is fully compliant with and according to the provisions of ICAO Doc 9643 [ref. 3] except for the following deviations:

ICAO requirement (Doc 9643)	**Finavia**
§ 2.2.1.1 i): If no dedicated radio channels are available for the radar controllers to control the aircraft until landing: 1) transfer of communication of aircraft to the respective aerodrome controller's frequency is effected before the higher of two aircraft on adjacent final approach tracks intercepts the ILS glide path or the specified MLS elevation angle, and; 2) the radar controllers monitoring the approaches to each runway are provided with the capability to override transmissions of aerodrome control on the respective radio channels for each arrival flow.	Finavia is using the communication system Schmid. This system contains a *priority call* - feature. This feature is needed to guarantee the fastest possible phone co-ordination between the RAD, ARR and TWR controller and will be used instead of an overriding capability. The priority call mode does not require any action from the receiving party (e.g. the RAD, ARR or TWR controllers respectively) - i.e. the line is open immediately via loudspeakers and handset microphone. ***Note: the priority call – feature is different from the override capability in the sense that the possibility to directly override transmissions does not exist. However, in Helsinki the monitoring responsibility when the aircraft is within the Tower area of responsibility is held by the TWR controller him-/herself and not by another controller, see item below. The issue is discussed in more detail in section 4.1.2.***
§ 2.2.1.3: Whenever parallel approaches are carried out, separate radar controllers should be responsible for the sequencing and spacing of arriving aircraft to each runway. § 2.2.1.9: Radar monitoring shall not be terminated until: a) visual separation is applied, provided procedures ensure that both radar controllers are advised whenever visual separation is applied; or b) the aircraft has landed or, in case of a missed approach, is at least 2 km (1.0 NM) beyond the departure end of the runway, and adequate separation with any other traffic is established.	Finavia would like to extend the responsibility of the TWR controller. At Helsinki - Vantaa when parallel independent procedures are in use the TWR controller will also be APP radar qualified. Finavia would like to change the monitoring responsibility to the TWR Radar controller when aircraft are within the Tower Area of responsibility (CTR – from surface to 1300ft) as listed in HLOK. ***Note: the requirement that the TWR controllers shall be radar qualified is more stringent than the ICAO requirement. Further, the ICAO requirement is solely that radar monitoring of the aircraft is performed. In practice this can be done by all radar qualified controllers as found most appropriate. Thus this issue is not considered to have a safety effect and is not discussed further.***
§ 2.2.1.5: A minimum of 300 m (1000 ft) vertical separation or, subject to radar system and radar display capabilities, a minimum of 5.6 km (3.0 NM) radar separation shall be provided at least until 19 km (10 NM) from the threshold and until aircraft are established:	Finavia would like to extend the distance from threshold separation minima for their independent approaches. Finavia wants to use 12 NM (as opposed to 10 NM as ICAO procedures allow) for independent parallel approaches. This is because of the increased range from touchdown required due to high side glide path point. ***Note: the requirement is less stringent than the***

ICAO requirement (Doc 9643)	Finavia
a) inbound on the ILS localizer course and/or MLS final approach track; and b) within the normal operating zone (NOZ).	***ICAO requirement. The difference is that following the Finavia procedure the aircraft will have a 2 NM longer period of flying with less than 1000 ft or 3 NM separation. This corresponds to less than 1 minute of flying time in average. All other requirements are fulfilled and the aircraft are both established on the LLZ and are within the NOZ.*** ***The issue is discussed in more detail in section 4.3.***

2.4 System Description

The new independent parallel approach procedures at Helsinki-Vantaa Airport will enable aircraft to land simultaneously on the parallel runways 04L/R or 22L/R in order to provide additional capacity for arriving traffic and reduce delays (and consequently fuel consumption).

Thus, the independent parallel approach procedure is a part of Finavia efforts to make full use of runway 04L/22R at Helsinki – Vantaa airport.

Appendix D contains the detailed system description.

2.5 Operational Environment Description (OED)

The OED constitutes the description of the operational environment in which the procedure shall operate. In addition the OED states the assumptions related to those conditions which cannot be fixed or predicted.

Consequently, the aim of the OED is to ensure that all participants have a common perception of the conditions under which the FHA was carried out.

Appendix D contains the detailed OED.

2.6 Regulatory Framework

The following standards constitute the regulatory framework:

- Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (SOIR) – ICAO Doc 9643 AN/941
- ESARR 4: Risk Assessment and Mitigation in ATM (Eurocontrol)
- ICAO Annex 11: Air Traffic Services
- ICAO Doc 4444: Procedures for Air Navigation Services – Air Traffic Management
- ICAO Annex 14: Aerodromes.

3 SAFETY ASSESSMENT METHODOLOGY

3.1 Introduction

The Safety Assessment of the independent parallel approach procedure has been performed in accordance with ESARR4 including the performance of the following two sessions:

1. Functional Hazard Assessment (FHA) session held at Helsinki – Vantaa Airport on 13 December 2005.
2. Preliminary System Safety Assessment (PSSA) session held at Helsinki – Vantaa Airport on 14 December 2005.

The sessions were attended by a pilot, a number of controllers and procedure designers. The list of the participants is included in Appendix P.

3.2 Safety Assessment Methodology

3.2.1 Methodology

The safety assessment is performed in compliance with ESARR4 (Risk Assessment and Mitigation in ATM) [ref. 6] and has been executed in accordance with the EUROCONTROL methodology for performing safety assessments “EUROCONTROL Safety Assessment Methodology; SAM” [ref. 1]. The SAM promotes the safety assessment process in three steps:

- Functional Hazard Assessment (FHA)
- Preliminary System Safety Assessment (PSSA)
- System Safety Assessment (SSA).

The performed safety assessment sessions included the two first steps, notably the FHA and PSSA. For simplicity of the document most descriptions and facts concerning the methodology and process are contained in Appendix C-F. Thus, the sections below provide only a brief introduction to the applied methodology.

3.2.2 Functional Hazard Assessment (FHA)

3.2.2.1 Objectives

As illustrated in Figure 3-1, the objective of the FHA sessions was to identify three issues: what can go wrong – what are the effects if it goes wrong – and how severe can it be? Accordingly, the output of the FHA sessions comprises:

1. what hazards can be identified?
2. what are the effects of the identified hazards?
3. how severe are the hazard effects (for each hazard effect)?

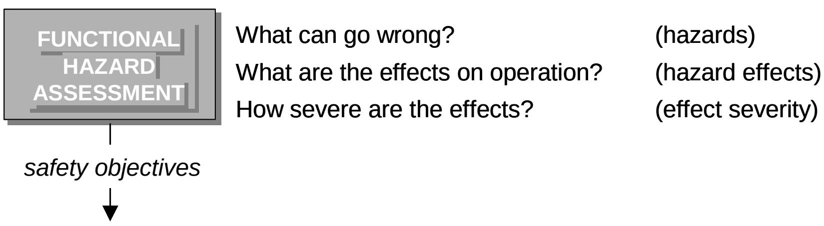


Figure 3-1: Functional Hazard Assessment

3.2.2.2 Process

The following process was adhered to at the session:

- Identification of hazards
  - Brainstorming
  - Functional Approach
- Identification of hazard effects and of External Mitigation Means
- Allocation of severities
- Discussion of worst credible effects.

Thus, the identification and discussion of hazards was initiated through brainstorming exercises with contribution from the experts attending the sessions. Based upon pre-developed scenarios (cf. Appendix A) the participants were requested to identify what could go wrong in the particular situations.

After the brainstorming session a functional approach was applied in order to further identify hazards and ensure completeness of the hazard identification. During the functional approach a set of keywords was used to identify hazards during the different phases of the procedure life cycle, cf. Figure 3-2. The keywords used to identify additional hazards were; Omit, Early, Late and Wrong. E.g. what can go wrong if the application of the independent parallel approach procedure begins too early?

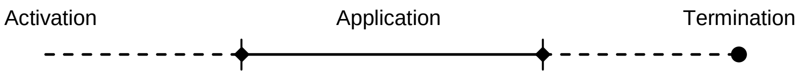


Figure 3-2: Procedure phases

Following, the identified hazards were grouped into three overall hazards by the safety assessment team and approved by the participants. Then, each hazard was discussed in forum in order to determine the *effects* of the hazards and the *severity* of the various effects.

In addition, Safety Requirements on External Mitigation Means were allocated.

Finally, the worst credible effects were discussed and agreed upon. The purpose of identifying the worst credible cases is to specify the relevant level of stringency of the Safety Objectives and avoid considering too over-stringent or too lenient cases.

3.2.2.3 Further Analysis

Upon the FHA sessions, the output was structured into a set of Safety Objectives expressing "how safe the procedure shall be". Thus, the safety objectives express to an extent the Safety Targets – with outset in the agreed safety objective classification scheme (cf. Section 4.2).

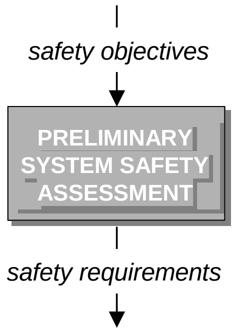
3.2.3 Preliminary System Safety Assessment (PSSA)

3.2.3.1 Objectives

As illustrated in Figure 3-3, the objective of the PSSA sessions was to derive a set of safety requirements that will mitigate the effects of the hazards identified during the FHA sessions.

This is achieved by considering:

1. what caused the hazards and led to the hazard effects?
2. how can we mitigate the effects already during the further procedure development phase?
3. what actions should be implemented to mitigate the effects?



What are the causes to the hazards?	(causes / failure modes)
What assurance activities can be applied during the development?	(procedure assurance levels)
How can we mitigate the effects?	(mitigation actions)

Figure 3-3: Preliminary System Safety Assessment

3.2.3.2 Process

The following process was adhered to at the session:

- Identification of causes and failure modes (Task Analysis)
- Discussion of initial mitigation means
- Allocation of Procedure Assurance Level (PAL).

The initial identification and discussion of the causes and failure modes was performed in forum with contribution from the experts attending the sessions.

The discussion was carried out through a *Task Analysis.* This Task Analysis describes task by task the activity of the different actors involved in the procedure (controller, pilot, vehicle driver etc). Based upon the description of the tasks, the deviation from a specific task to be performed by an actor is identified (e.g. that the pilot omits to follow clearance). All deviations constitute potential causes to hazards.

The task decomposition for the different actors is found in Appendix B.

Following the identification of causes, a first set of potential mitigation means was developed by identifying the potential actions which may eliminate, reduce or control that the causes lead to hazards.

Finally, the Procedure Assurance Level (PAL) was considered in the sense that the safety activities (e.g. the training plans for the ATCOs, the implementation plan, the calculations, the test and simulations etc) which have been performed so far during the procedure development process were discussed.

3.2.3.3 Further Analysis

Upon the PSSA sessions, the following complementary analyses were performed:

- further analysis to complete causes and mitigation means identification including development of fault trees, traceability matrices etc
- determination of the safety assurance activities to be implemented during the further procedure development and implementation process (i.e. the allocation of final PAL)
- development of the final set of safety requirements expressing the requirements to be placed on the system[1] in order to achieve the determined safety objectives.

[1] The safety assessment methodology considers a system as a combination of people, procedures and equipment.

4 RESULTS OF THE FUNCTIONAL HAZARD ASSESSMENT

4.1 Results of the FHA Session

4.1.1 Identified Hazards

During the first part of the FHA session approximately 30 safety issues were identified. These were subsequently grouped into a number of causes and three overall hazards. Accordingly, the identified hazards from the FHA of the procedure for the independent parallel approaches at Helsinki – Vantaa comprise as follows:

1. **Wrong application of independent parallel approach procedure**

   Wrong application of the procedure implies that the independent parallel approach is executed incorrectly or is not in compliance with the specified procedure.

   Most of the safety issues identified at the FHA session could be related to wrong application of the procedure, e.g. that the required High-side or Low-side levels are not reached properly (leading to separation infringement), the runways are mixed-up or poor vectoring by ATC (vectors to wrong runway or vectors through the final approach course).

2. **Wrong application of missed approach procedure**

   Wrong application of missed approach procedure implies that the standard missed approach procedure is executed incorrectly.

   During operation of independent parallel approaches, the separation is reduced resulting in the potential for more severe consequences if the missed approach is performed wrongly compared to dependent operations.

3. **Wrong conditions**

   Wrong conditions imply that the criteria for operating or not operating anymore the procedure are not satisfied.

   A number of conditions need to be in place to operate or terminate operation of independent parallel approaches. For example, the weather conditions shall satisfy specified criteria, the technical equipment shall satisfy performance specifications and the staffing shall be as prescribed (number and proficiency).

4.1.2 Identification of Hazard Effects and Assignment of Severities

Effects and Severities:

During the second part of the FHA session, the hazard effects were identified and each hazard effect was assigned a severity class indicating how strongly the safe provision of ATS will be affected by the particular effect. The severity classification is a verdict given by the experts attending the FHA session using the table in Appendix F.

Thus, the hazard effects were categorised into 5 categories, category 1-5, with category 1 as the most severe classification with complete loss of safety margins and category 5 as the least severe classification with no safety consequences:

1 **(most severe)**	**2**	**3**	**4**	**5** **(least severe)**
Accidents	Serious incidents	Major incidents	Significant incidents	No immediate effect on safety

Table 4-1: Overall severity classification scheme

Appendix F details the Severity Classification Scheme.

External Mitigation Means

External Mitigation Means (EMMs) are barriers outside the system being assessed which reduce the probabilities of the hazard effects to occur (last-moment safeguards enabling detection of hazards) or reduce the severity of the effects. When assigning the severities to the various hazard effects, such EMMs were taken account of. The EMMs may work fully or partly on the hazard itself or some of the causes leading to the hazard.

The following means were recognized:

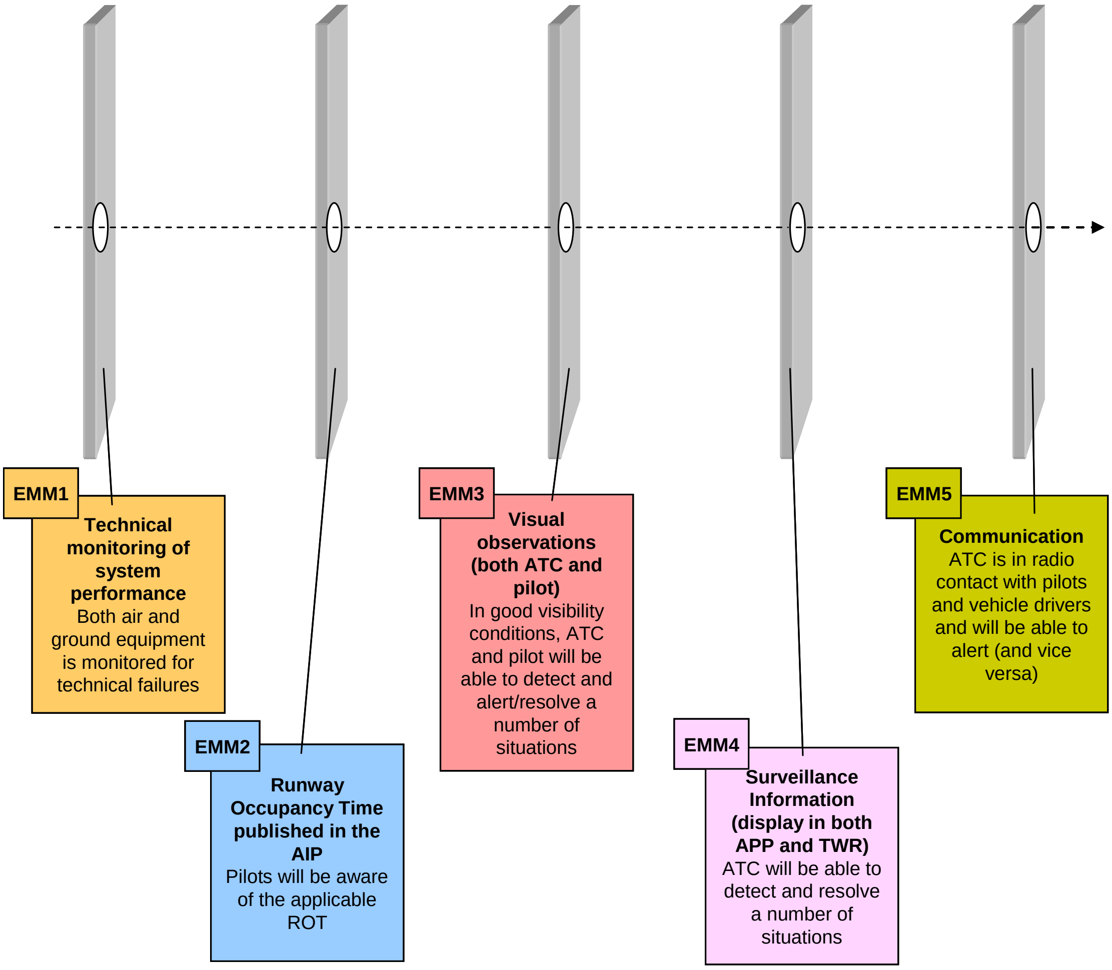


Figure 4-1: External Mitigation Means

In the case all or most of the EMMs fail, an accident is very likely to occur - if a hazard occurs - and most probably only avoided due to safety nets (e.g. TCAS) or providence. The event trees for the three hazards are enclosed in Appendix K. The trees illustrate how accidents such as e.g. mid air collision or loss of wake vortex separation could become reality.

The five EMMs illustrated above will reduce the probabilities of the hazard effects to become reality and/or reduce the severities of the effects as follows:

- **EMM1: Technical Monitoring**

Technical Monitoring may be considered as a basic equipment element to be in place for mitigation of technical failures. Correct technical monitoring shall alert either the pilot or ATCO that one or some system elements (ILS/MLS, VHF communication equipment, radar/surveillance system (SSR), transponder, Flight Management System, ATIS, VOR/DME, RNAV) are defective.

The ATCO and/or pilot has to apply a corrective action, but is assessed – in relation to the operation of the independent parallel approach procedure - that in the worst credible case this will not lead to more severe cases than increased workload for ATCO and/or pilot or minor loss of separation (from fault is detected till avoiding manoeuvre is completed, if necessary).

The availability requirements for the various system elements differ, but are not more demanding during independent parallel approach operations than what is required for other purposes.

- **EMM2: Runway Occupancy Times**

Runway Occupancy Times are as well considered as basic elements to be in place to reduce the probability of aircraft occupying the runways too long and be disrupting the landing of the succeeding aircraft.

If Runway Occupancy Time is not adhered to this may in the worst credible case – in relation to the operation of the independent parallel approach procedure - lead to a missed approach or breakout (aircraft is not able to land if preceding aircraft has not vacated runway). This causes increased workload for the pilot (to perform the manoeuvre) and for the ATCO (re-establishing inbound traffic flow and separation).

In Helsinki – Vantaa airport the Runway Occupancy Times are in average:

22L: 50s
22R: 55s
04L: 55s
04R: 60s

- for dry or damp runways.

Based upon operational experience, the workload for the ATCO will not be perceptible affected if up to 10% of the arrivals do not observe the Runway Occupancy Times. Thus, it is required that minimum 90% of the arriving traffic observes the Runway Occupancy Times. From a pilot perspective, the performance of a missed approach is considered as routine and only in very exceptional cases will the performance of a missed approach procedure have a slight impact on the workload.

- **EMM3: Visual Observations (both ATC and pilots)**

Visual observations by pilot from inside the aircraft can be difficult. Depending on the scenario, minor losses of separation (due to e.g. a wrong application of the procedure by another aircraft) are most commonly not detectable by pilots. For the pilot being able to detect a loss of separation, the distance to another aircraft on parallel approach must be relatively small – thus they have most likely both turned final.

However, if the wrong application of the procedure is detected (and a collision is thereby prevented) by the pilot by visual observation this leads in the worst credible case to increased workload as a corrective action / avoiding manoeuvre has to be performed. In this case, it is credible that either minor or major loss of separation has occurred.

Visual observation by ATC concerns the observations which can be made by the tower controller during good visibility conditions. However, even during good visibility the aircraft shall be approximately within 3 NM from the aerodrome (aerodrome traffic) if the ATC shall be able to observe visually.

If the wrong application of the procedure is detected by the ATC by visual observation this leads to increased workload as corrective instructions have to be provided. The worst credible case is major loss of separation (before visually detected).

- **EMM4: Surveillance Information**

Most frequently, the aircraft being off-track will be detected relatively quickly (within 15-30 seconds) through surveillance means by the ATCO. Radar monitoring is a fundamental task for the controller.

If the wrong application of the procedure is detected (and a collision is prevented) by the ATC, minor or major loss of separation has occurred. In the worst credible case, a major loss of separation has occurred.

The surveillance radar shall have a minimum azimuth accuracy of 0.3 degrees (one sigma) or better and an update period of 5 seconds or less. The availability requirements for surveillance radar (both position and altitude information required) are not more demanding during independent parallel approach operations than what is required for other purposes.

- **EMM5: Communication**

From an ATCO perspective, the worst means to lose is the COM (the second worst being the surveillance information). Even if the surveillance information - enabling the ATC to detect the conflict - is provided, the ATCO has no possibility to alert and give instructions to avoid collisions. The only means preventing the collision is now the safety nets (TCAS,…) or providence.

The *availability* requirements for the communication means are not more demanding during independent parallel approach operations than what is required for other purposes.

Note: the ICAO Doc 9643 puts forward the requirement that the monitoring controllers shall be able to, automatically, override any transmissions of the TWR controllers, or can use dedicated radio channels (since the TWR controllers do not have to be radar qualified).

The communication means in use by Finavia does not have a frequency override capability. Instead a priority call – feature is utilised.

However, the override capability is only relevant in the case where the monitoring responsibility is elsewhere than by the TWR controller. In Helsinki, the TWR controller will be radar qualified and hold the monitoring responsibility for all aircraft within the Tower area. Therefore, the need for an override capability is eliminated.

4.1.3 Summarised Hazard Effects and Severities

The relevant hazard effects for each of the three identified hazards were identified and discussed at the session. The most severe effects, which were identified, comprise the risk of mid air collisions and loss of wake vortex separation whilst the least severe effects comprise slightly increased workload for ATCO or pilot.

The subsequent paragraph summaries the main results relating to the three identified hazards and introduces the severity classes assessed at the sessions and derived for each identified hazard effect.

1. **Wrong application of independent parallel approach procedure**

   Six different hazard effects are identified with a mid air collision or loss of wake vortex separation being the worst severe effects (severity 1). The least severe effects comprise increased workload for ATCO or pilot or minor loss of separation (severity 3).

   A mid air collision may be the reality if an aircraft is off-track (incorrect performance of the procedure) and – at the same time – most of the external mitigation means fail (cf. Appendix K1) resulting in separation to other aircraft on parallel approach being lost.

   The loss of wake vortex separation may in the worst case result in loss of control due to turbulence and lead to an accident. Similarly to the mid air collision, most of the external mitigation means shall fail (cf. Appendix K1) for the effect to occur.

   In most cases, however, the wrong application of the procedure was assessed to lead to minor loss of separation (quickly detected by proper means) or increased workload for ATC or pilot (re-establishing separation and traffic flow or performing avoiding manoeuvres, respectively).

   More details concerning the hazard and its effects may be found in Appendix H (hazard log), Appendix J1 (fault tree) and Appendix K1 (event trees).

2. **Wrong application of missed approach procedure**

   Seven different hazard effects are identified with a mid air collision or loss of obstacle clearance (resulting in collision with obstacle) being the worst severe effects (severity 1). The least severe effects comprise increased workload for ATCO or loss of obstacle clearance (without colliding with obstacle) (both severity 4).

A mid air collision may be the reality if an aircraft is performing the missed approach incorrectly, consequently infringes another aircraft track, and – at the same time – most of the external mitigation means fail (cf. Appendix K2) resulting in lost separation.

The total loss of obstacle clearance may occur due to a wrongly performed missed approach (e.g. initiating a go-around after passing the published Minimum Approach Point). Similarly to the mid air collision, most of the external mitigation means shall fail (cf. Appendix K2) for the effect to occur.

In most cases, however, the increased workload for ATCO (handling the missed approach flight and re-establishing separation and traffic flow) or a loss of obstacle clearance with no catastrophic consequences were assessed to be the effects.

More details concerning the hazard and its effects may be found in Appendix H (hazard log), Appendix J2 (fault tree) and Appendix K2 (event trees).

3. **Wrong conditions**

Five different hazard effects are identified with a mid air collision being the worst severe effect (severity 1). The least severe effects comprise increased workload for pilot or minor loss of separation (severity 3).

A mid air collision may be the reality in situations where e.g. technical equipment does not satisfy required performance specifications. Examples include inaccuracy of the surveillance radar monitoring system or inaccuracy of the ILS signal leading to lost separation.

In most cases, however, the increased workload for pilot (having to perform an avoiding manoeuvre) or minor loss of separation (quickly detected by proper means) were assessed to be the effects.

More details concerning the hazard and its effects may be found in Appendix H (hazard log), Appendix J3 (fault tree) and Appendix K3 (event trees).

4.1.4 Worst Credible Cases

In connection with the allocation of the severities of the hazard effects, the participants were asked to determine the worst *credible* cases – thus taking into account both the severity of the effect and the likelihood of occurrence to identify the highest *risk*. For each of the hazards the worst credible case was:

Hazard 1: Worst *credible* case – Severity class 3

Hazard 2: Worst *credible* case – Severity class 3

Hazard 3: Worst *credible* case – Severity class 3.

The rationale was, therefore, that the effects such as minor loss of separation and increased workload (both ATCOs and pilots) were assessed to occur more frequently than the more severe effects such as mid air collision effect or major loss of separation taking into account the external mitigation means described in 4.1.3 above.

4.2 Safety Objectives

Based upon the identified hazards and hazard effects listed above, a number of safety objectives have been allocated, see Table 4-4, using a Qualitative Method (cf. SAM [ref. 1]). This method comprises 4 steps as follows:

1. Identify all the hazard effects
2. Allocate the severity class to each effect
3. Apply the worst credible case scenario

4. Allocate the Safety Objective applying the Qualitative Safety Objective Classification Scheme.

The Safety Objectives are derived directly from the Qualitative Safety Objective Classification Scheme (SOCS) shown in Table 4-3.

Severity class of the worst credible hazard effect (ESARR4)	Maximum acceptable frequency of hazard occurrence
1	EXTREMELY RARE
2	RARE
3	OCCASIONAL
4	LIKELY
5	NUMEROUS

Table 4-2: Qualitative Safety Objective Classification Scheme (SOCS)

The scheme specifies the maximum acceptable frequency of occurrence of a hazard using the severity of the worst credible effect.

It is important to note that the fulfilment of the safety objectives and the sufficiency of the connected External Mitigation Means must be validated through the later step of the Safety Assessment process, the System Safety Assessment (SSA).

Safety Objective Reference #	Safety Objective	EMM	Hazard Reference #
SO1	The frequency of the wrong application of independent parallel approach procedure in Helsinki - Vantaa Airport shall not be greater than occasional.	EMM1 EMM2 EMM3 EMM4 EMM5	H1
SO2	The frequency of the wrong application of missed approach procedure in Helsinki - Vantaa Airport shall not be greater than occasional.	EMM1 EMM2 EMM3 EMM4 EMM5	H2
SO3	The frequency of the wrong conditions to apply the independent parallel approach in Helsinki - Vantaa Airport shall not be greater than occasional.	EMM1 EMM2 EMM3 EMM4 EMM5	H3

Table 4-3: Safety Objectives

Note: For quantified Safety Objectives, see Appendix G.

4.3 Comments on the Results

It comes naturally that a procedure, which involves two aircraft approaching parallel runways simultaneously with a reduced separation compared to standard dependent operations, may result in hazards with potential catastrophic effects. However, in combination with appropriate supporting technologies and for equipped aircraft with eligible crews, independent parallel approaches are very similar to typical dependent instrument approaches.

From a pilot perspective, the two approaches (dependent / independent) imply identical on board procedures. The potential for catastrophic effects becomes a reality in the case where one aircraft flies off-path and threatens the safety of another.

Therefore, approach paths must be designed and flown such that the risk of one aircraft on one approach interfering with another aircraft on the other approach is reduced to an acceptable level. Second, in the case the event does occur nonetheless, means must be provided that will allow the non-offending aircraft to safely avoid the intruding aircraft.

The Finavia procedure has a deviation relating to the approach path compared to ICAO Doc 9643. Finavia would like to extend the distance from threshold separation minima for their independent approaches and apply 12 NM (as opposed to 10NM as ICAO procedures allow). This is because of the increased range from touchdown required due to high side glide path point. This deviation results in a slightly longer distance and thus period of flying with less than 1000 ft or 3 NM separation. The aspect is illustrated below:

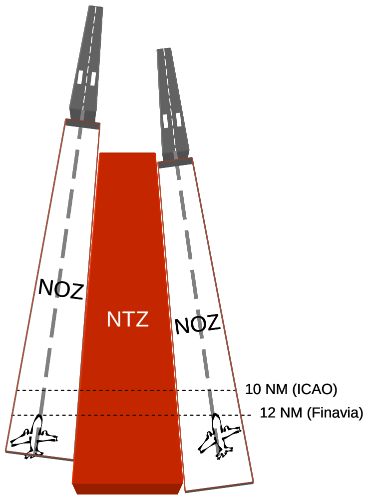


Figure 4-2: Illustration of distance from threshold

Both aircraft on approach are established on the ILS localizer and both are within the NOZ. The longer flying time corresponds in average to less than 1 minute. No hazards relating to this aspect were identified and thus from an operational perspective, this deviation is assessed to have insignificant safety effect.

With outset in these considerations - and taking into account the external mitigation means described above and the argument that the most catastrophic effects are assessed to occur less frequently - the worst credible cases are, therefore, identified by the participating experts to be of a Severity Class 3 implying minor separation loss or increased workload for ATCO/pilot.

5 RESULTS OF THE PRELIMINARY SYSTEM SAFETY ASSESSMENT

5.1 Introduction

As described in Section 3, the objective of the PSSA is to identify a set of Safety Requirements that will ensure that the hazard occurrence rate has been reduced to the frequencies specified by the Safety Objectives. Thus, the detailed safety requirements specify risk mitigation and give the detailed objective and description of the safety action to be implemented to mitigate the risk as well as the responsibility (who is responsible for the implementation) and the timing (when to implementation the requirement) if applicable.

The final list of safety requirements should comprise the safety requirements that have been identified as a reply to the causes and failure modes which have been identified as well as.the mitigation means expressed through the allocated PAL.

The performed PSSA followed the steps described in the SAM [ref. 1] and the SAAP [ref. 2]. Consequently, detailed analyses have been performed in order to elaborate a set of safety requirements and the PAL. Details pertaining to the analyses themselves can be found in Appendices G-M whilst the process and results are presented below.

5.2 Process

5.2.1 Safety Requirements

The first step of the process comprised the processing of the Initial Risk Mitigation Means identified during the PSSA session to a set of Safety Requirements. This process is illustrated below.

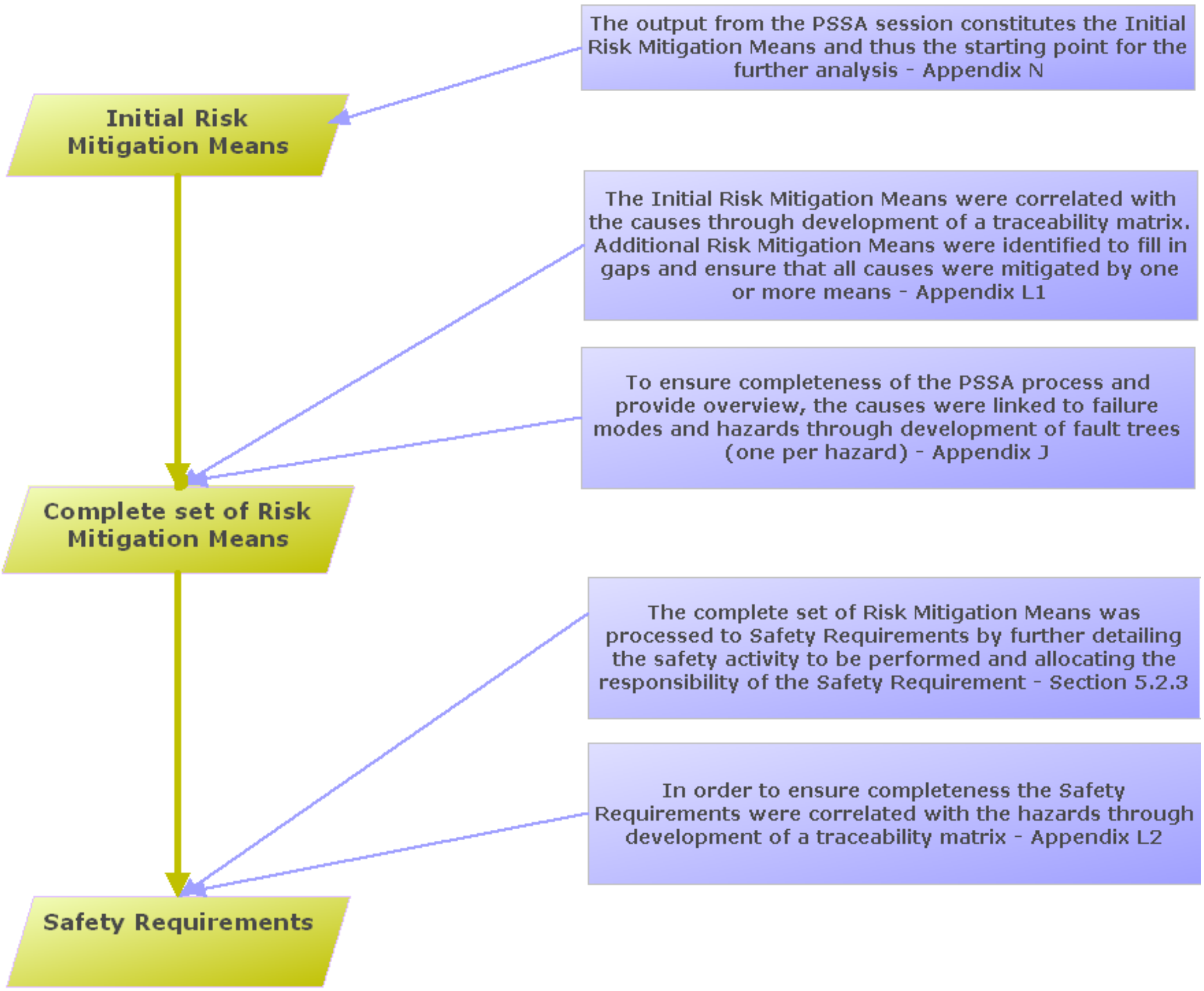


Figure: 5-1: Steps from initial risk mitigation means to safety requirements

5.2.2 PAL Allocation

The second step of the process comprised the allocation of the PAL. The PALs constitute an expression for the development and assurance effort that shall be applied during the procedure development in proportion with the risk associated with the procedure.

The results of the FHA (Appendix H) combined with the likelihood comprise the inputs to the definition of the PAL. The final PAL for the procedure is the most stringent one. More details concerning PALs are provided in Appendix C and M whilst the process is illustrated in the figure below.

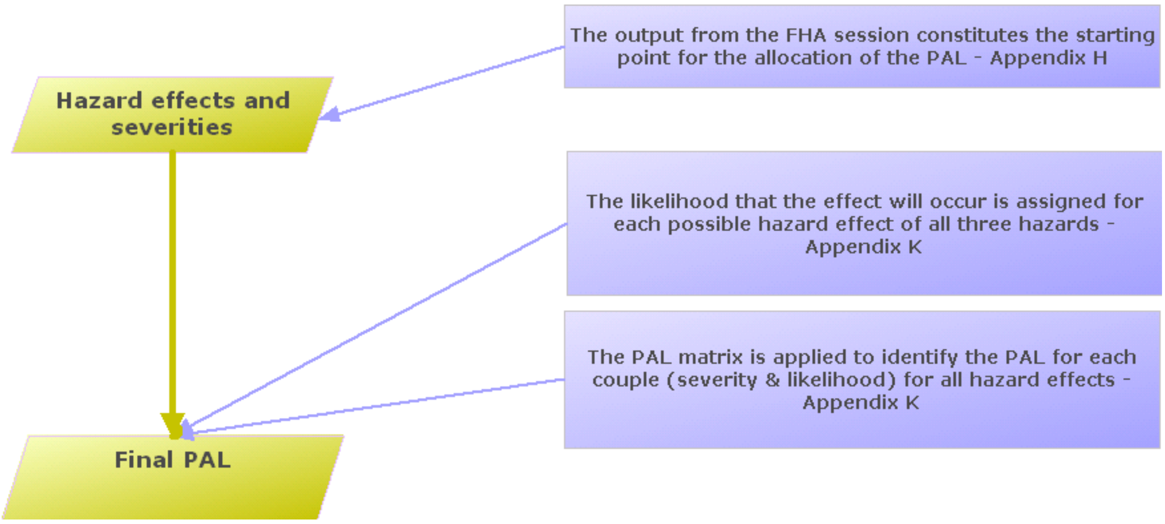


Figure 5-2: PAL allocation process

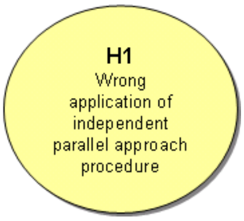
5.3 Results of the PSSA

5.3.1 Safety Requirements

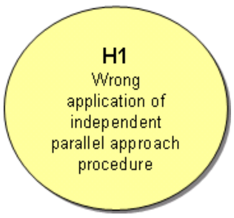
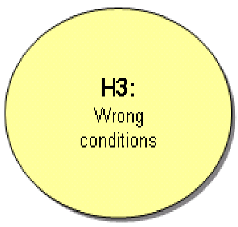
The proposed safety requirements apportion the mitigation actions on individual elements and the connected failure modes and supports with the rationale. The detailed list of safety requirements is contained in Appendix O. The table below presents only the condensed set of safety requirements. For particulars, please visit the Appendix.

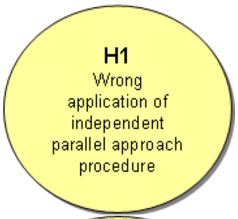
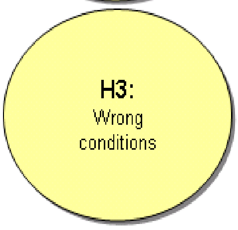
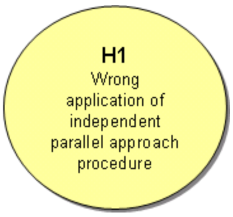
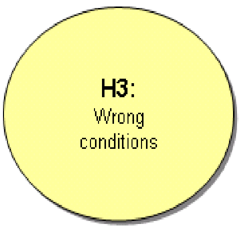
Note that three types of safety requirements are included:

1. The first set comprises the <u>firm</u> safety requirements which shall be implemented.
2. The second set comprises the <u>candidate</u> safety requirements where further investigation shall take place before establishing whether it is beneficial to implement the requirement. The candidate requirements are written in italics.
3. The third set comprises the External Mitigation Means (cf. also 4.1.2). These are all labelled EMM-SR0*x*.

Failure Modes	**Proposed Safety Requirements**
A. ATC error 	Dedicated training of ATCOs: SR1 Finavia shall develop and perform dedicated training in the procedure in general (for all ATCOs). Safety focus on at least: • Importance of precision in vectoring • Handling contingency and adverse situations such as ILS failure, loss of COM, loss of radar display, sudden runway closures and rapid unpredicted weather changes • Importance of timely hand-over • Importance of complete and unambiguous co-ordination relating to activation and termination of the procedure • Handling of runway mode changes – both planned and unexpected • Handling of lost VFR and similar traffic penetrating airspace • Use of non-standard clearances and the risk of misunderstanding • Familiarity with hot spots and critical moments. Improved HMI: SR2 Finavia shall improve the HMI in a way that reduces the possibilities for confusion and misunderstandings. Safety focus on at least: • Use of distinct colours of strip holders for each runway • Clear presentation of frequency lists. Change of runway numbering *SR3 Finavia shall investigate to change the runway numbering to e.g. 04 and 05 (instead of 04R and 04L) to reduce the risk of confusion.* EMM-SR03a Finavia shall ensure that controllers are trained in visual observations EMM-SR03b Finavia shall ensure that the construction of the new tower optimises the visual observation of the traffic EMM-SR03c Aircraft operators shall ensure that pilots are trained in the see-and-avoid concept EMM-SR04 Finavia shall ensure that the surveillance equipment complies with ICAO Doc 9643 (SOIR) - Appendix A EMM-SR05a Finavia shall ensure that communication equipment complies with standard ICAO provisions (ICAO Annex 10) EMM-SR05b Finavia shall ensure that the priority call – feature contained in the communications equipment is checked at each position prior to the controller assuming responsibility of the position

Failure Modes	Proposed Safety Requirements
B Pilot error **H1** Wrong application of independent parallel approach procedure **H2:** Wrong application of missed approach procedure	Dedicated training of pilots: SR4 Aircraft operators shall perform dedicated training in the procedure in general. Safety focus on at least: • Importance of reaching the required High Side and Low Side levels and the timely notification to ATC if unable to reach levels • Importance of immediate response to breakout instructions • Importance of ensuring that approach to correct runway is performed and that the applicable LLZ is armed • Importance of the reduced separation requiring strict adherence to rules • Importance of adherence to runway occupancy time (as published in AIP Finland) and thus exit runways as fast as possible • Operating during contingency and adverse situations, e.g. due to technical failures. Examination of checklists: SR5 Aircraft operators shall examine the cockpit checklists in order to ensure that it as a minimum includes: • checking of whether correct LLZ is armed • re-checking if runway is changed. Increase general awareness: SR6 Finavia shall develop briefing and awareness material including as a minimum: • content of the procedure • implications for aircraft operators • the focus areas listed in SR4. SR7 Finavia shall distribute the briefing and awareness material amongst the aviation community Awareness that the procedure is in use: *SR8 Finavia shall investigate which improvements to the ATIS read-out to implement in order to reduce the possibility for pilots failing to notice that the procedure is applied (e.g. shifting male and female voices reading out the ATIS – indicating that a new ATIS is in force)* *SR9 Finavia shall investigate which further means to utilise to ensure that pilots are notified that the procedure is applied (besides ATIS)* Use of standard clearances: SR10 Finavia shall prohibit conditional clearances when independent parallel approaches are applied in order to decrease the risk for misunderstanding Minimise runway occupancy time: SR11 Finavia shall declare more strict runway occupancy times in AIP

Failure Modes	Proposed Safety Requirements
	EMM-SR01a Finavia shall ensure that technical monitoring is in place for all safety-critical system elements including: • ILS/MLS • VHF communication equipment • radar/surveillance system (SSR) • ATIS • VOR/DME • RNAV. EMM-SR01b Aircraft operators shall ensure that technical monitoring is in place for all safety-critical system elements including: • ILS/MLS • VHF communication equipment • transponder • Flight Management System • VOR/DME • RNAV. EMM-SR02a Finavia shall ensure that Runway Occupancy Times are established and published in the AIP EMMSR02b Aircraft operators shall ensure that pilots are trained in observing the published runway occupancy times ***EMM-SR03-05 also applicable in relation to this failure mode. Cf. descriptions above.***
C Ground equipment failure   	Equipment performance and monitoring: SR12 Finavia shall ensure that the following minimum equipment including backup is in place in compliance with ICAO provisions: • ILS / MLS • SSR equipment with a minimum azimuth accuracy of 0.3 degrees (one sigma) or better and an update period of 5 seconds or less • COM with a priority call – feature. SR13 Finavia shall ensure that technical monitoring is performed of the minimum equipment as listed in SR12 *SR14 Finavia shall investigate whether further/increased technical monitoring is necessary and whether further preventive measures shall be implemented* Definition and implementation of contingency procedures: SR15 Finavia shall define and implement the necessary contingency procedures accounting for equipment failures/insufficiency occurring while Independent Parallel Approaches are in force SR16 Finavia shall define and implement the necessary contingency procedures accounting for failures relating to the Technical Monitoring System while Independent Parallel Approaches are in force

Failure Modes	**Proposed Safety Requirements**
	Control mechanisms relating to the ATIS: SR17 Finavia shall define and implement a control mechanism (e.g. a double-check procedure) of the information provided in ATIS Improved HMI: SR18 Finavia shall implement a means allowing for clear display to controllers when major changes of the ATIS occur (e.g. blinking or distinct highlighted) *SR19 Finavia shall investigate whether a procedure shall be developed for controllers to repeat such major changes to arriving aircraft* ***EMM-SR01-05 all applicable in relation to this failure mode. Cf. descriptions above.***
D Air equipment failure   	Equipment performance: SR20 Aircraft operators shall ensure that aircraft equipment is certified in accordance with regulations (JAR) Reducing false TCAS alerts: SR21 Finavia shall introduce in the AIP that only the TA function of TCAS shall be activated (if equipment allows) while Independent Parallel Approaches are operated ***EMM-SR01-05 all applicable in relation to this failure mode. Cf. descriptions above.***
E Other  	Weather condition display for ATCOs: SR22 Finavia shall implement means to display clearly for the Supervisor the criteria for operating / suspending the procedure – allowing for timely reaction – including: • weather criteria • equipment performance requirements • staffing criteria. SR23 Finavia shall display clearly the procedure for activation and termination of the Independent Parallel Approach Procedure Avoidance of traffic on active runways: SR24 Finavia shall ensure that procedures are in place for vehicles operating on manoeuvring area SR25 Finavia shall ensure that vehicle drivers are properly trained in the procedures for operating on manoeuvring area *SR26 Finavia shall investigate the possibilities for implementing additional stopping means*

Failure Modes	Proposed Safety Requirements
	Avoidance of penetration of airspace: SR27 Finavia shall advise balloon operators that balloons are prohibited when Independent Parallel Approaches are applied SR28 Finavia shall advise Malmi Aerodrome that flying above a defined altitude is prohibited when Independent Parallel Approaches are applied Medical helicopter: SR29 Finavia shall develop a procedure for handling the medical helicopter while Independent Parallel Approaches are in use SR30 Finavia shall train ATCOs in such procedure ***EMM-SR01-05 all applicable in relation to this failure mode. Cf. descriptions above.***

Table 5-1: Proposed safety requirements

5.3.2 Procedure Assurance Level (PAL)

Appendix M presents the detailed PAL allocation where each identified hazard has been allocated a PAL. This allocation is building on the results of the FHA sessions as regards severity and likelihood for the identified hazard effects.

The outcome of the allocation exercise is that the most stringent PAL that has been allocated is:

PAL3

Consequently, the following PAL objectives need to be fulfilled during the continuous procedure development:

Procedure Assurance Level	Objectives to be fulfilled during the Procedure Life Cycle Phases:				
	i Definition	ii Design and Validation	iii Implementation	iv Transfer in operations	v Operation
PAL3	*i1.* Ensure involvement of relevant operational expertise *i2.* Ensure a minimum set of quality assurance activities *i3.* Establish a proven and well-documented starting point for the definition exercises	*ii1.* Establish an acceptable risk level (in qualitative terms) *ii2.* Ensure that HMI has been assessed *ii3.* Ensure suitably validation <u>at different levels</u> *ii4.* <u>Ensure robustness</u>	*iii1.* Establish an Implementation Plan which includes quality assurance activities *iii2.* Ensure an acceptable quality assurance level *iii3.* <u>Ensure stakeholder acceptance</u> *iii4.* <u>Ensure training levels</u>	*iv1.* Ensure that feedback concerning the transfer process is provided to involved staff *iv2.* Ensure dissemination of contingency measures *iv3.* Ensure documented contingency measures *iv4.* <u>Ensure enhanced competence levels of staff to perform the transfer</u>	*v1* Ensure documentation control *v1* Establish a reporting system covering occurrences relating to the procedure *v1* Ensure high-ranking proficiency levels *v1* <u>Ensure validity of assumptions</u> *v1* <u>Ensure promulgation of related incident investigations</u>

Table 5-2: PAL3 objectives

In order to supplement the PAL3 objectives, a corresponding set of possible activities which may support the achievement of the objectives is developed. The entire set of activities for all PALs can be found in the Guidelines for the Safety Assessment of ATM Procedures (SAAP) [ref. 2]. The activities to be performed in relation to a PAL3 are shown in Appendix C.

Safety Activities / procedure assurance activities already performed by Finavia:

Finavia is in the middle of the Design and Validation phase of the independent parallel approach procedure. The following objectives have been fulfilled so far:

Procedure Assurance Level	**Objectives already fulfilled by Finavia:**									
	i **Definition**		**ii** **Design and Validation**		**iii** **Implementation**		**iv** **Transfer in operations**		**v** **Operation**	
PAL3	*i1.* Ensure involvement of relevant operational expertise	✓	*ii1.* Establish an acceptable risk level (in qualitative terms)	✓*	*iii1.* Establish an Implementation Plan which includes quality assurance activities	✓	*iv1.* Ensure that feedback concerning the transfer process is provided to involved staff		*v1* Ensure documentation control	
	i2. Ensure a minimum set of quality assurance activities	✓*	*ii2.* Ensure that HMI has been assessed		*iii2.* Ensure an acceptable quality assurance level		*iv2.* Ensure dissemination of contingency measures		*v2* Establish a reporting system covering occurrences relating to the procedure	
	i3. Establish a proven and well-documented starting point for the definition exercises	✓	*ii3.* Ensure suitably validation at different levels	✓	*iii3.* Ensure stakeholder acceptance	✓	*iv3.* Ensure documented contingency measures		*v3* Ensure high-ranking proficiency levels	
			ii4. Ensure robustness		*iii4.* Ensure training levels	✓	*iv4.* Ensure enhanced competence levels of staff to perform the transfer		*v4* Ensure validity of assumptions	
									v5 Ensure promulgation of related incident investigations	

Table 5-3: PAL3 objectives already fulfilled by Finavia

In relation to the performed procedure assurance activities, the following shall be noted:

- As regards ii1, Finavia are awaiting the results of the present Safety Assessment.
- Finavia are awaiting results of the Parallel Approaches Obstacle Assessment Surface (PAOAS) study which will provide the limitations for the breakout procedure (iv2 and iv3). This study is included in the Safety Case for the new Helsinki – Vantaa tower [ref. 11].
- Future safety activities concentrate on details of using technical warning systems. This includes a warning system in relation to NTZ infringement. Two alternative solutions are being investigated in this matter:

  1 The Danger Area Infringement Warning – used to designate areas which are dangerous for an aircraft to enter (e.g. missile firing area, gunnery, military manoeuvres, air exercises or shows,...).

  These areas are restricted areas: TRA (Temporary Restrictive Area), Permanent Restricted Area, Military Exercise Area etc. The Danger Area Infringement Warning (DAIW) capability shall ensure that any aircraft infringing or predicted to infringe one of the pre-defined danger areas (Finavia's plan is to use it as NTZ warning system) is detected. DAIW provides an alert when an aircraft is getting too close to danger areas.

  2 MSAW processing for approach path monitoring. This function performs a vertical check and a lateral check when the projected distance of the track to the runway extremity point is lower than the planned distance:

  - vertical check : the aircraft must not be below an axis defined by the runway extremity point, the glide path angle. If the track position is below the axis, a warning is generated.
  - lateral check : the aircraft must not be outside a pattern defined by a strip, whose length is limited from the runway extremity point by a radial distance, centred on the runway axis, and opened on both sides of the strip with a lateral angle. If the track is outside this pattern, a warning is generated.

  The Approach Path Monitor (APM) is designed to monitor that the aircraft remains in Final Approach Zone which is offline determined. If the aircraft exits in the area, the system provides a warning. The Final Approach Zone can be determined as square so the "empty" area between the Final Approach Zones is the same as NTZ (+ buffer if needed).

A future step for Finavia is, therefore, to ensure that all PAL3 objectives are or will be fulfilled. This forms part of the System Safety Assessment (SSA) step.

5.3.3 Comments on the Results

The proposed SRs focus on the correct execution of the procedure as well as the missed approach procedure as an incorrect execution may have very severe consequences due to the separation being below current ATC standards.

Further, many causes can be grouped under the heading **'human errors'** implying a relatively large contribution to hazards and that focus on training and awareness is essential. Consequently, the SRs relating to training of users appear in connection with either two or all three hazards.

Additionally, a number of uncertainties are related to the activation, operation and termination / suspension of the Independent Parallel Approach Procedure. Consequently, it shall be emphasized that the procedure (criteria for operating and procedure for activation/termination) shall be clearly displayed to the supervisor/controller avoiding educated guesses.

The list of SRs presented in this report is *proposed* – i.e. the verification of whether too many or too few requirements have been identified remains. However, where applicable, the listed safety requirements shall be implemented once validated and confirmed at the end of the implementation process (before entering into operation). The proposed safety requirements constitute a set of actions that need to be performed to eliminate, reduce or control the hazard effects. But whether the safety requirements, in general, are sufficient and appropriate and lead to a fulfilment of the Safety Objectives are verified through the next step of the Safety Assessment process; the System Safety Assessment (SSA).

The role of the PSSA only consists in deciding whether implementation can start because the list of SRs has been assessed as being able to satisfy the defined Safety Objectives and able to achieve an acceptable risk.

Following the further verification of the SRs, a Risk Mitigation Plan shall be developed stating the exact requirements to be implemented as well as the responsibilities and schedule for implementation.

6 SUMMARISED RESULTS AND CONCLUSION

6.1 Introduction

The Safety Assessment (FHA and PSSA) of the procedure for independent parallel approaches to parallel instrument runways has been performed based on the description of the procedure contained in [ref. 4]: Independent approaches to parallel instrument runways (Finavia) and considered that simultaneous independent parallel approaches shall be performed to the runways 04L/R or 22L/R in Helsinki – Vantaa Airport.

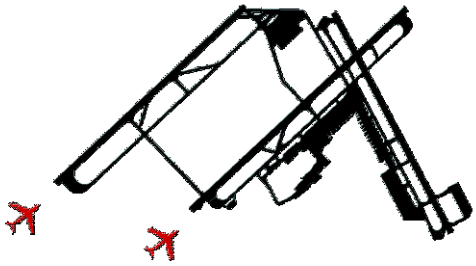


Figure 6-1: scenario

The safety assessment as described in this document covers only Functional Hazard Assessment (FHA) and Preliminary System Safety Assessment (PSSA) and included the following two sessions:

1. Functional Hazard Assessment (FHA) session held at Helsinki – Vantaa Airport on 13 December 2005.
2. Preliminary System Safety Assessment (PSSA) session held at Helsinki – Vantaa Airport on 14 December 2005.

The procedure is developed in compliance with the ICAO Manual of Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (SOIR) [ref. 3].

6.2 FHA

The FHA resulted in an identification of the following three hazards:

1. **Wrong application of independent parallel approach procedure**
   - the procedure is executed incorrectly

   Severity classes ranging from 1 to 3 for the identified hazard effects with the worst credible effect having a severity 3.

2. **Wrong application of missed approach procedure**
   - the missed approach procedure is executed incorrectly

   Severity classes ranging from 1 to 4 for the identified hazard effects with the worst credible effect having a severity 3.

3. **Wrong conditions**
   - the criteria for operating the procedure are not satisfied

   Severity classes ranging from 1 to 3 for the identified hazard effects with the worst credible effect having a severity 3.

Based on the identified hazards, hazard effects and associated severities, three safety objectives have been derived as follows:

Safety Objective Reference #	Safety Objective	EMM	Hazard Reference #
SO1	The frequency of the wrong application of independent parallel approach procedure in Helsinki - Vantaa Airport shall not be greater than occasional (twice per year).	EMM1 EMM2 EMM3 EMM4 EMM5	H1
SO2	The frequency of the wrong application of missed approach procedure in Helsinki - Vantaa Airport shall not be greater than occasional (twice per year).	EMM1 EMM2 EMM3 EMM4 EMM5	H2
SO3	The frequency of the wrong conditions to apply the independent parallel approach in Helsinki - Vantaa Airport shall not be greater than occasional (twice per year).	EMM1 EMM2 EMM3 EMM4 EMM5	H3

The safety objectives need to be agreed, applied and subsequently verified through a System Safety Assessment (SSA), before the procedure can finally be considered to be acceptably safe for introduction and to ensure that the identified hazards stay within acceptable levels.

6.3 PSSA

The PSSA resulted in an identification of 30 *proposed* safety requirements (SRs). Of these 30 SRs,. 6 are candidate requirements where further investigation shall take place to establish whether it is beneficial to implement the requirement. The remaining 24 SRs are firm requirements which shall be implemented.

The SRs include actions such as:

- dedicated training of users to increase knowledge and experience in applying the procedure
- improved HMI to reduce mistakes
- more stringent controls and new criteria for operating the procedure
- prevention of users constituting safety threats (e.g. balloons, VFR)
- development of contingency procedures.

The detailed SRs are presented in Section 5.3.1. Initial confirmation of the completeness of the SRs are analysed through elaboration of fault trees (Appendix J), event trees (Appendix K) and traceability matrices (Appendix L). Each SR can, therefore, be traced back to one or more hazards and one or more causes.

Supplementing the SR development, the Procedure Assurance Level (PAL) has been determined resulting in a **PAL3**. Consequently, Finavia needs to focus on fulfilling the PAL3 objectives during the further procedure development process to support that the risk of the procedure – when being implemented and operated – is at an acceptable level.

6.4 Conclusion

The FHA has identified 3 hazards having effects of severity classes 1 – 4; with a worst credible case being severity class 3. Based on the identified hazards and hazard effects, a number of safety objectives have been derived.

The PSSA has proposed a set of safety requirements to be implemented to ensure that the hazard effects are controlled, reduced or eliminated. Furthermore, the PSSA has allocated a PAL3 to the procedure giving the development effort to be applied during the further procedure development process supporting that the risk of the procedure stays at acceptable safety levels and safety requirements are satisfied.

The results achieved at the first steps (FHA and PSSA) of the safety assessment indicate relatively clearly that the procedure safely can be further developed and implemented pending Finavia development of certain criteria (e.g. contingency procedures and procedures for activation/termination etc).

A decision will have to be made at the end of the implementation phase (SSA implementation report) whether transfer into operation (the conditions of this phase will have to be defined: not done as of today) and/or operations can be performed.

It is, however, essential to establish proper safety monitoring means of the procedure to ensure that it – during its life cycle – continuously stays at an acceptable safety level.

APPENDICES

Appendix A: Scenarios

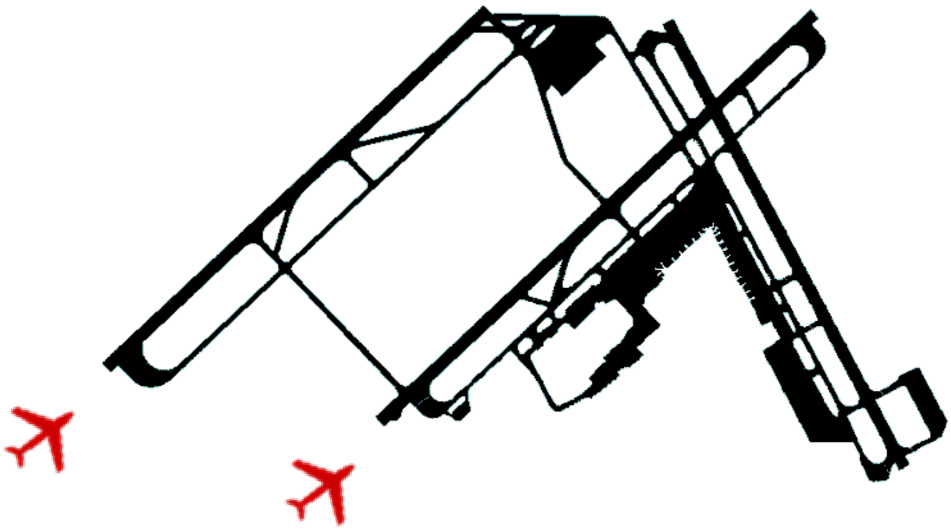


Figure A-1: Independent parallel approaches on runways 04L/R

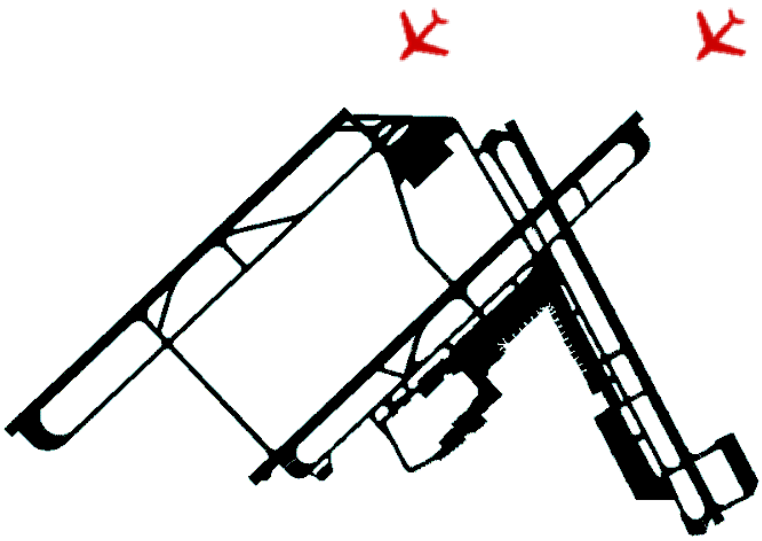


Figure A-2: Independent parallel approaches on runways 22L/R

Appendix B: Task Decomposition

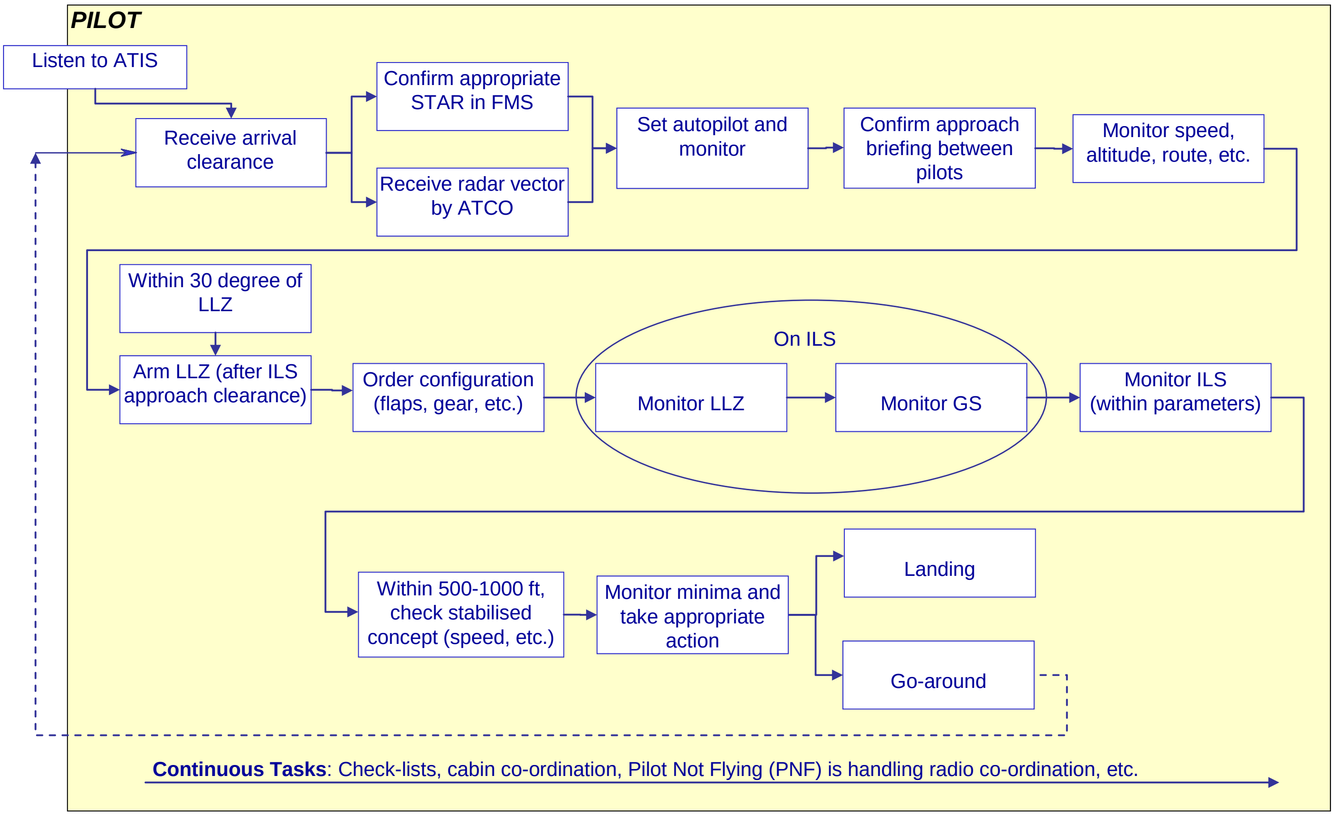


Figure B-1: Pilot tasks

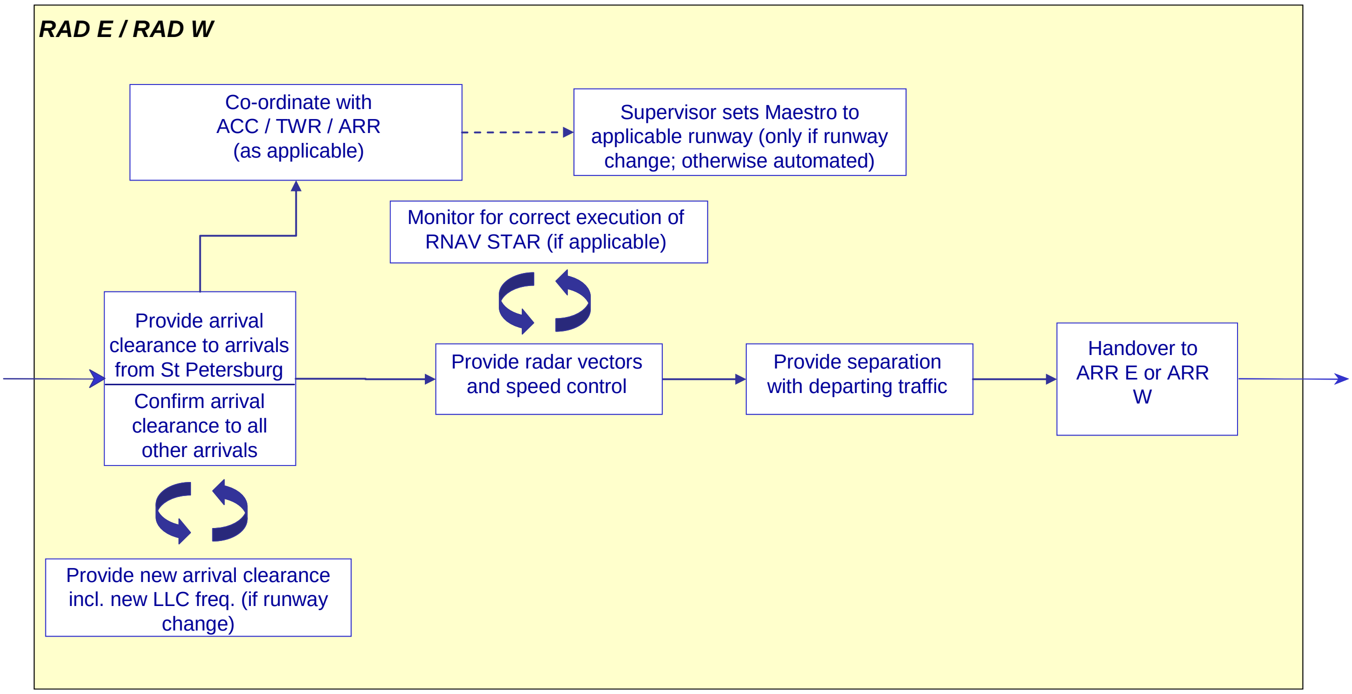


Figure B-2: Radar East / West tasks

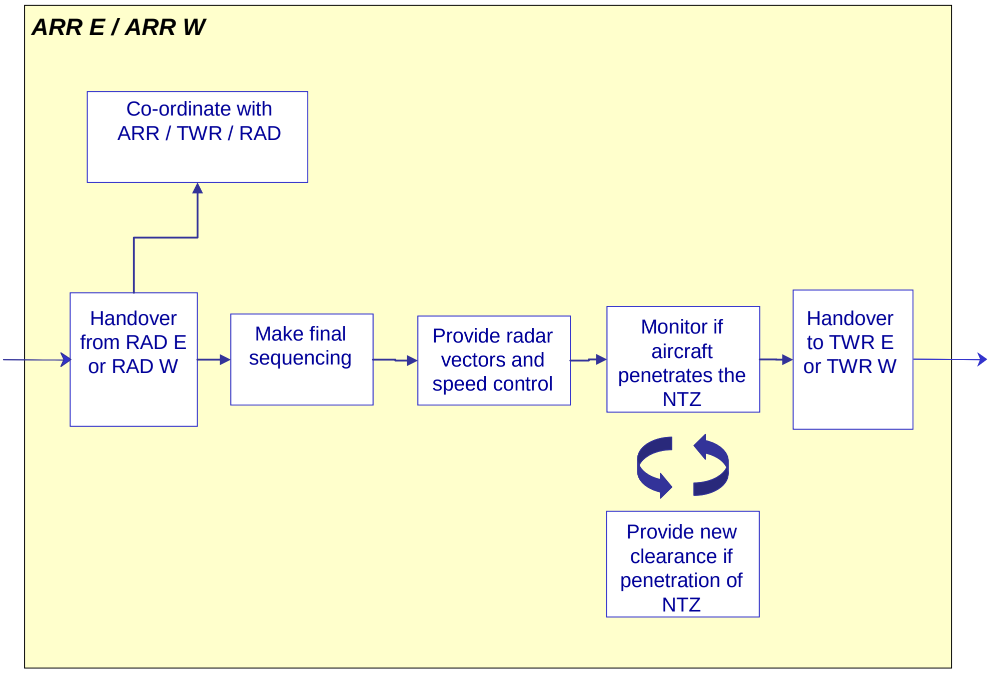


Figure B-3: Arrival East / West tasks

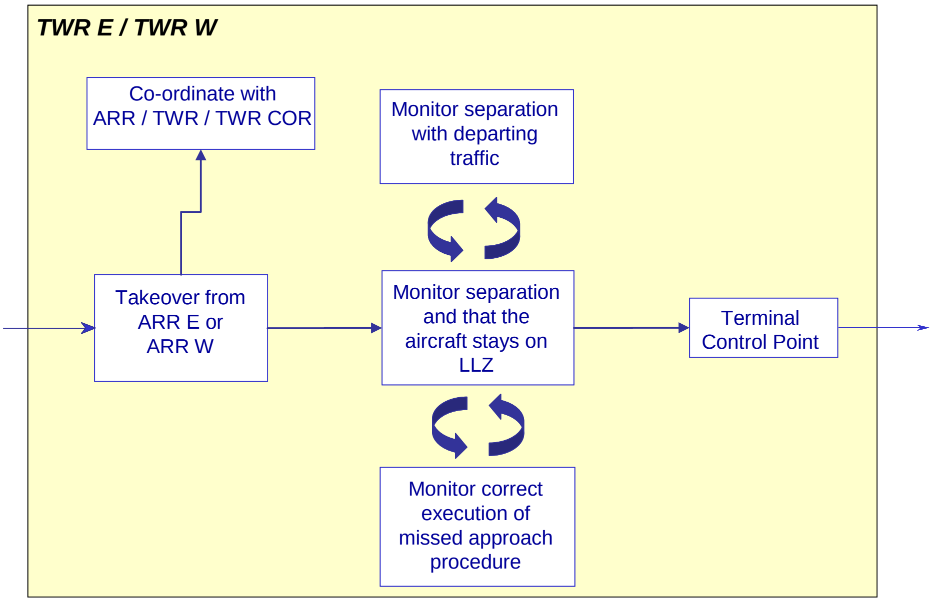


Figure B-4: Tower East / West tasks

Appendix C: Methodology Description

C1 THE SAFETY ASSESSMENT METHODOLOGY

C1.1 Objective

In accordance with the EUROCONTROL Safety Regulatory Requirement 3 – Safety Management in ATM (ESARR 3) [ref. 5] and provisions in ICAO Annex 11, paragraph 2.26.5 [ref. 7], all new and modified systems[2] shall be safety assessed to demonstrate that an acceptable level of safety will be met.

Consequently, the overall objective of the safety assessment of the independent parallel approach procedure is to demonstrate that the proposed implementation achieves an acceptable level of safety.

C1.2 Safety Assessment Methodology (SAM)

The EUROCONTROL methodology for performing safety assessments is structured around the overall Safety Assessment Methodology (SAM) [ref. 1]. The SAM promotes the safety assessment process in three phases:

- Functional Hazard Assessment (FHA)
- Preliminary System Safety Assessment (PSSA)
- System Safety Assessment (SSA).

The objective of the first phase, the *Functional Hazard Assessment,* is to determine how safe "the system" shall be by specifying the overall level of risk that this procedure can acceptably generate. In this context, overall safety objectives specify the maximum acceptable frequency of occurrence of a hazard.

The objective of the second phase, the *Preliminary System Safety Assessment*, is to demonstrate whether the assessed system architecture can reasonably be expected to achieve the safety objectives and level of risk specified in the FHA. The PSSA apportions safety objectives into safety requirements allocated to the system elements, i.e. specifies the risk level to be achieved by the system elements. Risk is the combination of the rate of occurrence of an effect (caused by a hazard) and the severity of this effect.

The objective of the third phase, the *System Safety Assessment*, is to demonstrate that the system as implemented actually achieves an acceptable level of risk, satisfies the safety objectives specified in the FHA and that the system elements meet their safety requirements as specified in the PSSA. The SSA process is initiated at the beginning of the implementation of the new or modified system. It collects evidence and provides assurance from implementation till decommissioning that the system and its elements achieve an acceptable level of risk, satisfy safety objectives and meet the safety requirements.

The safety assessment process should be initiated as early in the development phase as possible allowing an integration of safety aspects in parallel with the design maturation

C1.2.1 Safety Assessment ATM Procedure (SAAP)

When assessing ATM Procedures, EUROCONTROL has developed further guidelines to the SAM: the "Guidelines for the Safety Assessment of ATM procedures (SAAP)" [ref. 2]. These guidelines

2 The safety assessment methodology considers the three types of system elements: people, equipment and procedures as well as the environment of operation.

provide guidance to assess the *procedure* element of a system (recall that a system is a composition of people, equipment and procedures).

The SAM including the SAAP guidelines creates the methodical foundation for the safety assessment of the independent parallel approach procedure.

The SAAP considers primarily the PSSA step of the safety assessment process, namely the development of risk mitigation means / safety requirements. The approach to develop the safety requirements is twofold and includes both the development of specific safety requirements to mitigate the causes to the identified hazards (through the FHA) and the allocation of a Procedure Assurance Level (PAL) that aim at specifying the level of effort when demonstrating (providing assurance) that SRs are met.

SAAP Process

The SAAP procedure promotes a generic safety assessment process in six steps as illustrated in Figure C-1:

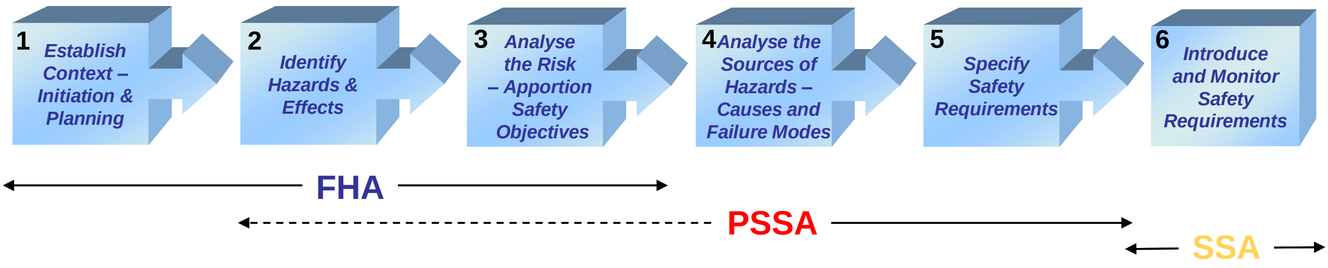


Figure C-1: Safety assessment process

These six steps complement the Functional Hazard Assessment, the Preliminary System Safety Assessment and the System Safety Assessment as advocated in the SAM.

Procedure Life Cycle

The SAAP introduces a Procedure Life Cycle that includes five phases. These five phases and the relationship between the SAM and SAAP are illustrated in Figure C-2 below:

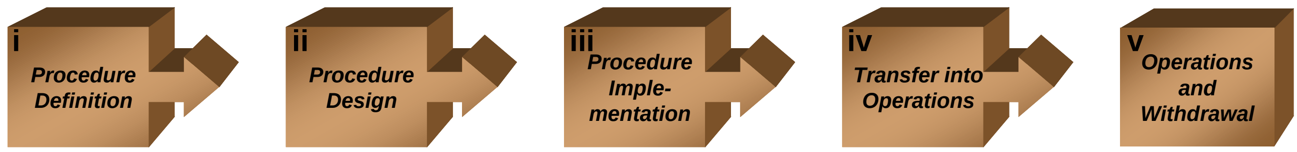


Figure C-2: Procedure life cycle

Procedure Assurance Levels

The objective of the PALs is to ensure that the procedure development effort becomes proportional to the potential risk associated with the procedure. Hence, PAL is setting some objectives to be met during the different phases of the procedure life cycle as illustrated in the Table C-1 below.

Procedure Assurance Level	Objectives to be fulfilled during the Procedure Life Cycle Phases:				
	i **Definition**	**ii** **Design and Validation**	**iii** **Implementation**	**iv** **Transfer into operations**	**v** **Operation**
PAL 1	*i1.* Ensure involvement of relevant operational expertise *i2.* Ensure a minimum set of quality assurance activities *i3.* Establish a proven and well-documented starting point for the definition exercises *i4.* Ensure stakeholder acceptance *i5.* Ensure an approved and systematic specification	*ii1.* Establish an acceptable risk level (in quantitative terms) *ii2.* Ensure that HMI has been assessed *ii3.* Ensure suitable validation at different levels *ii4.* Ensure robustness *ii5.* Ensure external expert acceptance *ii6.* Ensure enhanced competence levels of designers *ii7.* Ensure stakeholder acceptance *ii8.* Ensure independency in design and validation	*iii1.* Establish an Implementation Plan which includes quality assurance activities *iii2.* Ensure a minimum set of acceptable quality assurance activities *iii3.* Ensure stakeholder acceptance *iii4.* Ensure training levels *iii5.* Ensure approval at the Corporate level of management *iii6.* Establish evidence of acceptable design maturity *iii7.* Ensure independent auditing of the procedure *iii8.* Ensure corporate level of approval by stakeholders	*iv1.* Ensure that feedback concerning the transfer process is provided to involved staff *iv2.* Ensure dissemination of contingency measures *iv3.* Ensure documented contingency measures *iv4.* Ensure enhanced competence levels of staff to perform the transfer *iv5.* Ensure incremental transfer *iv6.* Ensure approval of the Transfer Plan at management level *iv7.* Ensure stakeholder acceptance of the Transfer Plan *iv8.* Ensure application of an approved and systematic method to verify the transfer process	*v1.* Ensure documentation control *v2.* Establish a reporting system covering occurrences relating to the procedure *v3.* Ensure minimum proficiency levels *v4.* Ensure validity of assumptions *v5.* Ensure promulgation of related incident investigations *v6.* Ensure acceptable performance levels *v7.* Ensure minimum competency levels of staff to operate the procedure *v8.* Ensure that the application of the procedure is reduced to its minimum
PAL 2	*i1.* Ensure involvement of relevant operational expertise *i2.* Ensure a minimum set of quality assurance activities *i3.* Establish a proven and well-documented starting point for the definition exercises *i4.* Ensure stakeholder acceptance	*ii1.* Establish an acceptable risk level (in qualitative terms) *ii2.* Ensure that HMI has been assessed *ii3.* Ensure suitable validation at different levels *ii4.* Ensure robustness *ii5.* Ensure external expert acceptance *ii6.* Ensure enhanced competence levels of designers *ii7.* Ensure stakeholder acceptance	*iii1.* Establish an Implementation Plan which includes quality assurance activities *iii2.* Ensure an acceptable quality assurance level *iii3.* Ensure stakeholder acceptance *iii4.* Ensure training levels *iii5.* Ensure approval at the Corporate level of management *iii6.* Establish evidence of acceptable design maturity	*iv1.* Ensure that feedback concerning the transfer process is provided to involved staff *iv2.* Ensure dissemination of contingency measures *iv3.* Ensure documented contingency measures *iv4.* Ensure enhanced competence levels of staff to perform the transfer *iv5.* Ensure incremental transfer *iv6.* Ensure approval of the Transfer Plan at management level *iv7.* Ensure stakeholder acceptance of the Transfer Plan	*v1.* Ensure documentation control *v2.* Establish a reporting system covering occurrences relating to the procedure *v3.* Ensure minimum proficiency levels *v4.* Ensure validity of assumptions *v5.* Ensure promulgation of related incident investigations *v6.* Ensure acceptable performance levels *v7.* Ensure minimum competency levels of staff to operate the procedure
PAL3	*i1.* Ensure involvement of relevant operational expertise *i2.* Ensure a minimum set of quality assurance activities *i3.* Establish a proven and well-documented starting point for the definition exercises	*ii1.* Establish an acceptable risk level (in qualitative terms) *ii2.* Ensure that HMI has been assessed *ii3.* Ensure suitable validation at different levels *ii4.* Ensure robustness	*iii1.* Establish an Implementation Plan which includes quality assurance activities *iii2.* Ensure an acceptable quality assurance level *iii3.* Ensure stakeholder acceptance *iii4.* Ensure training levels	*iv1.* Ensure that feedback concerning the transfer process is provided to involved staff *iv2.* Ensure dissemination of contingency measures *iv3.* Ensure documented contingency measures *iv4.* Ensure enhanced competence levels of staff to perform the transfer	*v1.* Ensure documentation control *v2.* Establish a reporting system covering occurrences relating to the procedure *v3.* Ensure minimum proficiency levels *v4.* Ensure validity of assumptions *v5.* Ensure promulgation of related incident investigations

PAL 4	*i1.* Ensure involvement of relevant operational expertise *i2.* Ensure a minimum set of quality assurance activities *i3.* Establish a proven and well-documented starting point for the definition exercises	*ii1.* Establish an acceptable risk level (in qualitative terms) *ii2.* Ensure that HMI has been assessed *ii3.* Ensure suitably validation	*iii1.* Establish an Implementation Plan which includes quality assurance activities *iii2.* Ensure an acceptable quality assurance level	*iv1.* Ensure that feedback concerning the transfer process is provided to involved staff *iv2.* Ensure dissemination of contingency measures *iv3.* Ensure documented contingency measures	*v1.* Ensure documentation control *v2.* Establish a reporting system covering occurrences relating to the procedure *v3.* Ensure minimum proficiency levels

Table C-1: PAL objectives

In the SAAP a full set of possible activities corresponding to the objectives in the different phases of the PALs is included. As indicated in Section 5.3.2, the allocated PAL for the independent parallel approach procedure at Helsinki – Vantaa is **PAL3**.

The corresponding activities that can be performed to fulfil the objectives for PAL3 are included in Table C-2 – Table C-6 below.

i. Definition	
Objective	**Activity / activities**
i1	• Involve familiar operational expertise in the definition of the procedure *Air traffic controllers and pilots who are working in the concerned environment and have relevant experience should be involved in the definition of the procedure to ensure practicality and applicability.*
i2	• Apply a minimum set of quality assurance activities to validate the procedure definition *The activities may include:* - *has a complete FHA been performed covering both the 'transfer into operations phase' and the 'operations phase'?* - *are the tasks of the procedure clearly identified and described?* - *are weather conditions considered (robustness to abnormal conditions)?* - *are specific traffic compositions (mixture of traffic) considered (overload tolerance)?* - *has a time sequence diagram been elaborated and considered?* *The evidence of the minimum set of quality assurance activities may be provided by references to the relevant documentation.*
i3	• Collect relevant benchmarking results and/or perform own experience benchmarking *Benchmarking with organisations that have successfully implemented a similar procedure in order to identify the gaps and benefits compared to own environment - or benchmarking based upon experience and "best guesses" of experts (if no comparable organisations or procedures exist) - may provide a valuable input to the definition phase.* • Include best practice and lessons learnt *Learn from other's mistakes and successes.*

Table C-2: PAL3 definition activities

ii. Design and Validation	
Objective	**Activity / activities**
ii1	• Perform a quantitative / qualitative risk analysis *The results of the risk analysis shall provide the level of risk of the procedure and the required activities to ensure an acceptable risk level. Thus, the risk analysis activities include the performance of the PSSA, e.g. by applying the present SAAP.*
ii2	• Perform assessment of the HMI *All HMI, which is linked (e.g. specifically designed or modified) to the procedure, should be validated.*
ii3	*Depending on the PAL and the feasibility of the validation (it is not possible to implement all types of procedures for trial in a real life environment)* • Perform pre-implementation trials covering e.g. shadow operations (PAL 1, 2, 3, 4) • Perform fast time simulations (PAL 1, 2, 3, 4) • Perform real time simulations (PAL 1, 2, 3) • Request aircraft operators to validate the procedure through own simulations (PAL 1, 2)
ii4	• Apply fail-safe measures *Proper fail-safe measures will automatically and safely compensate for failures.* • Apply error-tolerance measures *The procedure design should minimise the consequences of some unintended errors (e.g. human errors).* • Validate the procedure when under stress or when confronted with an invalid application *- to warrant a certain resilience.*

Table C-3: PAL3 design and validation activities

iii. Implementation	
Objective	**Activity / activities**
iii1	• Develop an Implementation Plan *The Implementation Plan shall specify in a clear and transparent manner how the implementation is planned to be performed including the related quality assurance activities. The minimum content should include:* - *scope and goals* - *description of tasks of the implementation* - *quality assurance activities* - *resource requirements* - *time schedule* - *milestones.*
iii2	• Apply a minimum set of quality assurance activities / assessments to validate the procedure implementation *The activities may include:* - *has a pre-SSA been performed covering both the 'transfer into operations phase' and the 'operations phase'?* - *are responsibilities during the implementation process allocated?* - *are the implementation process as described in the Implementation Plan considered to be correct and complete?* - *are critical paths of the implementation process considered?* *The evidence of the minimum set of quality assurance activities may be provided by references to the relevant documentation.*
Iii3	• Perform relevant stakeholder consultations *The consultations should reach all stakeholders to support that as many risks as possible related to the implementation are anticipated (different stakeholders may have different risks).* • Implement awareness programmes *- to ensure that all staff acknowledge the procedure and its implementation.*
Iii4	• Develop a training plan setting the required training levels *- to warrant that acceptable levels are achieved.* • Perform dedicated training of staff *Develop training programme(s) for the future users of the procedure which is devoted to ensure correct application of the procedure.* • Implement awareness programmes *The awareness programmes should reach not only the staff who will be directly affected by the procedure, but as well staff who indirectly are affected, in order to create a common understanding of the safety implications related to the procedure.*

Table C-4: PAL3 implementation activities

iv. Transfer in Operations	
Objective	**Activity / activities**

iv. Transfer in Operations	
Objective	**Activity / activities**
iv1	• Implement feedback means *All concerned staff should be able to receive feedback on the transfer process and possible deviations from the Transfer Plan.*
iv2	• Disseminate the contingency plan *Ensure that all relevant controllers and pilots know what contingency measures to be taken and when.*
iv3	• Develop a contingency plan *- to ensure that all abnormal situations are considered.*
iv4	• Establish competency argumentation for the staff to perform the transfer *It should be verified that the staff performing the transition has the necessary level of experience and skills in order to ensure a correct transfer into operations of the procedure.*

Table C-5: PAL3 transfer in operation activities

v. Operation	
Objective	**Activity / activities**
v1	• Strict document control should be applied *- to ensure that correct version is always applied in operations.*
v2	• A specific reporting system should be developed for reporting of occurrences related to the procedure *- in order to implement corrective actions if required and disseminate lessons learnt.*
v3	• Implement a minimum set of activities to support excessive proficiency levels *The activities may include:* - *performing regular proficiency checks* - *implementing dedicated training as well as recurrence training* - *performing awareness campaigns.*
v4	• Perform dedicated assumptions monitoring *Periodical review of the assumptions should be performed to ensure that the assumptions are still valid.*
v5	• Implement feedback means and the associated means to implement corrective actions *Incident reports should be disseminated to relevant controllers and pilots if an incident relating to the procedure occurs, enabling them to pay extra attention.*

Table C-6: PAL3 operation activities

Appendix D: Safety Assessment Initiation

D1 SYSTEM DEFINITION

The applied safety assessment process has been described in general in Section 3.1. The safety assessment sessions have been performed addressing both FHA and PSSA aspects. More details as regards the arrangement and process are provided in Appendix E (FHA) and I (PSSA).

However, prior to the sessions, the following elements needed to be developed:

1. System Description
2. Operational Environment Description
3. Scenario Definition
4. Severity Classification.

Thus, these elements need to be defined to ensure a homogeneous starting point for the assessment and an agreed framework. Details of the four elements are presented below.

D1.1 System Description

Helsinki - Vantaa is a co-ordinated airport where runway space is allocated to airlines in accordance with EU regulations. The slots, i.e. the take-offs and landings scheduled for a given period, are allocated by a special co-ordinator at Helsinki - Vantaa airport who works independently from the airlines and the airport. The runways in use are assigned according to the principles of EFHK operational handbook (HLOK) [ref. 10].

When the independent parallel approach procedure is coming in operation arriving traffic from IAF LAKUT is positioned to runway 04L/22R and arriving traffic from IAF PEXEN, PVO, ORM and INTOR is positioned to runway 04R / 22L.

In the case of the traffic forecast from the CFMU not being divided equally to both runways, the EFHK APP shift supervisor allows the use of the other runway for specific IAFs to balance traffic flow. When using parallel runways 22L/R, arriving traffic from IAF ORM may also use runway 22R for landing and in case of parallel 04L/R, arriving traffic from IAF PEXEN may also use runway 04L for landing. These changes require the co-ordination between EFHK APP shift supervisor and EFES ACC supervisor. They will decide and implement the relative database changes to the Maestro.

Communication with adjacent units is made through direct communication lines and information through OLDI, except from St Petersburg ACC. No direct communication line with St Petersburg ACC exists; meaning that traffic is handed over by telephone. Approximately 10 flights per day are arriving from St Petersburg of which 1-2 are older aircraft with limited onboard equipment. Tampere ACC provides arrival clearance to all aircraft before handing over to APP. Thus, the RAD controller only confirms the clearance. Exception is flights from St Petersburg where the RAD controller provides the clearances.

The AIP Finland and the procedure description in Appendix R provide further detail.

D1.2 Operational Environment Description (OED)

At Helsinki - Vantaa airport the following radar equipment is available:

- Surface Movement Radar
- Primary Surveillance Radar (SSR)
- Monopulse Secondary Surveillance Radar.

The parallel runway centre lines are spaced by 1350 metres and the accuracy and performance of the SSR equipment meets the minimum requirements in ICAO Doc 9643 [ref. 3].

The independent parallel approach procedure will only be operational with ILS approaches, meaning that non-precision approaches will not be allowed. All EFHK ILS equipment has co-located DMEs.

Runways 04L and 22L are determined to be the low side. The intermediate altitude of 04R and 22R's ILS is 1000 ft higher and is determined to be the high side.

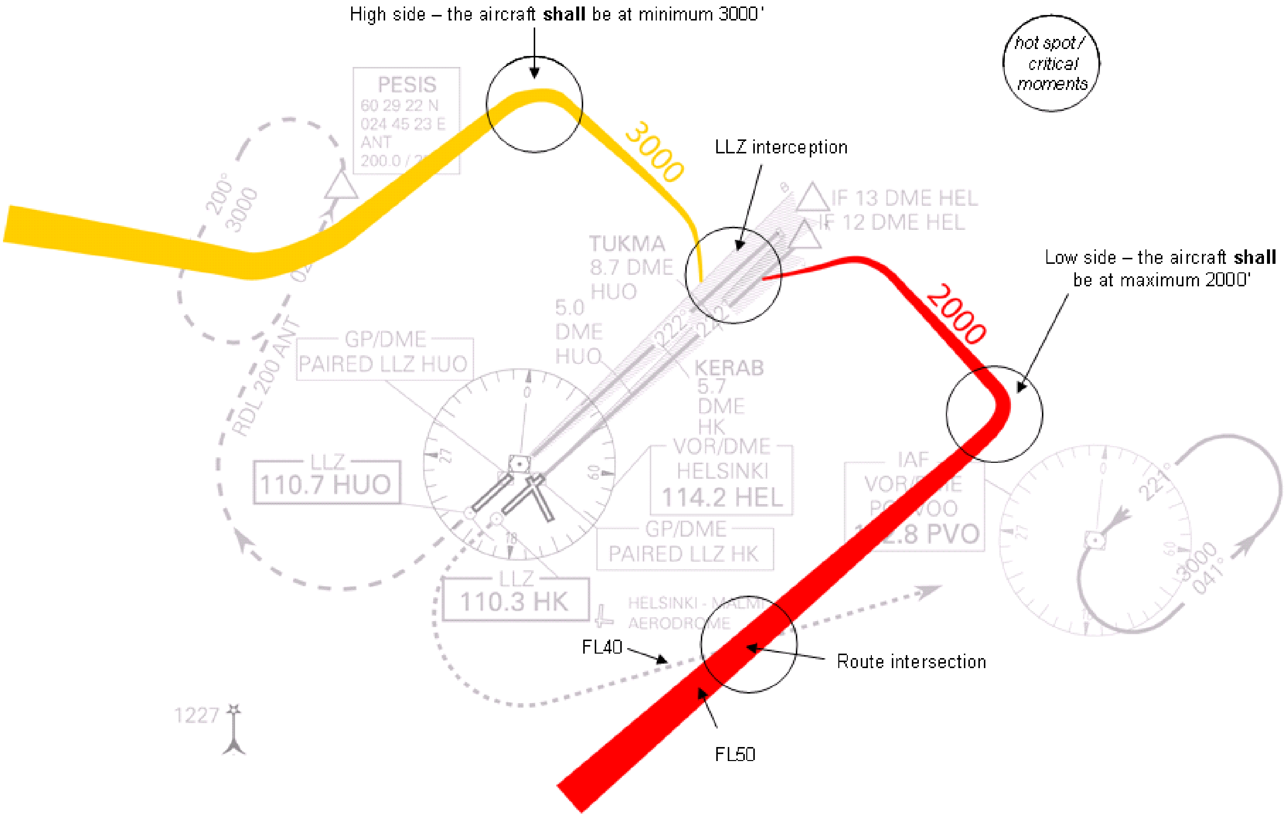


Figure D-1: High side and low side for runways 22L and 22R – as well as hotspots

Conditions

It will be possible to execute the independent parallel approach procedure on runways 04L/04R or 22L/22R at Helsinki – Vantaa airport when the following conditions are met:

- Aircraft are advised that independent parallel approaches are in force. This information is normally provided through an ATIS broadcast.
- Radar vectoring is used to intercept the ILS localizer (LLZ) and ILS approaches are being conducted on both runways, 04L/R or 22L/R.
- Separate radar controllers are responsible for the sequencing and spacing of arriving aircraft to each runway.
- Separate radar controllers monitor the approaches to each runway and ensure that, when the 1000 ft vertical separation is reduced, aircraft do not penetrate the depicted No Transgression Zone (NTZ) and the applicable minimum longitudinal separation between aircraft on the same ILS LLZ course

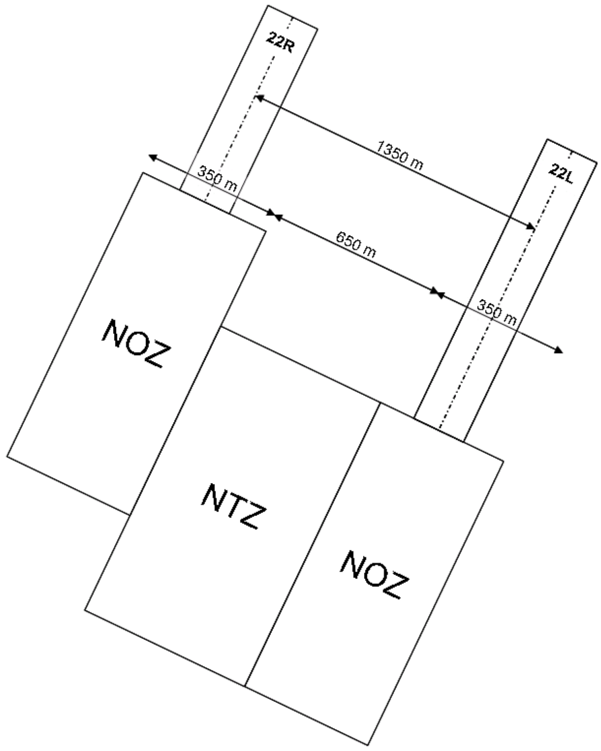


Figure D-2: Normal Operating Zone and No Transgression Zone runways 22R/L

- When an aircraft is being vectored to intercept the ILS LLZ course, the final vector shall enable the aircraft to intercept the ILS LLZ course at an angle not greater than 30 degrees and to provide at least 1.0 NM straight and level flight prior to ILS LLZ course. The vectors shall also enable the aircraft to be established on the ILS LLZ course in level flight for at least 2.0 NM prior to intercepting the ILS glide path (GP).
- A minimum of 1000 ft vertical separation or a minimum of 3.0 NM radar separation shall be provided at least until 12 NM from threshold and until aircraft are established inbound on the ILS LLZ and within the Normal Operating Zone (NOZ).
- The working positions TWR E and TWR W shall be manned with EFHK APS / RAD qualified personnel and the TWR COR working position shall be manned. For the departing traffic, the TWR controllers are responsible of getting confirmation from the APP controllers that sufficient spacing between arriving aircraft is present.
- The communication system is operating normally and the priority-call feature has been tested. Cf. also EMM-SR05.
- Low Visibility Procedures (LVP) are not in use.
- Snow sweeping not performed.
- Wind shear, downdrafts, turbulence and/or thunderstorms shall lead to suspension of the procedure.

Breakout

The conditions for making a breakout manoeuvre should be included in the AIP, e.g. if an aircraft is penetrating the No Transgression Zone (NTZ), cf. Figure D-3. During a breakout manoeuvre pilots shall be given instructions on breakout that will not conform to a standard track or level. Pilots shall be instructed to turn immediately, climb or descend to routes and levels that maintain traffic and terrain clearance. The breakout altitude which should be included in the AIP is approximately 550 - 600 ft.

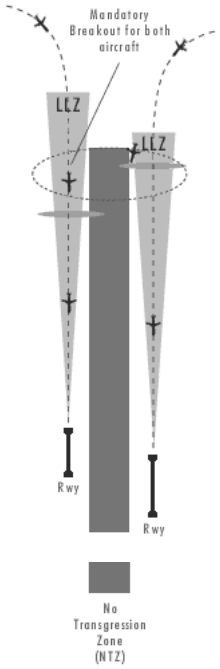


Figure D-3: Breakout manoeuvre

The backup communications frequency (cf. first assumption below) is a key element relating to breakout manoeuvres and simultaneous independent parallel approaches. Either the pilots shall get a dedicated backup frequency or antiblocking devices shall be installed in aircraft to ensure the pilots' ability to hear the controller's instructions if the controller has to call on the pilots to fly a breakout manoeuvre.

Finavia is awaiting results of the PAOAS study (contained in the safety case prepared in relation to the new tower (location 2) [ref. 11]). The PAOAS study will provide the limitations for designing the breakout procedure.

Assumptions

Many aspects of the operational environment are actual assumptions as to what the likely operational environment would be. These assumptions have been discussed with the participants to make sure that they were realistic, i.e. they are not overly pessimistic or optimistic.

The following descriptions and assumptions are made with respect to the envisaged operational environment for the independent parallel approach procedure:

- Aircraft Operators and Air Traffic Controllers of a broad, but realistic professional standard
- Aircraft types: broad variety (performance) of light, medium and heavy aircraft (up to 747)
- Peak hour traffic: 36-38 arrivals per hour
- Runway 15/33 not operational when operating parallel approaches on runways 04R/L and 22R/L
- Arriving traffic from IAF LAKUT is positioned to runway 04L/22R
- Arriving traffic from IAF PEXEN, PVO, ORM and INTOR is positioned to runway 04R/22L

- Non-precision approaches not allowed
- Runway 04L/22L is determined as low side and 04R/22R is determined as high side
- Information that independent parallel approaches are in force is provided through ATIS
- Weather criteria for operating / suspending are defined
- Standard contingency procedures in place.

More descriptions and assumptions can be found in “Independent approaches to parallel instrument runways – EFHK procedures” [ref. 4].

D1.3 Scenario Definition

In advance of the FHA session, 12 different scenarios were developed. The scenarios were – prior to commencing the session – assessed (by the participants) for suitability.

Two examples of the agreed scenarios are presented above in Appendix A.

D1.4 Severity Classification Scheme

The severity classification scheme presented in Appendix F below (adopted from the SAM, ref. 4) provides a framework for assessing how strongly the safe provision of ATS will be affected by the hazard effects. The severity classification is a verdict given by the operational participants at the FHA session using the table in Appendix F.

The scheme allows classifying the hazard effects into 5 categories, category 1-5, with category 1 as the most severe classification with complete loss of safety margins and category 5 as the least severe classification with no safety consequences.

Appendix E: FHA Process

E1 Process

The FHA and PSSA process has together adhered to the following steps:

Figure E-1: FHA/PSSA process

E1.1 Initiation and Planning

The initiation and planning step included three main elements:

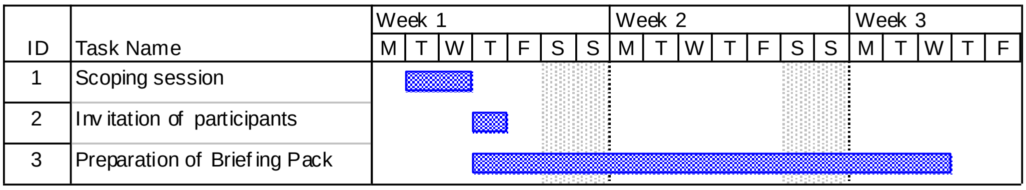


Figure E-2: FHA initiation and planning

1. Scoping Session

The first activity performed by the safety assessment team (the FHA facilitator and/or safety experts) was a scoping session. The purpose of this session was to create a more detailed and common understanding of the scope of the safety assessment and to discuss the potential output - and thus be better prepared to manage the FHA session.

Consequently, the first framing of the safety assessment focussed on details relating to the scope for the system being assessed, the Operational Environment, the scenario(s) to apply and the relevant assumptions. The results of these discussions constituted the basis for the Briefing Pack described below.

Subsequently, the scoping session included an initial performance (dry-run) of a functional assessment to pre-identify potential hazards, causes and External Mitigation Means in order to be thoroughly prepared to the actual session.

Finally, the scoping session created the basis for depicting the appropriate operational / technical profiles to be invited to the FHA session.

2. Invitation of participants

Based upon the understanding created at the scoping session, the selection and invitation of participants was performed. The depiction of the relevant experts was performed by the safety assessment team, whilst the issue of the invitation was performed by Finavia.

Various local experts including flight crew members, air traffic controllers and other experts were invited to the FHA session. The complete list of participants is shown in Appendix P.

A great deal of importance was attached to selecting the operational experts and depicting the optimal profiles, as their operational knowledge and experience was required to fulfil the overall objective. The final result of the FHA session was very dependent on the involvement from the attendees and the selected participants did all have a relation to the area in focus for the FHA session.

3. Briefing Pack

Finally, the initiation and planning steps comprised the preparation of the Briefing Pack to be distributed to the participants prior to the session to allow them to familiarise themselves with some of the most important aspects. The Briefing Pack covered:

- The description of the scope and objectives of the entire safety assessment (both FHA and PSSA objectives)
- The agenda for the sessions (both FHA and PSSA)
- The list of participants
- Short introduction to the safety assessment methodology (both FHA and PSSA aspects)
  Only those issues necessary for the participants to familiarise themselves with the process and understand their role in the sessions.
- Definitions (both FHA and PSSA definitions)
- Operational Environment Description (OED)
  Describing the operational environment in which the procedure will be implemented as well as assumptions, cf. Appendix D.
- Static illustration of Scenarios
  The scenarios were dynamic and running on wide screen during the brainstorming. Cf. Appendix A.
- Description of the functional decomposition
  The procedure was decomposed into three phases: activation, application & termination. This decomposition was used at the dry run described above as well as during the FHA session for completing the hazard identification. More details provided below.
- Severity Classification Scheme, cf. Appendix F
- Safety Objective Classification Scheme, cf. section 4.2
- Copy of the draft procedure for Independent Parallel Approaches
  Developed by Finavia (cf. Appendix R).

E1.2 FHA Session

The overall process of the FHA session is as illustrated in Figure E-3 below:

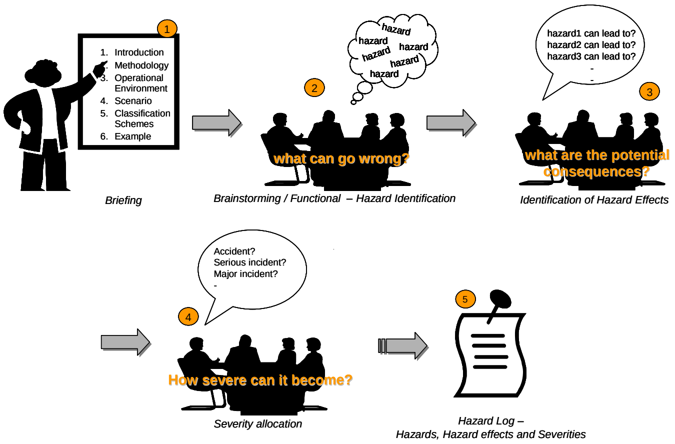


Figure E-3: the FHA session

First the participants were briefed on the procedure, the FHA methodology, the OED and the scenarios (the contents of the briefing pack).

Thereupon, the brainstorming session was commenced. This was followed by the structured functional approach to the findings and an evaluation and agreement of the final hazards.

Following, the hazard effects were identified and each effect assigned a severity. These steps are described below in further detail.

Thus, the FHA session step included the following elements:

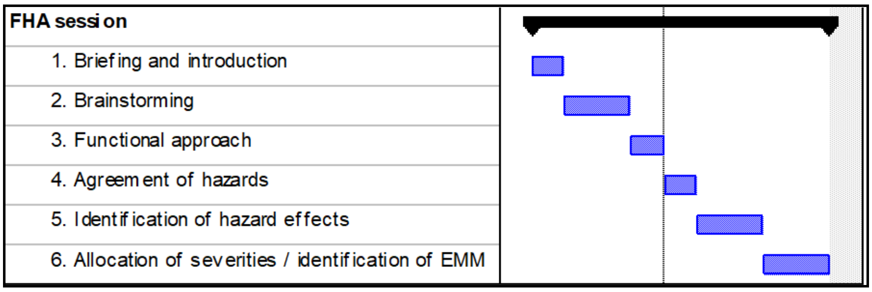


Figure E-4: The FHA session elements

1. Briefing and introduction

As stated above, the participants were briefed on the procedure, the FHA methodology, the OED and the scenarios (the contents of the briefing pack). On purpose this briefing was very short and concise as the only objective is to ensure that the participants have a common understanding of the scope and objective of the session and the expectations to their input – and not to teach in safety assessment techniques.

2. Brainstorming

An important part of the brainstorming is the use of an exploratory technique. This shall provide a free-flowing diversity of thoughts whilst ensuring that all aspects are covered. No input during the brainstorming is rejected, no matter how irrelevant it appears, until it has been thoroughly evaluated when the brainstorming is completed.

A moderator facilitated this session in order to keep the process within the distinct scope, but also in order to support a dynamic and optimal environment for a creative identification of hazards.

3. Functional Approach

The functional approach was applied in order to further identify hazards and ensure completeness of the hazard identification. During the functional approach a set of keywords was used to identify hazards during the different phases of the procedure life cycle, cf. Figure E-5. The keywords used to identify additional hazards were; Omit, Early, Late and Wrong. E.g. what can go wrong if the application of the independent parallel approach procedure begins too early?

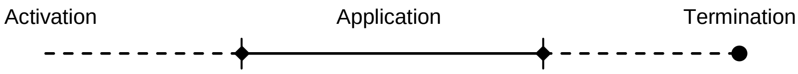


Figure E-5: Procedure phases

A moderator chaired this part of the session as well.

4. Agreement of Hazards

The final identified hazards were visually presented allowing the participants continuously to relate to the findings and for plenary approval.

5. Identification of Hazard Effects

Each hazard was discussed in detail to identify the effect which can occur due to the hazard. When discussing the effects, the focus was placed on how the hazard may affect:

- the air crew and/or the Air Traffic Controllers (e.g., workload, ability to perform his/her functions)
- the aircraft functional capabilities
- the functional capabilities of the ground part of the ATM System
- the ability to provide safe ATM Services; (e.g., magnitude of loss or corruption / interruption of ATM services/functions).

The identified hazard effects were simultaneously presented on projector during the identification process for plenary approval.

6. Severity Allocation and identification of EMM

Once the participants at the FHA sessions were confident that all potential hazards and hazard effects were covered, the identified hazard effects were severity assessed – cf. Appendix F.

In connection with the severity allocation, the External Mitigation Means were identified as well. The logic connection being that the External Mitigation Means naturally come up during the discussion of severity classes as arguments for the severity class being of a certain size. For example, it could be argued that a certain hazard may never have an effect with catastrophic consequences (severity class 1) as specific external means will prevent it to occur.

Based upon the agreed severities, the safety objectives are later derived to form the input to the next step of the safety assessment: the PSSA.

E1.3 Evaluation and Analysis – Reporting and Completion

The further evaluation and analysis is performed after the session. In relation to the FHA session output, it included the development of event trees.

The Event Tree Analysis (ETA) constitutes the visual representation of all the events (hazard effects) which can occur as a result of a hazard. The hazard effects are combined with the external mitigation means illustrating how a single or combined failure of any of these External Mitigation Means can lead to the effect. The Event Trees can be found in Appendix K.

Two types of event trees have been created in relation to the present FHA:

1. The traditional representation of event trees illustrating all possible combinations of failure of the External Mitigation Means relating to the hazard - and what the most severe effect (event) for each combination will be.

   The advantages of the traditional representation are that all possible combinations are considered and validated. One of the main goals of the traditional event tree is to determine the probability of an event based on the outcomes of each event in the chronological sequence of events leading up to it. By analysing all possible outcomes, it is possible to determine the percentage of outcomes which lead to the particular hazard effect. The traditional event trees are thus often applied in quantitative analyses.

   The disadvantages of the traditional event tree are that the tree very often ends up in numerous combinations which are almost impossible to portray in a reader-friendly or useful manner. Furthermore, it may be difficult to identify for each and every combination what the effect will be (in more than overall terms). Often it can only be identified that there is a risk for an incident, but not at what level (i.e. serious, major, significant).

2. The weighted representation of the External Mitigation Means illustrating how the severity increases following the failure of one or more critical External Mitigation Means.

The goal of this type of event tree is to show the importance of the particular EMMs and illustrate how an accident can be the effect of the hazard. Such event trees are usually creatable even with very little data material.

The rationale behind the weighting in the developed event trees (Appendix K) is that any ATCO will always state that the worst element to lose is the COM - if the ATCO cannot speak to the aircraft, he can just silently watch an accident happen even though he may have been able to detect the loss of separation through the surveillance information. If the ATCO loses the radar picture, but are still able to speak to the aircraft, the ATCO can receive flight reports from the aircraft and thus provide procedural ATS. And so forth.

The 5 EMMs are, therefore, prioritised and the worst credible effects are identified subsequently.

The final results of the evaluation and analysis effort are incorporated in the safety assessment (FHA/PSSA report).

APPENDIX F: SEVERITY CLASSIFICATION SCHEME

Severity Class	**1 [Most Severe]**	**2**	**3**	**4**	**5 [Least Severe]**
Effects on Operations	**Accidents**	**Serious Incidents**	**Major Incidents**	**Significant Incidents**	**No Immediate Effect on Safety**
SEVERITY INDICATORS SET1: EFFECTS ON AIR NAVIGATION SERVICE					
Effect on Air Navigation Service within the area of responsibility	Total inability to provide or maintain safe service	Serious inability to provide or maintain safe service	Partial inability to provide or maintain safe service	Ability to provide or maintain safe but degraded service	No safety effect on service
ATCO and/or Flight Crew Working Conditions	Workload, stress or working conditions are such that they cannot perform their tasks at all	Workload, stress or working conditions are such that they are unable to perform their tasks effectively	Workload, stress or working conditions such that their ability is significantly impaired	Workload, stress or working conditions are such that their abilities are slightly impaired	No effect
Effect on ground ATM System and Aircraft Functional Capabilities	Total loss of functional capabilities	Large reduction of functional capabilities	Significant reduction of functional capabilities	Slight reduction of functional capabilities	No effect
ATCO and/or Flight Crew Ability to Cope with Adverse Operational and Environmental Conditions	Unable to cope with adverse operational and environmental conditions	Large reduction of the ability to cope with adverse operational and environmental conditions	Significant reduction of the ability to cope with adverse operational and environmental conditions	Slight reduction of the ability to cope with adverse operational and environmental conditions	No effect

SEVERITY INDICATORS SET 2: EXPOSURE					
Exposure time	The presence of the hazard is almost permanent. Reduction of safety margins persists even after recovering from the immediate problem	Hazard may persist for a substantial period of time	Hazard may persist for a moderate period of time.	Hazard may persist for a short period of time such that no significant consequences are expected.	Too brief to have any safety-related effect
Number of aircraft exposed	All aircraft in the area of responsibility	All aircraft in several ATC Sectors	Aircraft within a small geographic area or an area of low traffic density	Single aircraft	No aircraft affected
SEVERITY INDICATORS SET 3: RECOVERY					
Annunciation, Detection and Diagnosis	Misleading indication. Hard to detect or diagnose. Diagnosis very likely to be incorrect	Ambiguous indication. Not easily detected. Incorrect diagnosis likely	May require some interpretation. Detectable. Incorrect diagnosis possible	Clear annunciation. Easily detected, reliable diagnosis	Clear annunciation. Easily detected and very reliable diagnosis
Contingency measures (other systems or procedures) available	No existing contingency measures available. Operators unprepared, limited ability to intervene	Limited contingency measures, providing only partial replacement functionality. Operators not familiar with procedures or may need to devise a new procedure at the time.	Contingency measures available, providing most of required functionality. Fall back equipment usually reliable. Operator intervention required, but a practised procedure within the scope of normal training	Reliable, automatic, comprehensive contingency measures	Highly reliable, automatic, comprehensive contingency measures
Rate of development of the hazardous condition, compared to the time necessary for annunciation, detection, diagnosis and application of contingency measures	Sudden. It does not allow recovery	Faster	Similar	Slower	Much slower. Plenty of time available

APPENDIX G: QUANTIFIED SAFETY OBJECTIVES

Quantified Safety Objectives have been derived using SAM FHA Chapter 3 Guidance Material E.

The following Risk Classification Scheme for Finavia can be set by taking into account the volume of controlled traffic in 2004: 312.000 Flight-hours

Safety Target	Finavia RCS (per flight-hour)
ST1	1E-09
ST2	1E-06
ST3	1E-05
ST4	1E-03

Safety Target	Finavia RCS (per hour)	Finavia RCS (per year)	Finavia RCS (once per ..)
ST1	3E-08	3E-04	3.200 years
ST2	3E-05	3E-01	3 years
ST3	3E-04	3	120 days
ST4	3E-01	312	1 day

However, Vantaa Airport does not encompass the overall volume of traffic controlled by Finavia. This airport controls 640 operations/day (235.000 operations/year: 50% approach, 50% departure).

An average duration of an Independent Parallel Approach (IPA) is assumed to be 15 minutes.

50% of total approaches will be IPA.

Vantaa is classified as a Complexity 3 airport.

From that Risk Classification scheme, the following quantitative Safety Objectives for the Independent Parallel Approach (IPA) hazards as specified in §4.2 can be set (using SAM-FHA Chapter 3 GM E):

Occasional = twice per year or 2 E-4 /h or 3E-5/IPA (once per 30.000 IPA).

APPENDIX H: HAZARD LOG

#	Hazard	Hazard Effects	Environmental Conditions	Severity Class	Rationale Remarks
1	Wrong application of the independent parallel approach procedure	a. mid air collision	• situational awareness / surveillance information – both APP/TWR • visual observation (both ATCO and pilot) • ATC in radio contact with pilots and vehicle drivers • technical monitoring of system performance • AIP restrictions in relation to runway occupancy time	1	**Worst credible case: 3.** Loss of separation (major or minor) affects two aircraft (separation infringement). Loss of wake vortex separation covers the case where the required separation between a heavy and light aircraft is insufficient resulting in the light aircraft being overturned.
		b. loss of separation (major)		2	
		c. loss of separation (minor)		3	
		d. increased workload for ATCO		3	
		e. increased workload for pilot		3	
		f. loss of wake vortex separation		1	
2	Wrong application of the missed approach procedure	a. mid air collision	• situational awareness / surveillance information – both ARR/TWR • visual observation (both ATCO and pilot) • ATC in radio contact with pilots and vehicle drivers • technical monitoring of system performance	1	**Worst credible case: 3.** *Potential mitigation: break-out procedures should be described in the AIP (not existing today)* The workload increase for the ATCO is less severe in this case as fewer aircraft are involved (compared to hazard #1).
		b. loss of separation (major)		2	
		c. loss of separation (minor)		3	
		d. increased workload for ATCO		4	
		e. increased workload for pilot		3	
		f. loss of terrain / obstacle clearance (collision with obstacle)		1	
		g. loss of terrain / obstacle clearance (no collision with obstacle)		4	
3	Wrong conditions	a. mid air collision	• situational awareness / surveillance information –	1	**Worst credible case: 3.** *An internal mitigation means*

#	Hazard	Hazard Effects	Environmental Conditions	Severity Class	Rationale Remarks
		b. loss of separation (major)	both APP/TWR • visual observation (both ATCO and pilot) • ATC in radio contact with pilots and vehicle drivers • technical monitoring of system performance • procedure in place that ATC shall revert to 3NM separation if conditions are not fulfilled.	2	*include the creation of a checklist; a list of the criteria which shall be fulfilled before activation of Independent Parallel Approaches can take place.*
		c. loss of separation (minor)		3	
		d. increased workload for ATCO		2	
		e. increased workload for pilot		3	

APPENDIX I: PSSA PROCESS

I1 The Process

The FHA and PSSA process has adhered to the following steps:

Figure I-1: FHA/PSSA process

I1.1 Initiation and Planning

The initiation and planning step included two main elements:

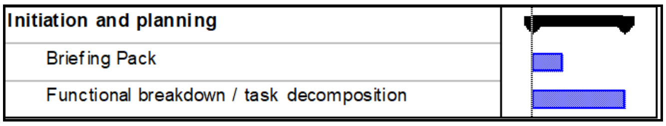


Figure I-2: PSSA initiation and planning

1. Briefing Pack

The Briefing Pack prepared in connection with the FHA initiation and planning contained a number of elements related to the PSSA as well (i.e. it combined FHA and PSSA aspects):

- scope and objectives: the descriptions relating to the PSSA are included in the Briefing Pack
- the agenda: an agenda for the PSSA session is as well included in the Briefing Pack
- the safety assessment methodology: brief explanations relating to the PSSA methodology are included in the Briefing Pack
- definitions: PSSA relevant definitions are included in the Briefing Pack.

In addition, the OED is relevant for both FHA and PSSA.

2. Functional breakdown / task decomposition

The functional breakdown is enabling causes and failure modes to be linked to specific tasks so that mitigation of that element/source can be identified.

Four task decompositions were made (cf. Appendix B) in connection with the breakdown. Thus, all tasks for the actors in the operational environment of the procedure were identified. The actors comprised:

1. Pilot tasks
2. Radar E / W tasks
3. Arrival E / W tasks
4. Tower E / W tasks.

The representation of the decomposed tasks (Appendix B) was included in the Briefing Pack and accordingly distributed to the participants prior to the session.

I.1.2 PSSA session

At the PSSA session, the following activities were accomplished:

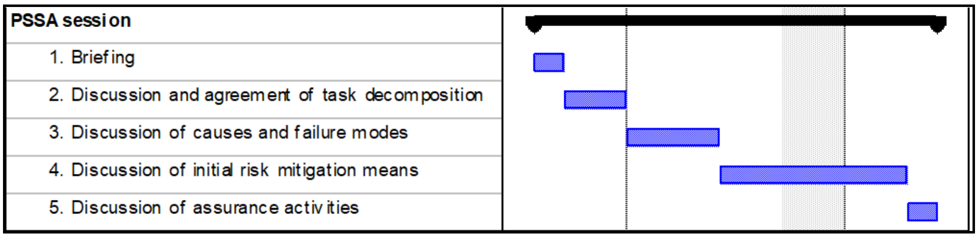


Figure I-3: The PSSA session elements

The same group of operational experts who attended the FHA session, participated in the PSSA session.

<u>1. Briefing</u>

Briefing on the agenda and objectives of the session. On purpose this briefing was very short and concise as the only objective is to ensure that the participants have a common understanding of the scope and objective of the session and the expectations to their input – and not to teach in safety assessment techniques.

<u>2. Discussion and agreement of the task decomposition</u>

As described above, a set of task decompositions (cf. Appendix B) was prepared in advance and included in the Briefing Pack. These decompositions were discussed with the local experts and amended accordingly.

<u>3. Discussion of causes and failure modes applying the task decomposition representation</u>

Based upon the task decompositions, the potential causes / failure modes to the hazards were identified/discussed. A number of causes was already identified during the FHA session and brought forward. Through the application of a task analysis, the list of causes and failure modes was completed.

<u>4. Discussion of initial risk mitigation means</u>

For each identified cause, potential risk mitigation means were discussed. The level for the discussion was overall leading to a set of initial mitigation means which was further analysed following the session (see next section). The initial risk mitigation means are presented in Appendix N.

<u>5. Discussion of assurance activities</u>

The various assurance activities, which are applied (or planned to be applied) during the procedure development, were discussed with Finavia as basis for the PAL allocation (cf. Appendix M).

I1.3 Evaluation & Analysis

The further evaluation and analysis are performed after the session. In relation to the PSSA session output, the following analyses were subsequently performed:

- The Fault Tree Analysis (FTA)

  The FTA constitutes the graphical representation of the linked causes, failure modes and hazards.

  Thus, Fault Tree Analysis (FTA) is a logical representation of the many events and component failures that may combine to cause one critical event (e.g. a system failure). It uses logic gates (mainly AND or OR gates) to show how basic events may combine to cause the critical top event. The resulting logic diagram can then be analysed to identify single and multiple events that can cause the top event. Probabilities of occurrence values and mitigation actions can be assigned to the lowest events in the tree. From the resulting diagram or graph, the probability of occurrence of the top (and intermediate) events can be determined utilising Boolean algebra. When properly done, the FTA shows all the problem areas and makes the critical areas stand out.

  The comprehensive Fault Trees can be found in Appendix J.

- The Traceability Matrices

  The matrices have been created in order to correlate the causes with the initial risk mitigation means and the hazards with the safety requirements. The Traceability Matrices are developed in order to ensure completeness and verify that no gaps are present (i.e. all causes are covered by one or more mitigation means – and all hazards are related to a number of detailed safety requirements.

  Two matrices have been created in order to associate the causes with the risk mitigation means and the hazards with the safety requirements, respectively.

  The matrices can be found in Appendix L.

- Safety Requirements

  The safety requirements make up the elaborated mitigation actions - associated with the various failure modes. The safety requirements shall, when implemented, ensure that the safety objectives are met.

  The detailed Safety Requirements are contained in Appendix O.

Summarising, the evaluation and analysis process comprised the processing of the Initial Risk Mitigation Means identified during the PSSA session to a set of Safety Requirements. This process is illustrated below:

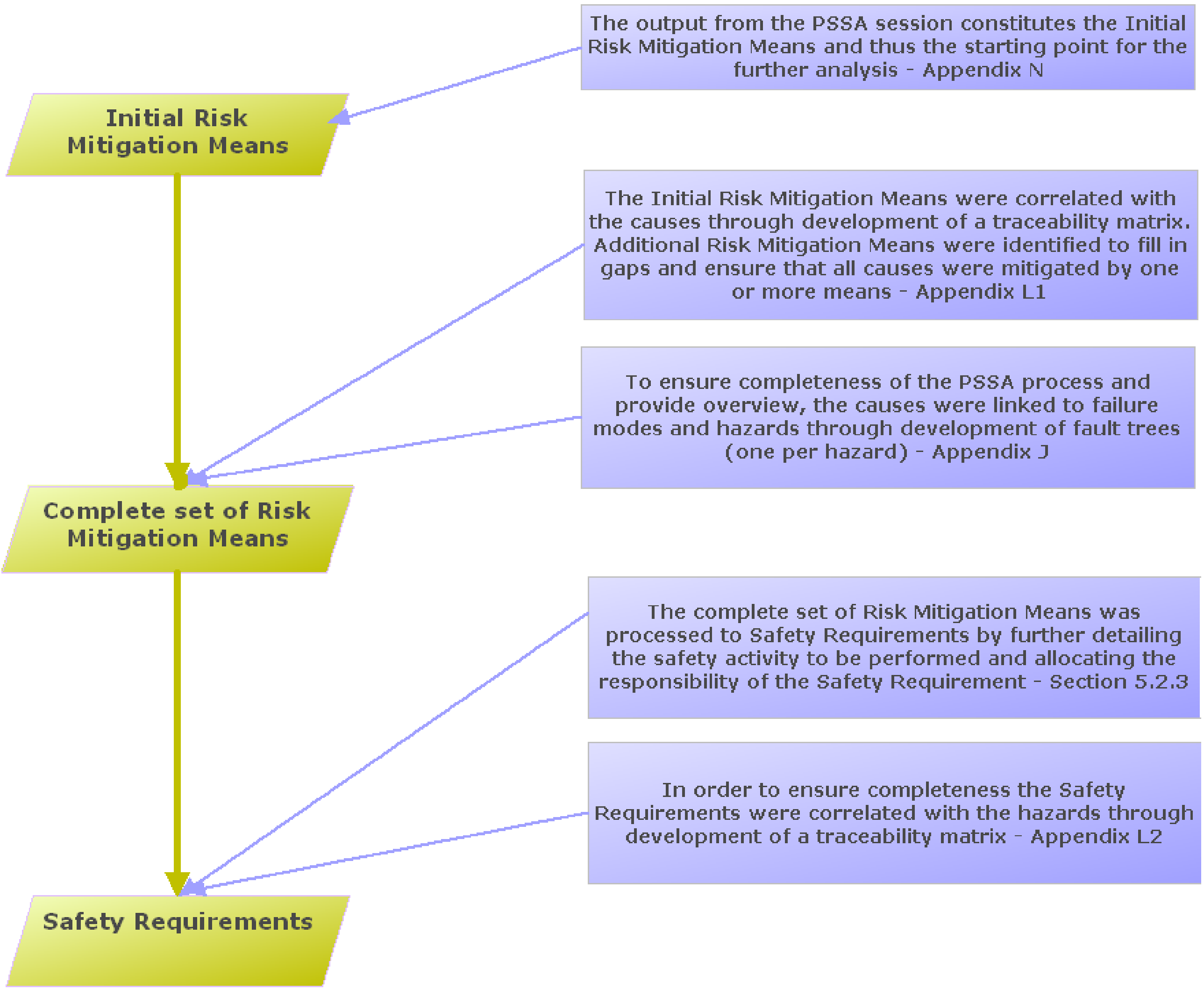


Figure: I-4: steps from initial risk mitigation means to safety requirements

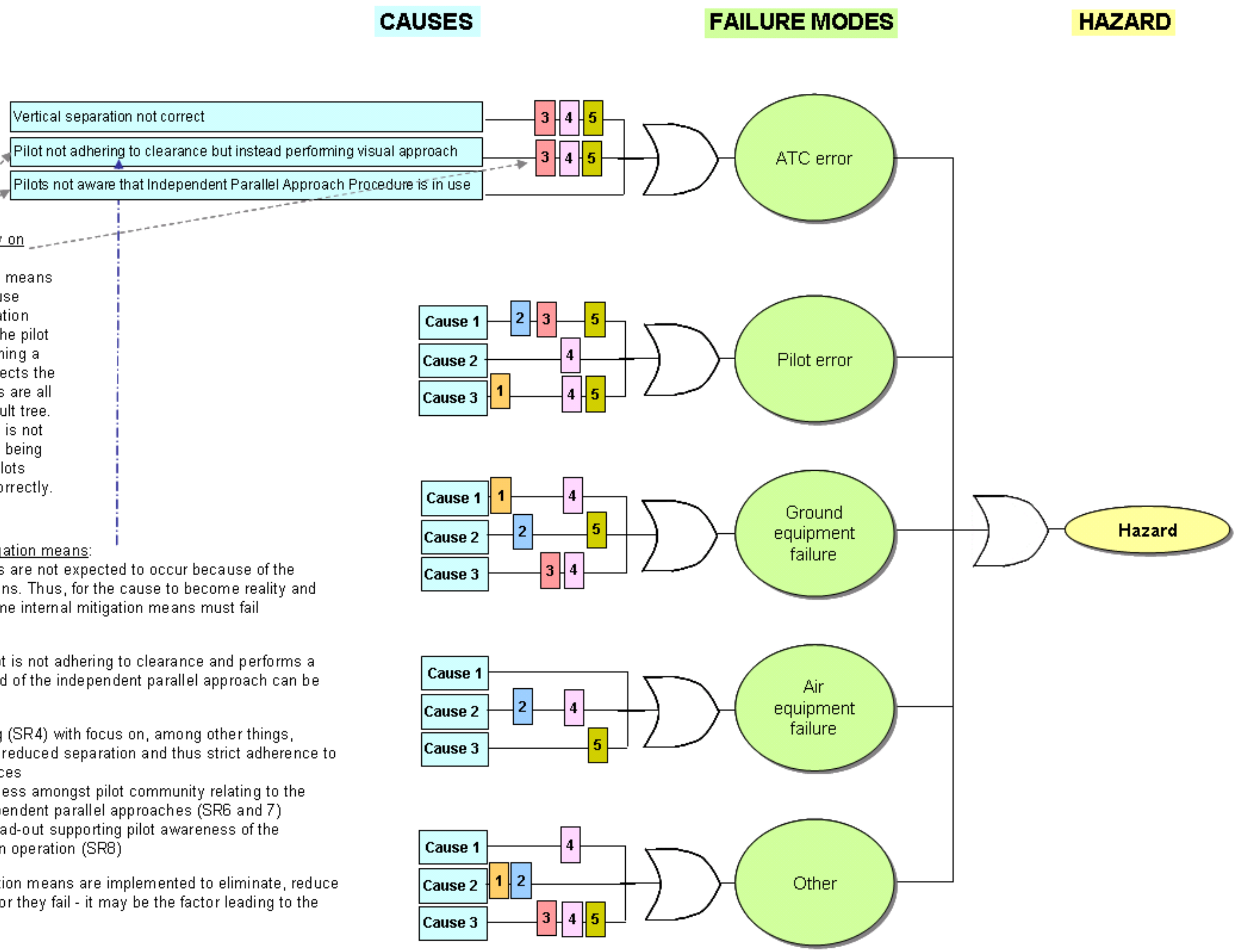
I1.4 Report and Completion

The final step constitutes the development of the report at hand.

APPENDIX J0: FAULT TREE – NOTATION

The fault tree below provides an introduction to the understanding and notation of the succeeding fault trees for the three hazards.

NOTATION



x <u>External mitigation means working directly on causes</u>:
In some cases, the five external mitigation means (EMM1-5) are able to mitigate that the cause leads to the hazard. E.g. by visual observation other pilots or the ATCO may detect that the pilot is not adhering to clearance and is performing a visual approach instead. Or the ATCO detects the off-track on the radar display. These cases are all indicated by the numbered boxes in the fault tree. On the other hand, the cause that the pilot is not aware of independent parallel approaches being in use is not detectable by ATC or other pilots before the procedure is visibly applied incorrectly.

<u>Failure of internal mitigation means</u>:
Note that most hazards are not expected to occur because of the internal mitigation means. Thus, for the cause to become reality and lead to the hazard, some internal mitigation means must fail

Example:
The cause that the pilot is not adhering to clearance and performs a visual approach instead of the independent parallel approach can be mitigated by:

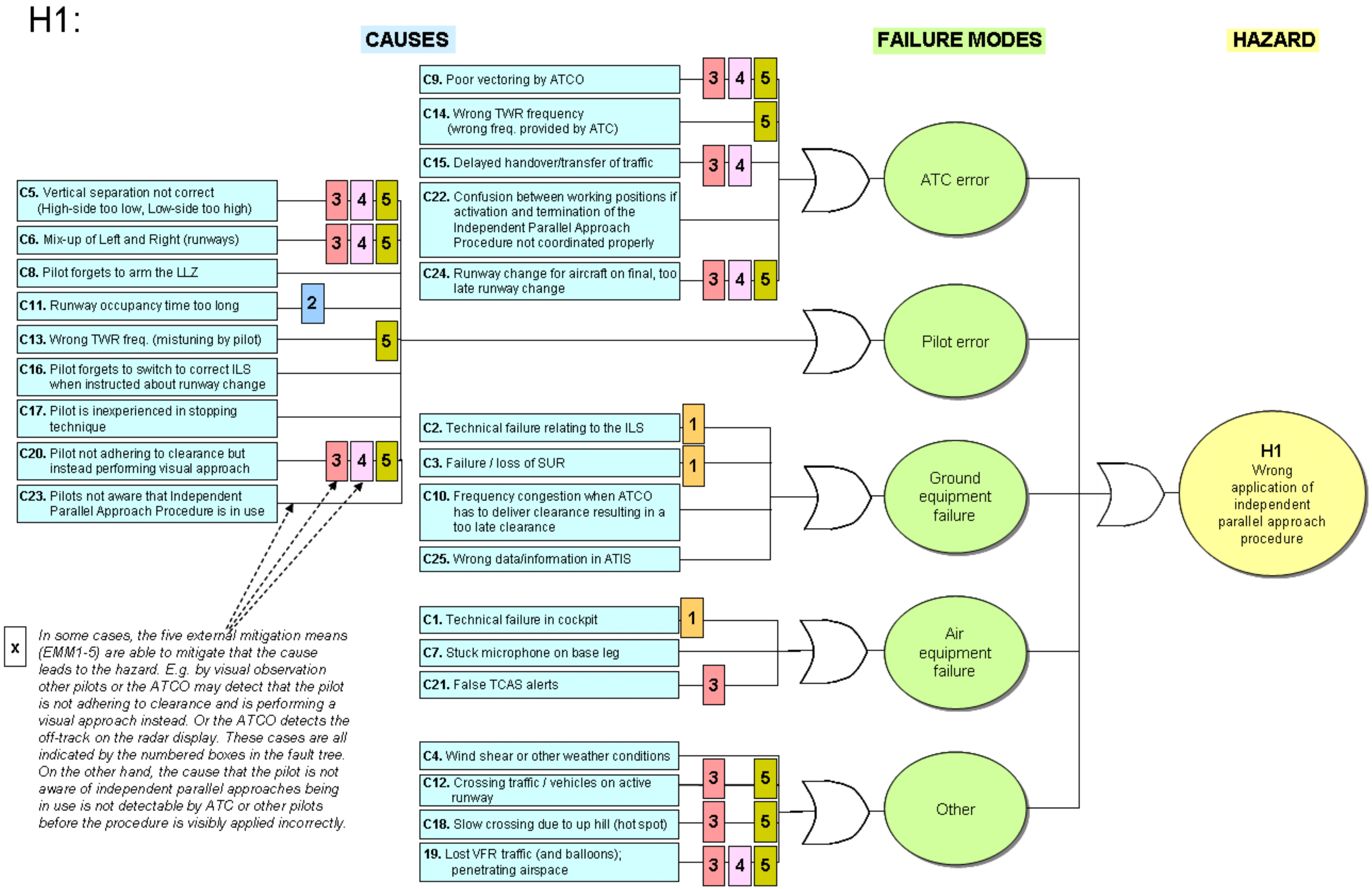
- Dedicated training (SR4) with focus on, among other things, importance of the reduced separation and thus strict adherence to rules and clearances
- Increased awareness amongst pilot community relating to the operation of independent parallel approaches (SR6 and 7)
- Improved ATIS read-out supporting pilot awareness of the procedure being in operation (SR8)

If none of these mitigation means are implemented to eliminate, reduce or control the cause – or they fail - it may be the factor leading to the hazard.

EXTERNAL MITIGATION MEANS

EMM1	**Technical monitoring of system performance**	Both air and ground equipment is monitored for technical failures
EMM2	**Runway Occupancy Time published in the AIP**	Pilots will be aware of the applicable ROT
EMM3	**Visual observations (both ATC and pilot)**	In good visibility conditions, ATC and pilot will be able to detect and alert/resolve a number of situations
EMM4	**Surveillance Information (display in both APP and TWR)**	ATC will be able to detect and resolve a number of situations
EMM5	**Communication**	ATC is in radio contact with pilots and vehicle drivers and will be able to alert (and vice versa)

APPENDIX J1: FAULT TREE – WRONG APPLICATION OF THE PROCEDURE (H1)

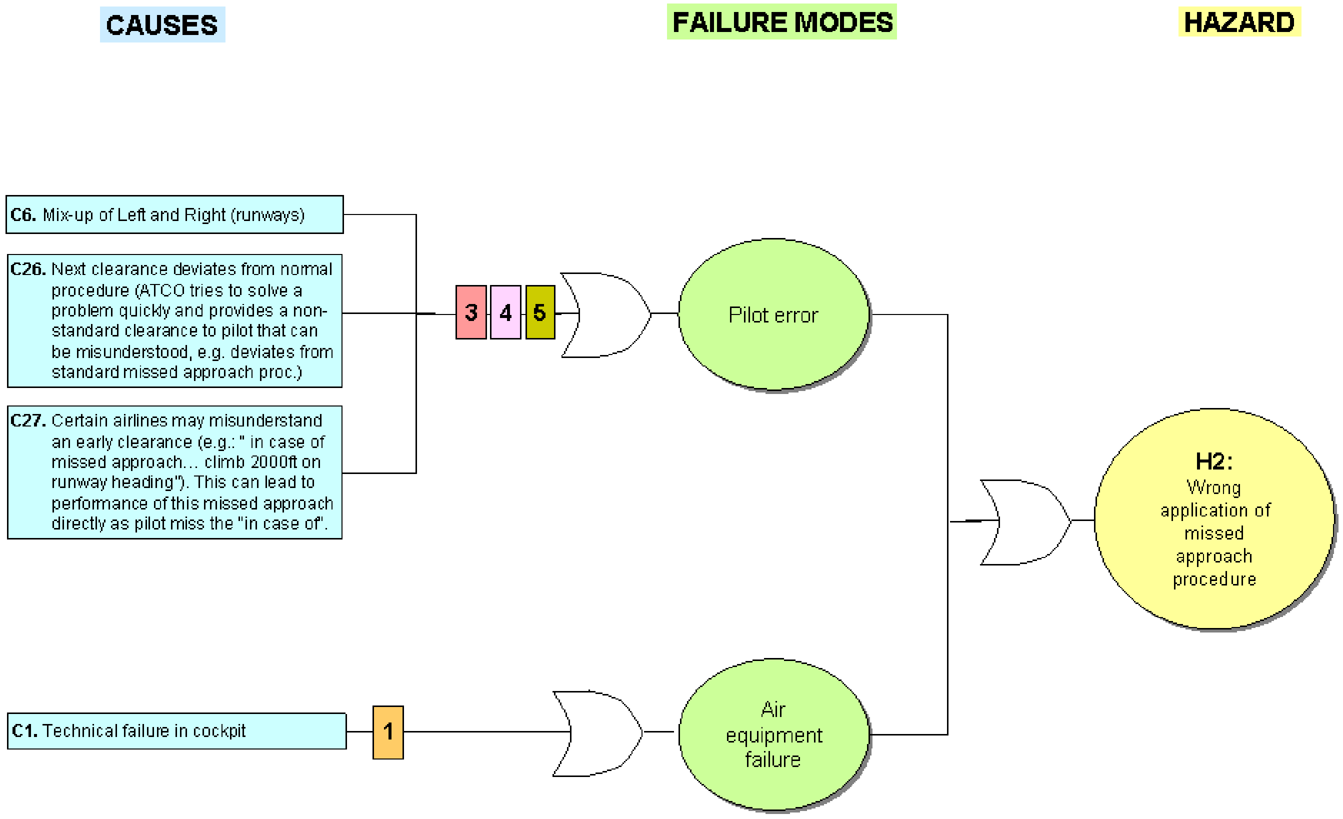


EXTERNAL MITIGATION MEANS

EMM1	**EMM2**	**EMM3**	**EMM4**	**EMM5**
Technical monitoring of system performance Both air and ground equipment is monitored for technical failures	**Runway Occupancy Time published in the AIP** Pilots will be aware of the applicable ROT	**Visual observations (both ATC and pilot)** In good visibility conditions, ATC and pilot will be able to detect and alert/resolve a number of situations	**Surveillance Information (display in both APP and TWR)** ATC will be able to detect and resolve a number of situations	**Communication** ATC is in radio contact with pilots and vehicle drivers and will be able to alert (and vice versa)

APPENDIX J2: FAULT TREE – WRONG APPLICATION OF MA PROCEDURE (H2)

H2:



EXTERNAL MITIGATION MEANS

EMM1 – **Technical monitoring of system performance**
Both air and ground equipment is monitored for technical failures

EMM2 – **Runway Occupancy Time published in the AIP**
Pilots will be aware of the applicable ROT

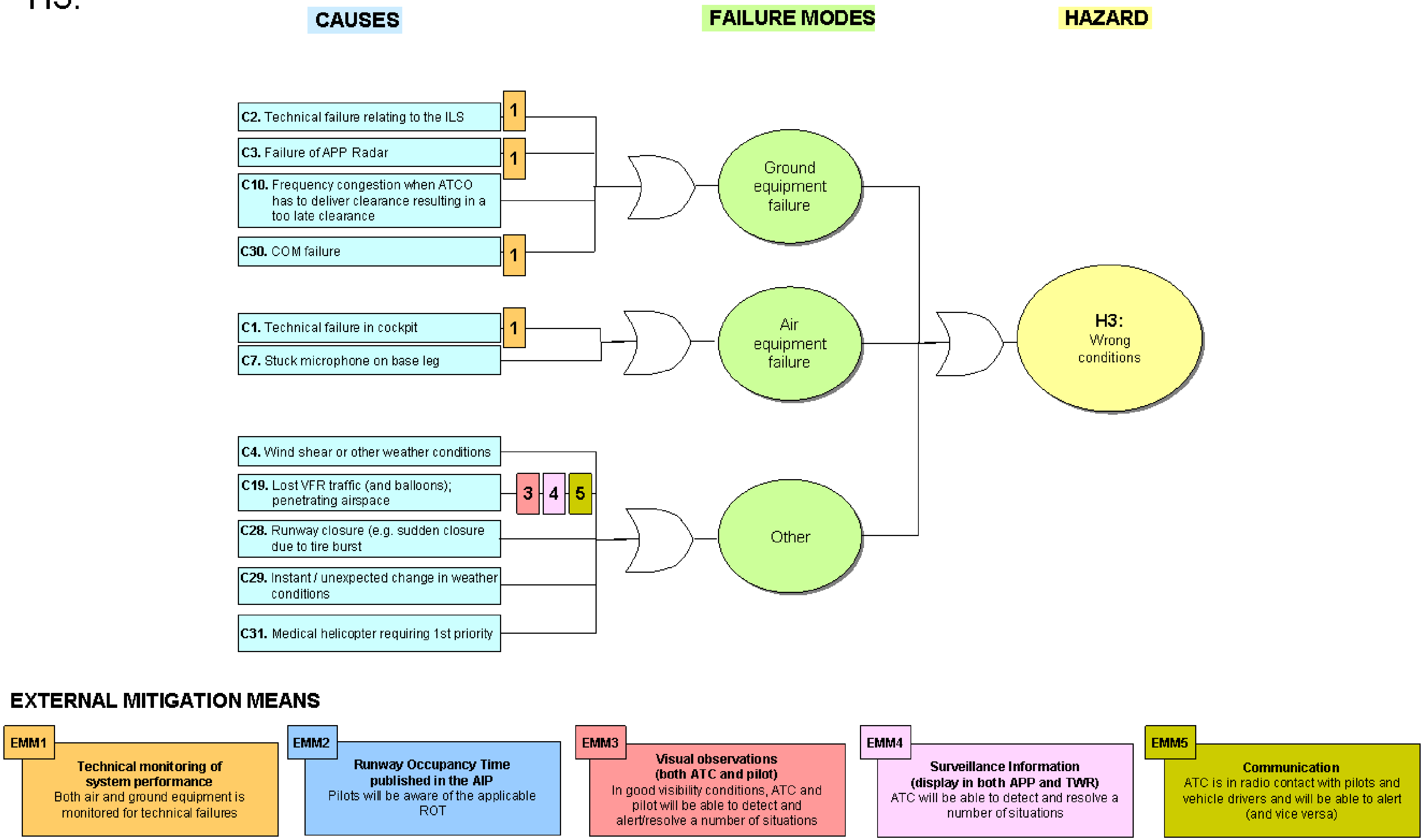
EMM3 – **Visual observations (both ATC and pilot)**
In good visibility conditions, ATC and pilot will be able to detect and alert/resolve a number of situations

EMM4 – **Surveillance Information (display in both APP and TWR)**
ATC will be able to detect and resolve a number of situations

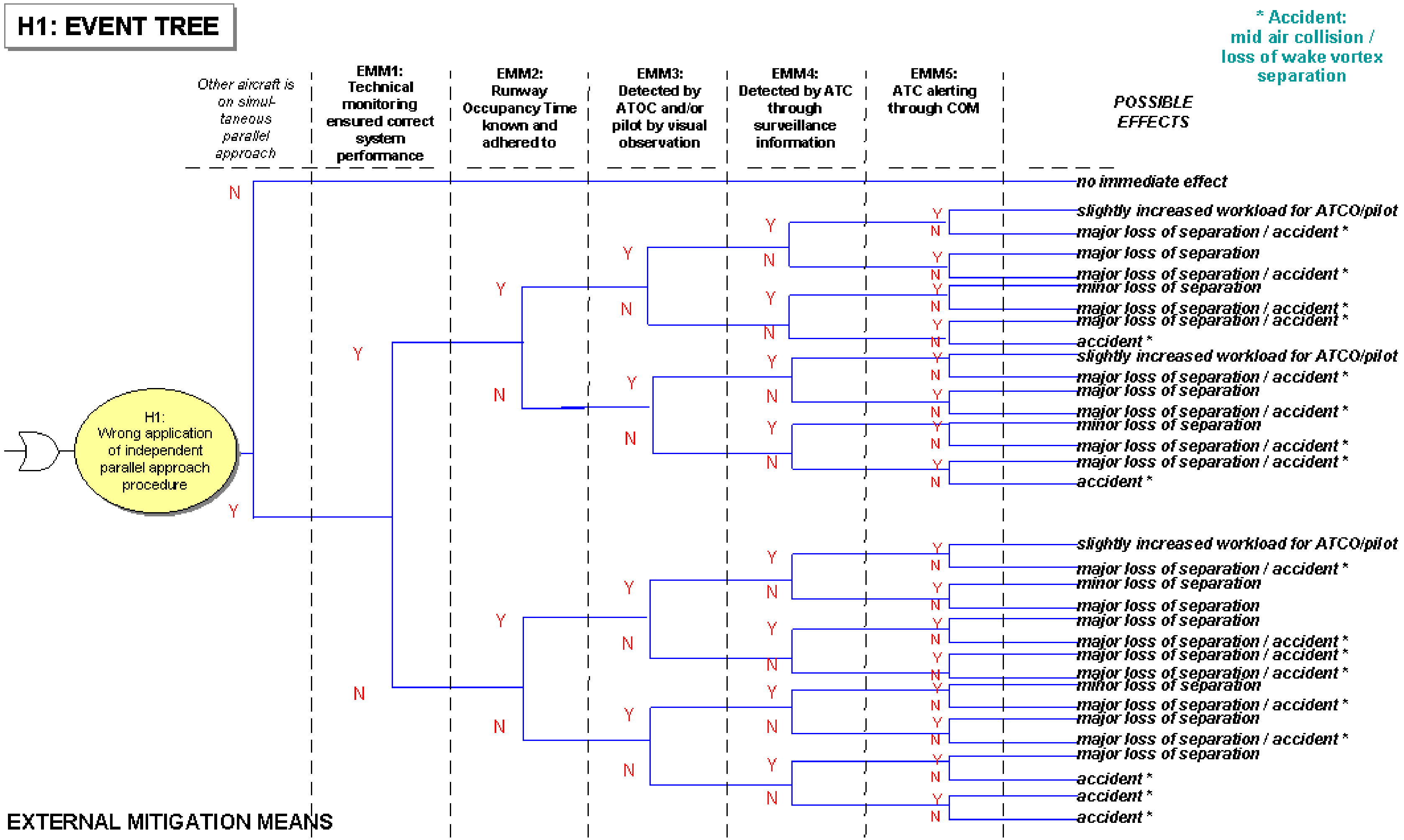
EMM5 – **Communication**
ATC is in radio contact with pilots and vehicle drivers and will be able to alert (and vice versa)

APPENDIX J3: FAULT TREE – WRONG CONDITIONS (H3)

H3:



APPENDIX K1: EVENT TREES – WRONG APPLICATION OF THE PROCEDURE (H1)



EXTERNAL MITIGATION MEANS

EMM1
Technical monitoring of system performance
Both air and ground equipment is monitored for technical failures

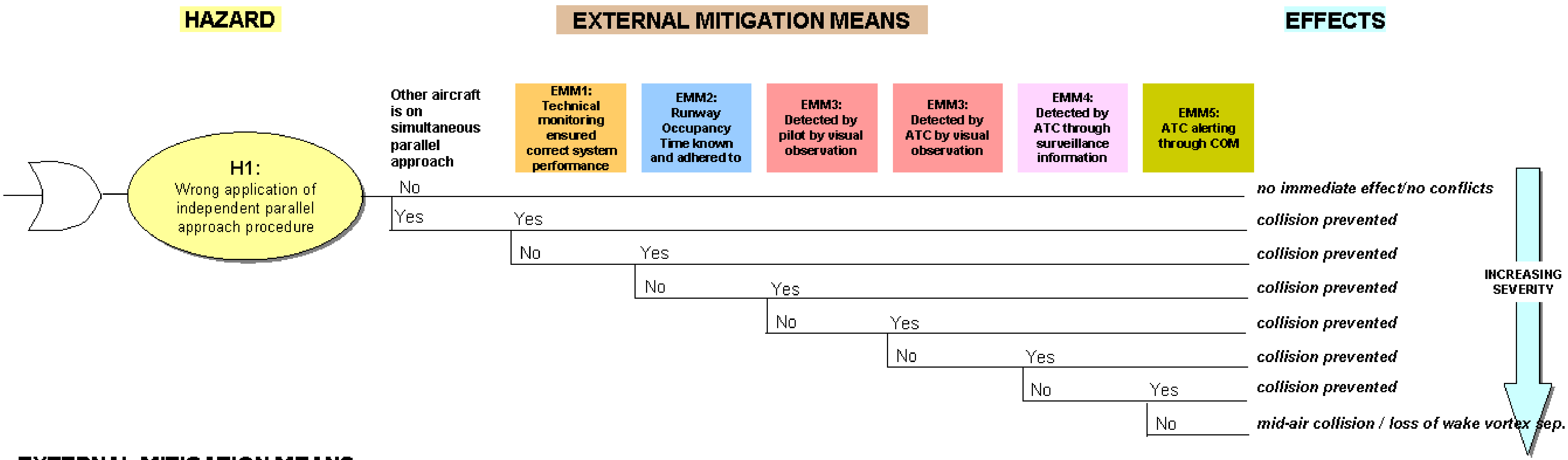
EMM2
Runway Occupancy Time published in the AIP
Pilots will be aware of the applicable ROT

EMM3
Visual observations (both ATC and pilot)
In good visibility conditions, ATC and pilot will be able to detect and alert/resolve a number of situations

EMM4
Surveillance Information (display in both APP and TWR)
ATC will be able to detect and resolve a number of situations

EMM5
Communication
ATC is in radio contact with pilots and vehicle drivers and will be able to alert (and vice versa)

H1:



EXTERNAL MITIGATION MEANS

EMM1
Technical monitoring of system performance
Both air and ground equipment is monitored for technical failures

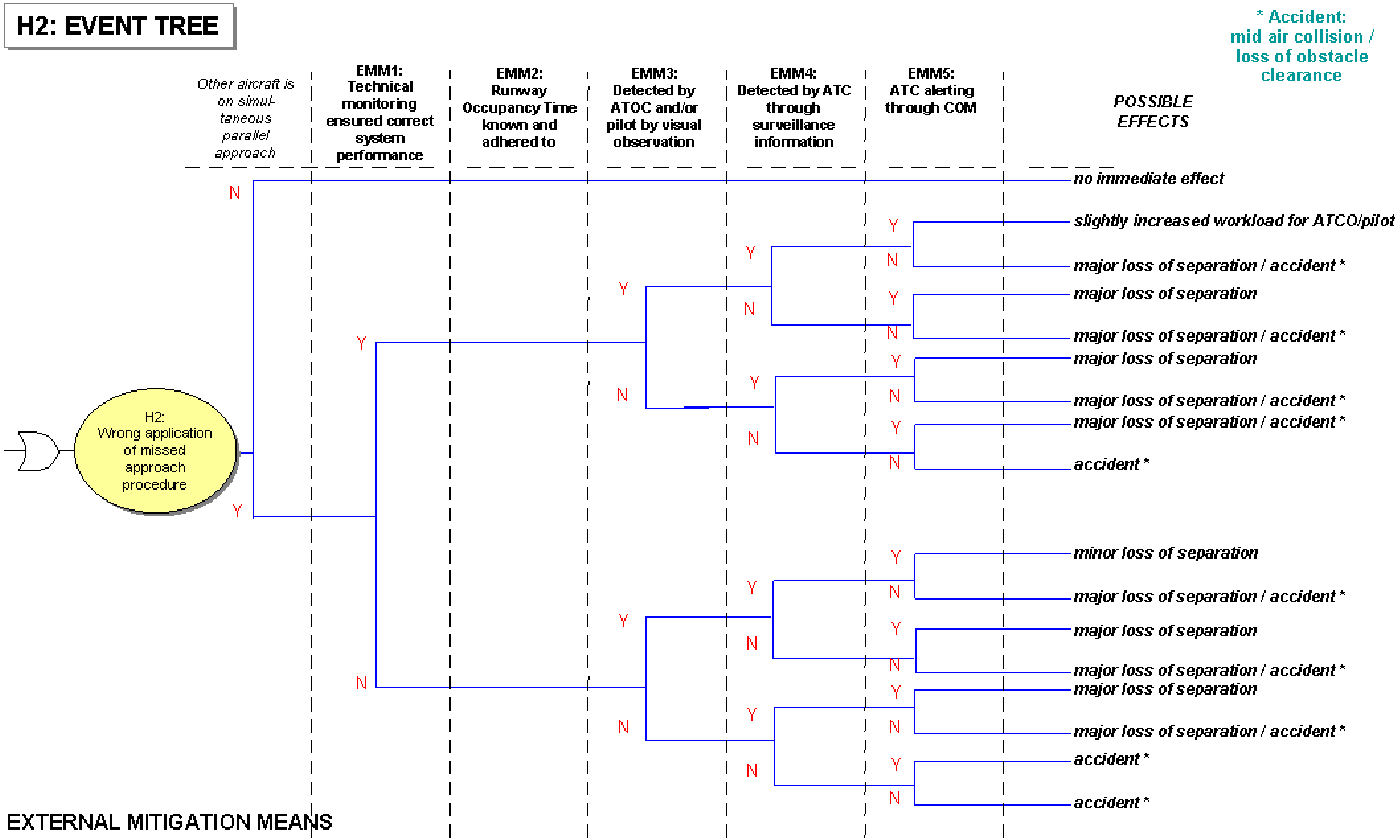
EMM2
Runway Occupancy Time published in the AIP
Pilots will be aware of the applicable ROT

EMM3
Visual observations (both ATC and pilot)
In good visibility conditions, ATC and pilot will be able to detect and alert/resolve a number of situations

EMM4
Surveillance Information (display in both APP and TWR)
ATC will be able to detect and resolve a number of situations

EMM5
Communication
ATC is in radio contact with pilots and vehicle drivers and will be able to alert (and vice versa)

APPENDIX K2: EVENT TREES – WRONG APPLICATION OF MA PROCEDURE (H2)



EXTERNAL MITIGATION MEANS

EMM1
Technical monitoring of system performance
Both air and ground equipment is monitored for technical failures

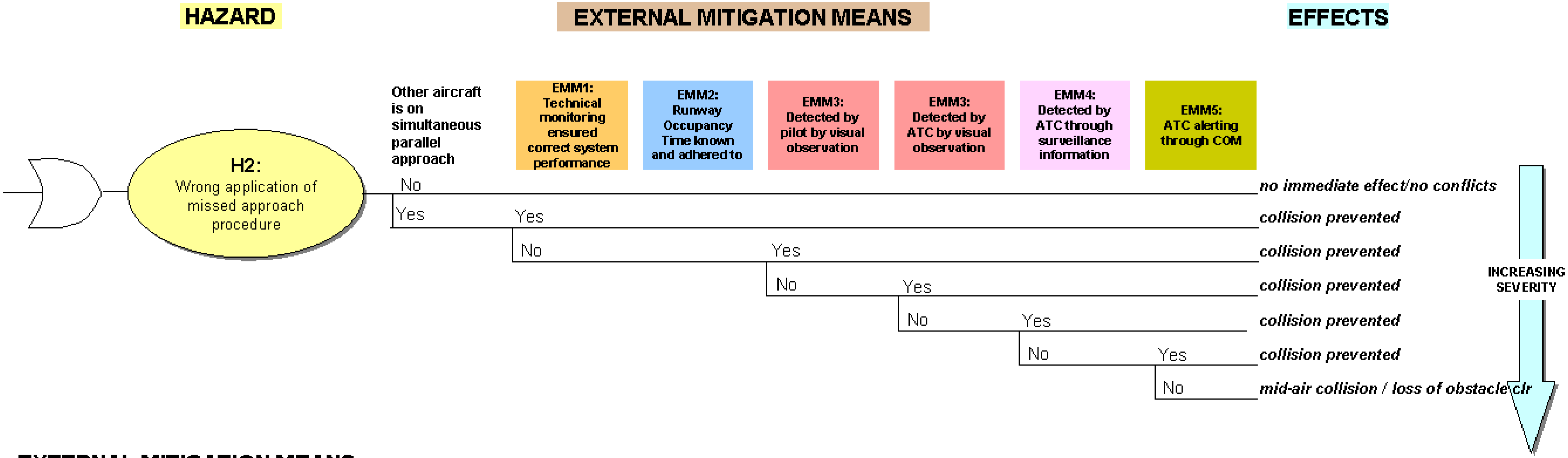
EMM2
Runway Occupancy Time published in the AIP
Pilots will be aware of the applicable ROT

EMM3
Visual observations (both ATC and pilot)
In good visibility conditions, ATC and pilot will be able to detect and alert/resolve a number of situations

EMM4
Surveillance Information (display in both APP and TWR)
ATC will be able to detect and resolve a number of situations

EMM5
Communication
ATC is in radio contact with pilots and vehicle drivers and will be able to alert (and vice versa)

H2:



EXTERNAL MITIGATION MEANS

EMM1
Technical monitoring of system performance
Both air and ground equipment is monitored for technical failures

EMM2
Runway Occupancy Time published in the AIP
Pilots will be aware of the applicable ROT

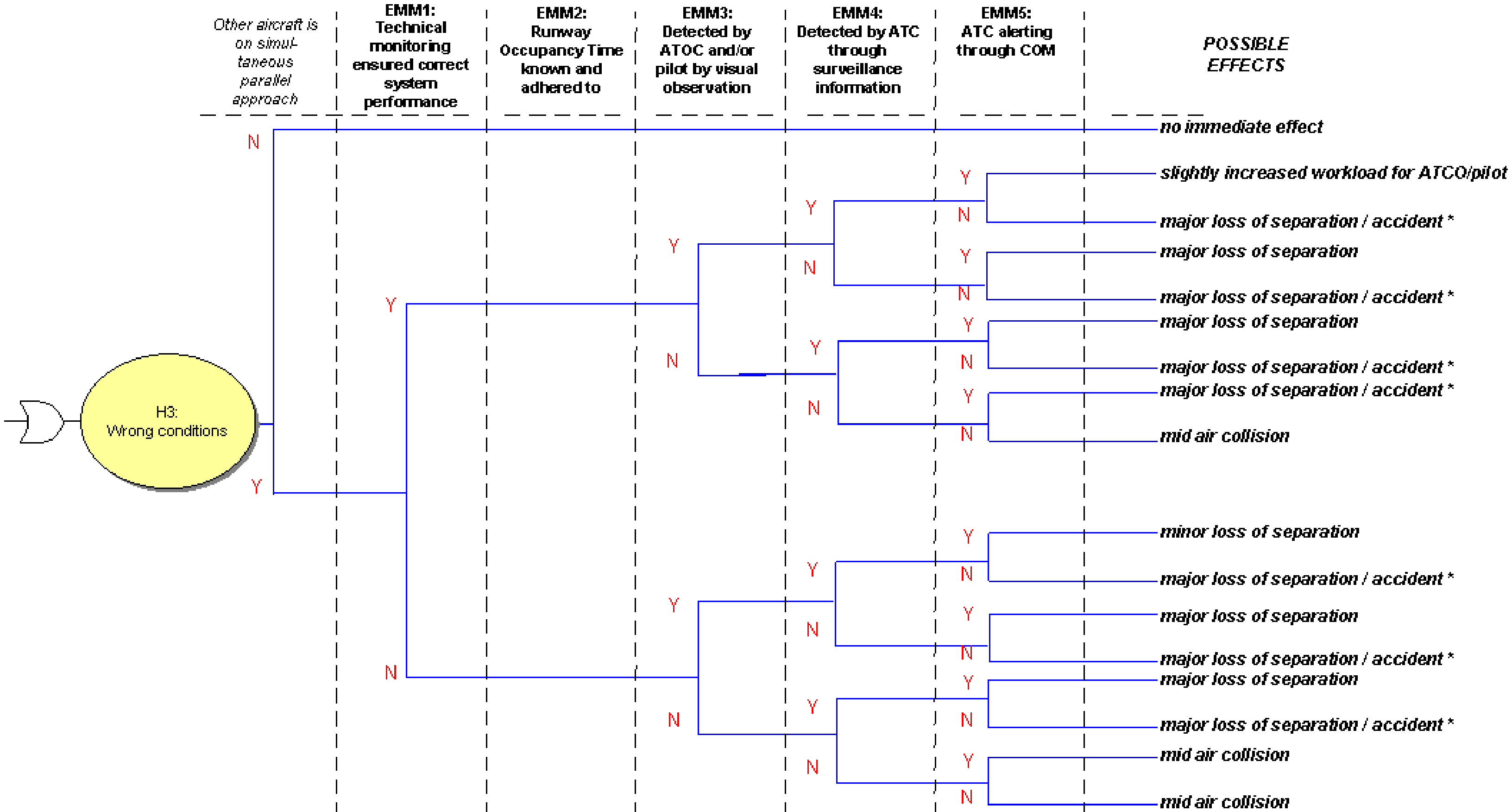
EMM3
Visual observations (both ATC and pilot)
In good visibility conditions, ATC and pilot will be able to detect and alert/resolve a number of situations

EMM4
Surveillance Information (display in both APP and TWR)
ATC will be able to detect and resolve a number of situations

EMM5
Communication
ATC is in radio contact with pilots and vehicle drivers and will be able to alert (and vice versa)

APPENDIX K3: EVENT TREES – WRONG CONDITIONS (H3)

H3: EVENT TREE



EXTERNAL MITIGATION MEANS

EMM1
Technical monitoring of system performance
Both air and ground equipment is monitored for technical failures

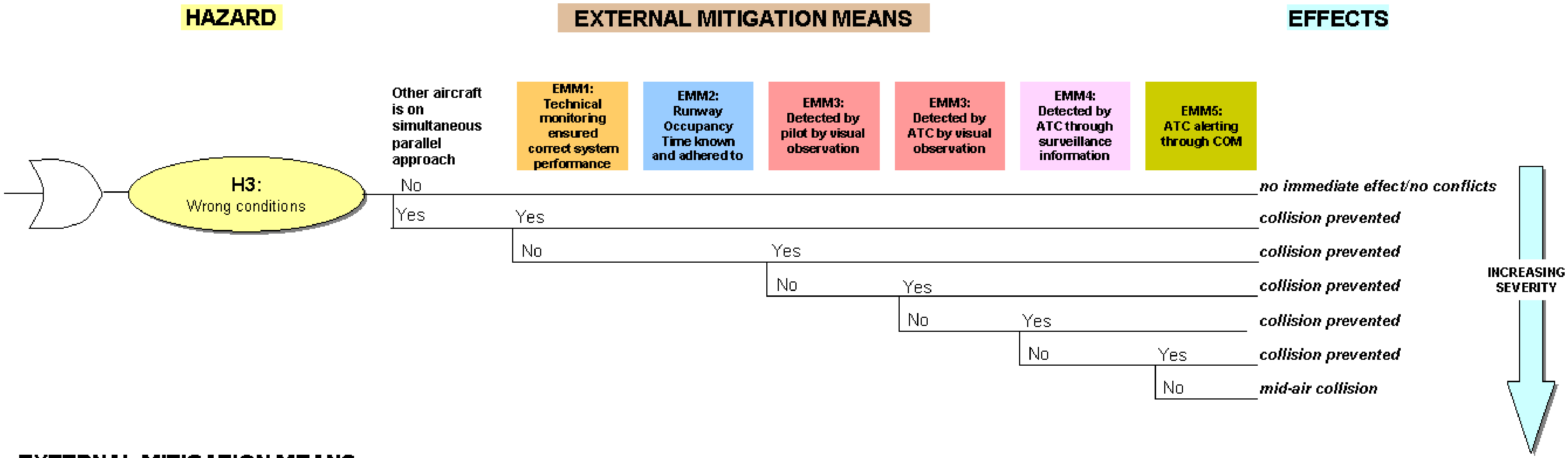
EMM2
Runway Occupancy Time published in the AIP
Pilots will be aware of the applicable ROT

EMM3
Visual observations (both ATC and pilot)
In good visibility conditions, ATC and pilot will be able to detect and alert/resolve a number of situations

EMM4
Surveillance Information (display in both APP and TWR)
ATC will be able to detect and resolve a number of situations

EMM5
Communication
ATC is in radio contact with pilots and vehicle drivers and will be able to alert (and vice versa)

H3:



EXTERNAL MITIGATION MEANS

EMM1

Technical monitoring of system performance
Both air and ground equipment is monitored for technical failures

EMM2

Runway Occupancy Time published in the AIP
Pilots will be aware of the applicable ROT

EMM3

Visual observations (both ATC and pilot)
In good visibility conditions, ATC and pilot will be able to detect and alert/resolve a number of situations

EMM4

Surveillance Information (display in both APP and TWR)
ATC will be able to detect and resolve a number of situations

EMM5

Communication
ATC is in radio contact with pilots and vehicle drivers and will be able to alert (and vice versa)

APPENDIX L1: TRACEABILITY MATRIX: CAUSE – MITIGATION MEANS

Note: A number of the risk mitigation means can be linked directly to the later SRs as indicated in the fourth row. Note that additional SRs have been identified subsequently during the further analysis to ensure completeness (See §5.2.1).

Mitigation means	Reduction							Control							Elimination						
	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
	Perform dedicated training of ATCOs	Perform dedicated training of pilots	Increase awareness through communica-tion with flying schools	Increase awareness through publishing in aviation magazines	Publish information about inde-pendent, dependent or segregated operations on website	Indicate the major ATIS changes on controller display / implement control mechanisms of ATIS information	Use different strip-holder colours for different runways / improve HMI displaying information re. frequencies to ATCO	Use shifting male and female voice reading out ATIS	Change runway numbering (e.g. 04 and 05 instead of 04L/R)	Display clearly for ATCOs the defined / valid wind conditions for operating the procedure	Advise balloons that flying is prohibited when independent parallel approaches are in use	More strict runway occupancy times declared in AIP	MALMI only to operate below specified altitudes when independent parallel approaches are in use	Inform pilot about runway in use (at least), waypoint and altitude before entering TMA	Include in AIP the typical hous when independent parallel approaches can be expected to be applied at Vantaa	Train the vehicle drivers in radio communicati on	Develop contingency procedure for operations in case of radar failure	Pilot automati-cally intercepts LZZ even if not cleared for ILS on base leg	Install additional stopping means at hot spots (e.g. only active when independent parallel approaches are in use	Include in AIP that only TA function of TCAS should be activated when flying independent parallel app.	Prohibit conditional clearances when independent parallel approaches in use
Causes	SR1	SR4, SR5	SR6, SR7, SR9	SR6, SR7, SR9	SR6, SR7	SR8, SR18, SR22	SR2	SR8, SR18, SR22	SR3	SR22, SR23	SR27	Sr11	SR28	SR19	SR9	SR24, SR25	SR15	SR15	SR26	SR21	SR10
1. Technical failure in cockpit		√																			
2. Technical failure relating to the ILS	√																				
3. Failure of APP radar	√																√				
4. Wind shear or other weather conditions										√											
5. Vertical separation not correct (High-side too low, Low-side too high)	√	√																			
6. Mix-up of Left and Right (runways)		√							√												
7. Stuck microphone on base leg																		√			
8. Pilot forgets to arm the LLZ		√																			
9. Poor vectoring by ATCO	√	√																			
10. Frequency congestion when ATCO has to deliver clearance resulting in a too late clearance	√	√																√			
11. Runway occupancy time too long												√									
12. Crossing traffic / vehicles on active runway	√															√			√		
13. Wrong TWR freq. (mistuning by pilot)		√																			

Mitigation means / Causes	Reduction							Control							Elimination						
	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.	xvi.	xvii.	xviii.	xix.	xx.	xxi.
	Perform dedicated training of ATCOs	Perform dedicated training of pilots	Increase awareness through communication with flying schools	Increase awareness through publishing in aviation magazines	Publish information about independent, dependent or segregated operations on website	Indicate the major ATIS changes on controller display / implement control mechanisms of ATIS information	Use different strip-holder colours for different runways / improve HMI displaying information re. frequencies to ATCO	Use shifting male and female voice reading out ATIS	Change runway numbering (e.g. 04 and 05 instead of 04L/R)	Display clearly for ATCOs the defined / valid wind conditions for operating the procedure	Advise balloons that flying is prohibited when independent parallel approaches are in use	More strict runway occupancy times declared in AIP	MALMI only to operate below specified altitudes when independent parallel approaches are in use	Inform pilot about runway in use (at least), waypoint and altitude before entering TMA	Include in AIP the typical hours when independent parallel approaches can be expected to be applied at Vantaa	Train the vehicle drivers in radio communication	Develop contingency procedure for operations in case of radar failure	Pilot automatically intercepts LZZ even if not cleared for ILS on base leg	Install additional stopping means at hot spots (e.g. only active when independent parallel approaches are in use	Include in AIP that only TA function of TCAS should be activated when flying independent parallel app.	Prohibit conditional clearances when independent parallel approaches in use
	SR1	SR4, SR5	SR6, SR7, SR9	SR6, SR7, SR9	SR6, SR7	SR8, SR18, SR22	SR2	SR8, SR18, SR22	SR3	SR22, SR23	SR27	Sr11	SR28	SR19	SR9	SR24, SR25	SR15	SR15	SR26	SR21	SR10
14. Wrong TWR frequency (wrong freq. provided by ATC)	√						√														
15. Delayed handover/transfer of traffic	√																				
16. Pilot forgets to switch to correct ILS when instructed about runway change		√																			
17. Pilot is inexperienced in stopping technique		√																			
18. Slow crossing due to up hill (hot spot))																			√		
19. Lost VFR traffic (and balloons); penetrating airspace	√		√	√							√		√		√						
20. Pilot not adhering to clearance but instead performing visual approach		√																			
21. False TCAS alerts		√																		√	
22. Confusion between working positions if activation and termination of the Independent Parallel Approach Procedure not coordinated properly	√																				
23. Pilots not aware that Independent Parallel Approach Procedure is in use		√			√			√						√	√						
24. Runway change for aircraft on final, too late runway change	√																				
25. Wrong data / information in ATIS						√															

Mitigation means / Causes	Reduction							Control							Elimination						
	i.	**ii.**	**iii.**	**iv.**	**v.**	**vi.**	**vii.**	**viii.**	**ix.**	**x.**	**xi.**	**xii.**	**xiii.**	**xiv.**	**xv.**	**xvi.**	**xvii.**	**xviii.**	**xix.**	**xx.**	**xxi.**
	Perform dedicated training of ATCOs	Perform dedicated training of pilots	Increase awareness through communica-tion with flying schools	Increase awareness through publishing in aviation magazines	Publish information about inde-pendent, dependent or segregated operations on website	Indicate the major ATIS changes on controller display / implement control mechanisms of ATIS information	Use different strip-holder colours for different runways / improve HMI displaying information re. frequencies to ATCO	Use shifting male and female voice reading out ATIS	Change runway numbering (e.g. 04 and 05 instead of 04L/R)	Display clearly for ATCOs the defined / valid wind conditions for operating the procedure	Advise balloons that flying is prohibited when independent parallel approaches are in use	More strict runway occupancy times declared in AIP	MALMI only to operate below specified altitudes when independent parallel approaches are in use	Inform pilot about runway in use (at least), waypoint and altitude before entering TMA	Include in AIP the typical hours when independent parallel approaches can be expected to be applied at Vantaa	Train the vehicle drivers in radio communication	Develop contingency procedure for operations in case of radar failure	Pilot automati-cally intercepts LZZ even if not cleared for ILS on base leg	Install additional stopping means at hot spots (e.g. only active when independent parallel approaches are in use	Include in AIP that only TA function of TCAS should be activated when flying independent parallel app.	Prohibit conditional clearances when independent parallel approaches in use
Causes	SR1	SR4, SR5	SR6, SR7, SR9	SR6, SR7, SR9	SR6, SR7	SR8, SR18, SR22	SR2	SR8, SR18, SR22	SR3	SR22, SR23	SR27	Sr11	SR28	SR19	SR9	SR24, SR25	SR15	SR15	SR26	SR21	SR10
26. Next clearance deviates from normal procedure (ATCO tries to solve a problem quickly and provides a non-standard clearance to pilot that can be misunderstood, e.g. deviates from standard missed approach proc.)	√	√																			√
27. Certain airlines may misunderstand an early clearance (e.g.: " in case of missed approach… climb 2000ft on runway heading"). This can lead to performance of this missed approach directly as pilot miss the "in case of".	√	√																			√
28. Runway closure (e.g. sudden closure due to tire burst	√																				
29. Instant / unexpected change in weather conditions	√																				
30. COM failure	√																				
31. Medical helicopter requiring 1st priority	√																				

Table L-1: Cause – mitigation means matrix

APPENDIX L2: TRACEABILITY MATRIX: HAZARD – SAFETY REQUIREMENTS

Safety Requirements \ Hazards		Wrong application of independent parallel approach procedure	Wrong application of missed approach procedure	Wrong conditions
		H1 / SO1	**H2 / SO2**	**H3 / SO3**
SR1	Dedicated training of ATCOs	√		√
SR2	Improved HMI to minimise risk of mistakes	√		
SR3	Changed runway numbering	√	√	
SR4	Dedicated training of pilots	√	√	√
SR5	Examination/elaboration of cockpit checklists	√	√	
SR6	Develop briefing and awareness material	√	√	
SR7	Distribute briefing and awareness material	√	√	
SR8	Improve ATIS read out	√		
SR9	Seek means to notify pilots that the procedure is in use	√		
SR10	Use of standard clearances to minimise risk of misunderstanding	√	√	
SR11	Minimise runway occupancy time	√		
SR12	Ensure minimum set of equipment in place incl. backup	√	√	√
SR13	Ensure that technical monitoring is in place	√	√	√
SR14	Investigate whether further techn. Monitoring is necessary	√	√	√
SR15	Develop and implement required contingency procedures	√		√
SR16	Develop and implement contingency re. techn. Monitoring	√		√
SR17	Implement ATIS control mechanism	√		
SR18	Display major ATIS changes to ATCO	√		
SR19	Investigate whether a procedure to repeat ATIS changes to pilots shall be developed	√		
SR20	Ensure aircraft is certified in accordance with JARs	√		√
SR21	State in AIP that only TA function of TCAS to be activated	√		
SR22	Display weather criteria, equip. requirements, staffing criteria for operating the procedure for ATCO	√		√

Hazards / Safety Requirements	Wrong application of independent parallel approach procedure	Wrong application of missed approach procedure	Wrong conditions
	H1 / SO1	**H2 / SO2**	**H3 / SO3**
SR23 Display criteria for activating and terminating the procedure	√		√
SR24 Develop and train procedures for vehicle drivers	√		
SR25 Train vehicle drivers	√		
SR26 Implement additional stopping means if beneficial	√		
SR27 Prohibit balloons	√		√
SR28 Prohibit VFR flights at Malmi above specified altitude	√		√
SR29 Develop procedure for handling the medical helicopter	√		√
SR30 Train ATCOs in procedure for medical helicopter	√		√

Table L-2: Hazard – safety requirements matrix

APPENDIX M: PAL ALLOCATION

The following steps should be performed to allocate a PAL:

1. Identify the likelihood that, once the procedure fails, this procedure can generate an end-effect which has a certain severity (do that for each effect of a hazard);
2. Identify the PAL for that couple (severity, likelihood) using the matrix hereafter;
3. This has to be done for all the hazards due to the procedure.

The final PAL of an ATM procedure is the most stringent one.

Effect severity / **Likelihood of generating such an effect**	**1**	**2**	**3**	**4**
Very possible	PAL1	PAL2	PAL3	PAL4
Possible	PAL2	PAL3	PAL3	PAL4
Very Unlikely	PAL3	PAL3	PAL4	PAL4
Extremely Unlikely	PAL4	PAL4	PAL4	PAL4

Table M-1: PAL matrix

Likelihood

Likelihood for each hazard effect							
Hazard effect / Hazard #	**a** *Severity 1*	**b** *Severity 2*	**c** *Severity 3*	**d** *Severity 3*	**e** *Severity 3*	**f** *Severity 3*	
Hazard 1	Extremely Unlikely	Very Unlikely	Very Unlikely	Possible	Very Unlikely	Extremely Unlikely	
	a *Severity 1*	**b** *Severity 2*	**c** *Severity 3*	**d** *Severity 4*	**e** *Severity 3*	**f** *Severity 1*	**g** *Severity 4*
Hazard 2	Extremely Unlikely	Extremely Unlikely	Very Unlikely	Possible	Possible	Extremely Unlikely	Extremely Unlikely
	a *Severity 1*	**b** *Severity 2*	**c** *Severity 3*	**d** *Severity 2*	**e** *Severity 3*		
Hazard 3	Extremely Unlikely	Very Unlikely	Very Unlikely	Possible	Possible		

Table M-2: Likelihood matrix

The likelihood that the procedure can generate an end effect is identified in accordance with the following definitions:

<u>**Very Possible**</u>**:** This effect will certainly occur due to a procedure failure.

<u>**Possible:**</u> This effect may happen (it is not unreasonable to expect such effect to happen due to a procedure failure).

<u>**Very Unlikely**</u>**:** It is not expected to have such an effect more than exceptionally and in some extreme cases throughout the system lifetime.

<u>**Extremely Unlikely**</u>**:** Such an effect is not expected to happen throughout the system lifetime.

As illustrated above, the most stringent PAL that has been allocated is PAL3

APPENDIX N: RISK MITIGATION LOG

Note: The table below contains the raw data from the PSSA session.

#	Hazard	Causes / Failure Modes	Remarks	Risk Mitigation
1	Wrong application of the independent parallel approach procedure	1. Technical failure in cockpit – e.g. of a dual simultaneously FMS failure		- Perform dedicated training of ATCOs - Perform dedicated training of pilots - Increase awareness through communication with flying schools - Increase awareness through publishing in aviation magazines - Publish information about independent, dependent or segregated operations on website - Indicate the major ATIS changes on controller display / implement control mechanisms of ATIS information - Use different strip-holder colours for different runways / improve HMI displaying information re. frequencies to ATCO - Use shifting male and female voice reading out ATIS - Change runway numbering (e.g. 04 and 05 instead of 04L/R) - Display clearly for ATCOs the defined / valid wind conditions for operating the procedure - Advise balloons that flying is prohibited when independent parallel approaches are in use - More strict runway occupancy times declared in AIP - MALMI only to operate below specified altitudes when independent parallel approaches are in use - Inform pilot about runway in use (at least), waypoint and altitude before entering TMA - Include in AIP the typical hours when independent parallel approaches can be
		2. Technical failure relating to the ILS (LLZ / GP signal either lost or corrupted; snow on antenna)		
		3. Failure of APP Radar	3. No contingency procedures exist relating to operations without radar	
		4. Windshear or other weather conditions		
		5. Human error by Pilot		
		6. Vertical separation not correct (e.g. the aircraft arriving on Low Side runway not reaching 2000ft in time)	6. Problem on low side runway to descent fast enough to 2000 ft, e.g. due to pilots wanting to apply optimal flight profile	
		7. Mixup of Left and Right (runways)		
		8. Stuck microphone on baseleg (consequence: clearance received too late, bursts the LLZ)		
		9. Pilot forgets to activate the LLZ – (mistake by pilot)	9. Internal mitigation means: ATC procedure to: "check LLZ frequency xxx.xx" (cf. proc. description)	
		10. To early descent by aircraft arriving on High Side runway (has to keep 3000ft until passed FAP and starts descent on GP) (related to no.5)		
		11. Poor vectoring by ATCO (e.g. leading to the aircraft bursting the LLZ)		
		12. Frequency congestion when ATCO has to deliver clearance resulting in a too late clearance (related to the stuck microphone problem)		
		13. Runway occupancy time too long (e.g. slow reaction time of departing aircraft, slow taxiing by previous landed aircraft, miss of high speed exit)	13. Potential mitigation: more strict runway occupancy times declared in the AIP	
		14. Crossing traffic / vehicles on active runway	14. Most vehicles only have one radio. Those few vehicles with two radios do not listen to traffic anyway. Language with vehicles is Finnish.	

#	Hazard	Causes / Failure Modes	Remarks	Risk Mitigation
		15. Wrong TWR frequency (mistuning by pilot)		expected to be applied at Vantaa - Train the vehicle drivers in radio communication - Develop contingency procedure for operations in case of radar failure - Pilot automatically intercepts LZZ even if not cleared for ILS on base leg - Install additional stop bars / physical barriers at hot spots (e.g. only active when independent parallel approaches are in use - Include in AIP that only TA function of TCAS should be activated when flying independent parallel app. - Prohibit conditional clearances when independent parallel approaches in use
		16. Delayed handover/transfer of traffic		
		17. Pilot forgets to switch to correct ILS when instructed about runway change		
		18. Pilot is inexperienced in stopping technique (stops far from exit)	18. & 19. Pilot may think that the runway is slippery (maybe poor weather conditions / winter). Worst braking action is on taxiway. 19. There are restrictions on intersection use on active runway – must turn on certain exit	
		19. Slow crossing due to up hill (hot spot)		
		20. Lost VFR traffic (and balloons); penetrating airspace	20. Mitigation: inform pilots on website? 20. VFR have no transponders	
		21. Pilot not adhering to clearance but instead performing visual approach	21. Pilots may be cutting a corner…	
		22. False TCAS alerts (for some aircraft types, TCAS is automatically switched off below certain altitude – for other aircraft types, TCAS has to be switched off manually)	22. TCAS on/off not a condition to operate	
		23. Confusion between working positions (including unprepared tower) if activation and termination of the Independent Parallel Approach Procedure not co-ordinated properly		
		24. Pilots not aware that Independent Parallel Approach Procedure is in use		
		25. Runway change for aircraft on final, too late runway change	25. E.g. when changing from using two parallel runways to runway 15 for landing. Going from 'independent' to 'segregated' is the main problem (complicated). Open V-mode (22L/R for take-off and 15 for landing) is used on S and W winds. Timing is critical because of traffic volume. Pilots prefer to receive runway in use for landing when entering TMA (vital for pilot to know what runway. Waypoint and altitude to expect in order to prepare – whether Parallel or not is in use is not vital). When entering TMA or on downwind is ok to receive runway in use for landing.	

#	Hazard	Causes / Failure Modes	Remarks	Risk Mitigation
		26. Wrong data/information in ATIS		
2	Wrong application of the missed approach procedure	1. Technical failure in cockpit – e.g. of a dual simultaneously FMS failure		- Perform dedicated training of ATCOs - Perform dedicated training of pilots - Change runway numbering (e.g. 04 and 05 instead of 04L/R) - Develop contingency procedure for operations in case of radar failure - Pilot automatically intercepts LZZ even if not cleared for ILS on base leg - Prohibit conditional clearances when independent parallel approaches in use
		2. Human error / pilot mistake		
		3. Mixup of Left and Right (runways)		
		4. Next clearance deviates from normal procedure (ATCO tries to solve a problem quickly and provides a non-standard clearance to pilot that can be misunderstood, e.g. deviates from standard missed approach proc.)		
		5. Certain airlines may misunderstand an early clearance. " in case of missed approach…climb 2000ft on runway heading" can lead to performance of this missed approach directly as pilot miss the "in case of".		
3	Wrong conditions	1. Technical failure in cockpit – e.g. of a dual simultaneously FMS failure		- Perform dedicated training of ATCOs - Perform dedicated training of pilots - Increase awareness through communication with flying schools - Increase awareness through publishing in aviation magazines - Publish information about independent, dependent or segregated operations on website - Indicate the major ATIS changes on controller display / implement control mechanisms of ATIS information - Use shifting male and female voice reading out ATIS - Display clearly for ATCOs the defined / valid wind conditions for operating the procedure - Advise balloons that flying is prohibited when independent parallel approaches are
		2. Technical failure relating to the ILS (LLZ / GP signal either lost or corrupted).		
		3. Failure of APP Radar		
		4. Windshear or other weather conditions	4. Identify and clarify the criteria relating to wind conditions for operating the procedure.	
		5. Stuck microphone when on baseleg (clearance received too late)		
		6. Runway closure (e.g. sudden closure due to tire burst	6. & 8. In case of sudden occurrences, it will require some time to inform ACC and stop the flow – leading to congested airspace (e.g. many aircraft approaching, but one runway gets blocked and Independent Parallel not to be used)	

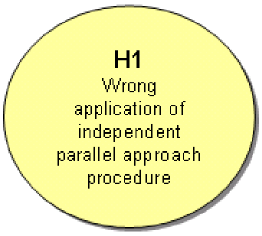
#	Hazard	Causes / Failure Modes	Remarks	Risk Mitigation
		7. Frequency congestion when ATCO has to deliver clearance resulting in a too late clearance (related to the stuck microphone problem)		in use - MALMI only to operate below specified altitudes when independent parallel approaches are in use - Include in AIP the typical hours when independent parallel approaches can be expected to be applied at Vantaa - Develop contingency procedure for operations in case of radar failure - Pilot automatically intercepts LZZ even if not cleared for ILS on base leg.
		8. Instant / unexpected change in weather conditions	See above	
		9. COM failure		
		10. Lost VFR traffic (and balloons); penetrating airspace		
		11. Medical helicopter requiring 1st priority		

APPENDIX O: DETAILED SAFETY REQUIREMENTS

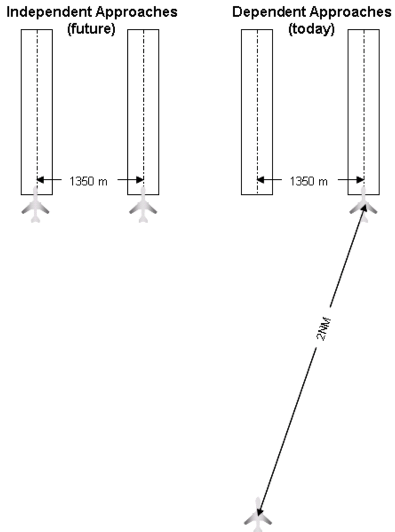
The subsequent proposed safety requirements constitute the detailed and reconciled mitigation actions. They apportion the mitigation actions on individual elements and the connected failure modes and supports with the rationale.

The safety requirements listed below can be traced back to the three identified hazards through causes and failure modes via the fault trees and traceability matrices included in Appendices J and L.

Note that three types of safety requirements are included. The first set comprises the firm safety requirements which shall be implemented. The second set comprises the candidate safety requirements where further investigation shall take place before determining whether it is beneficial to implement the requirement. The candidate requirements are written in *italics*. The third set comprises the External Mitigation Means. These are all labelled EMM-SR0*x*.

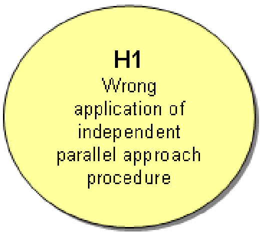
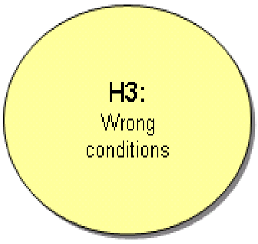
Failure Modes	**Proposed Safety Requirements**	**Rationale**
A. ATC error 	Dedicated training of ATCOs: SR1 Finavia shall develop and perform dedicated training in the procedure in general (for all ATCOs). Safety focus on at least: • Importance of precision in vectoring • Handling contingency and adverse situations such as ILS failure, loss of COM, loss of radar display, sudden runway closures and rapid unpredicted weather changes • Importance of timely hand-over • Importance of complete and unambiguous co-ordination relating to activation and termination of the procedure • Handling of runway mode changes – both planned and unexpected • Handling of lost VFR and similar traffic penetrating airspace • Use of non-standard clearances and the risk of misunderstanding • Familiarity with hot spots and critical moments	During Independent Parallel Approach operations, the horizontal separation is reduced (1350 m / 0.8 NM) leaving very little room for manoeuvres. Further, the procedure will only be in use when traffic density is high. It is, therefore, important – through the training – to get the ATCOs attention to the possible safety impact in case of errors, misunderstandings and complacency.
	Improved HMI: SR2 Finavia shall improve the HMI in a way that reduces the possibilities for confusion and misunderstandings. Safety focus on at least: • Use of distinct colours of strip holders for each runway • Clear presentation of frequency lists	Carefully developed HMI can reduce the possibility for confusions etc. Such HMI includes strip-holders in different colours depending on runway as well as visible and easy accessible frequency lists etc.

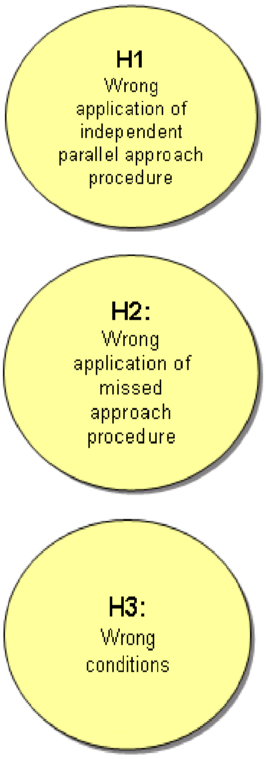
Failure Modes	Proposed Safety Requirements	Rationale
	Change of runway numbering *SR3 Finavia shall investigate to change the runway numbering to e.g. 04 and 05 (instead of 04R and 04L) to reduce the risk of confusion*	The risk of mixing up the runways and thus fly/instruct a wrong approach will be reduced if runway numbering is more clearly separated. The size of the risk reduction should, though, be investigated to prove its usefulness. If the runway numbering has been in force for many years, it may create more severe effects to change numbering (pilots are used to the present runway designators).
	EMM-SR03a Finavia shall ensure that controllers are trained in visual observations	Relying on radar and visual observation, ATCOs closely monitor each aircraft under his responsibility to ensure a safe distance between all aircraft.
	EMM-SR03b Finavia shall ensure that the construction of the new tower optimises the visual observation of the traffic	Linked to Ref. [11].
	EMM-SR03c Aircraft operators shall ensure that pilots are trained in the see-and-avoid concept	Whenever the pilot of one aircraft can see another aircraft, the see-and-avoid-concept applies.
	EMM-SR04 Finavia shall ensure that the surveillance equipment complies with ICAO Doc 9643 (SOIR) - Appendix A	**Linked to SR12** Cf. Ref. [3]
	EMM-SR05a Finavia shall ensure that communication equipment complies with standard ICAO provisions (ICAO Annex 10)	**Linked to SR12**
	EMM-SR05b Finavia shall ensure that the priority call – feature contained in the communications equipment is checked at each position prior to the controller assuming responsibility of the position	**Linked to SR12** Cf. Ref. [3]

Failure Modes	Proposed Safety Requirements	Rationale
B Pilot error **H1** Wrong application of independent parallel approach procedure **H2:** Wrong application of missed approach procedure	Dedicated training of pilots: SR4 Aircraft operators shall perform dedicated training in the procedure in general. Safety focus on at least: • Importance of reaching the required High Side and Low Side levels and the timely notification to ATC if unable to reach levels • Importance of immediate* response to breakout instructions • Importance of ensuring that approach to correct runway is performed and that the applicable LLZ is armed • Importance of the reduced separation** requiring strict adherence to rules • Importance of adherence to runway occupancy time (as published in AIP Finland) and thus exit runways as fast as possible • Operating during contingency and adverse situations, e.g. due to technical failures	Separation is infringed if High Side is too low and/or Low Side is too high. Furthermore, an infringement of the NTZ does not allow any time for confusion or indecision on the part of the pilots (nor the controllers). Breakout instructions require an immediate response and pilots should keep an increased sense of awareness when conducting Independent Parallel Approaches, so as to immediately act and respond to any 'breakout' instruction they may be given. * immediate corresponds to "prompt obedience" and the breakout shall be performed instantly / with no delay. ** a change from dependent parallel approaches to independent parallel approaches reduces the separation as illustrated: 
	Examination of checklists: SR5 Aircraft operators shall examine the cockpit checklists in order to ensure that it as a minimum includes: • checking of whether correct LLZ is armed • re-checking if runway is changed	Several accidents and incidents have been attributed in part to misuse, non-use or incomplete cockpit checklists.

Failure Modes	Proposed Safety Requirements	Rationale
	Increase general awareness: SR6 Finavia shall develop briefing and awareness material including as a minimum: • content of the procedure • implications for aircraft operators • the focus areas listed in SR4 SR7 Finavia shall distribute the briefing and awareness material amongst the aviation community	Not all parts of the aviation community are equally easy to reach to distribute awareness. Suitable information channels should be sought and utilised (e.g. flight magazines, through flying school facilities, web announcements).
	Awareness that the procedure is in use: *SR8 Finavia shall investigate which improvements to the ATIS read out to implement in order to reduce the possibility for pilots failing to notice that the procedure is applied (e.g. shifting male and female voices reading out the ATIS – indicating that a new ATIS is in force)* *SR9 Finavia shall investigate which further means to utilise to ensure that pilots are notified that the procedure is applied (besides ATIS)*	The application of Independent Parallel Approaches is notified on ATIS. However, in order to increase the awareness of the pilots that they may expect Independent Parallel Approaches other means may be utilised. For example, notification on website or AIP of usual hours for operating the procedure allowing the pilots to be aware already in the preparation phase.
	Training of ATCOs in use of simple clearances – cf. SR 1. Use of standard clearances: SR10 Finavia shall prohibit conditional clearances when independent parallel approaches are applied in order to decrease the risk for misunderstanding	ATCOs may issue a clearance that deviates from normal procedure in order to try to solve a problem quickly (e.g. deviates from standard missed approach proc.) – or ATCOs may provide a conditional clearance (…in case of missed approach…) Such clearances may be misunderstood by the pilot.
	Minimise runway occupancy time: SR11 Finavia shall declare more strict runway occupancy times in AIP	**SR11: LINKED TO EMM2** Slow taxiing of previous landed aircraft, slow reaction of departing aircraft, miss of high-speed exit – these issues may lead to a too long runway occupancy impacting the spacing to the succeeding aircraft.
	EMM-SR01a Finavia shall ensure that technical monitoring is in place for all safety-critical system elements including: • ILS/MLS • VHF communication equipment • radar/surveillance system (SSR) • ATIS • VOR/DME • RNAV	**Linked to SR13**

Failure Modes	**Proposed Safety Requirements**	**Rationale**
	EMM-SR01b Aircraft operators shall ensure that technical monitoring is in place for all safety-critical system elements including: • ILS/MLS • VHF communication equipment • transponder • Flight Management System • VOR/DME • RNAV	
	EMM-SR02a Finavia shall ensure that Runway Occupancy Times are established and published in the AIP EMMSR02b Aircraft operators shall ensure that pilots are trained in observing the published runway occupancy times ***EMM-SR03-05 also applicable in relation to this failure mode. Cf. descriptions above.***	**Linked to SR11** Improved operational consistency in adhering to the runway occupancy times increases capacity, but does also reduce the risk for loss of separation / missed approach (preceding not vacated runway timely)

Failure Modes	Proposed Safety Requirements	Rationale
C Ground equipment failure   	Equipment performance and monitoring: SR12 Finavia shall ensure that the following minimum equipment including backup is in place in compliance with ICAO provisions: • ILS / MLS • SSR equipment with a minimum azimuth accuracy of 0.3 degrees (one sigma) or better and an update period of 5 seconds or less • COM with a priority call - feature SR13 Finavia shall ensure that technical monitoring is performed of the minimum equipment as listed in SR12 *SR14 Finavia shall investigate whether further/increased technical monitoring is necessary and whether further preventive measures shall be implemented*	**SR12: LINKED TO EMM4 & EMM5** **SR13: LINKED TO EMM1** Relevant ICAO annexes include: • DOC 4444: Air Traffic Management • Annex 3: Meteorological Service for International Air Navigation • Annex 10: Aeronautical Telecommunication • Annex 11: Air Traffic Services • Annex 14: Aerodromes • Annex 15: Aeronautical Information Services
	Definition and implementation of contingency procedures: SR15 Finavia shall define and implement the necessary contingency procedures accounting for equipment failures/insufficiency occurring while Independent Parallel Approaches are in force SR16 Finavia shall define and implement the necessary contingency procedures accounting for failures relating to the Technical Monitoring System while Independent Parallel Approaches are in force	If contingency procedures need to be different – due to the reduced horizontal separation etc – from existing contingency procedures these shall be developed, tested and implemented. Further, timely delivery of clearances is a key element of the application of the procedure. Thus, in the case frequency congestion / stuck mic results in a too late clearance, it should be investigated whether a procedure where pilots automatically intercept the LLZ even if not cleared on base leg is mitigating the problem.
	Training of ATCOs in contingency situations – cf. SR 1.	
	Control mechanisms relating to the ATIS: SR17 Finavia shall define and implement a control mechanism (e.g. a double-check procedure) of the information provided in ATIS	Wrong / corrupted information in the ATIS can be crucial. An additional check of the ATIS could, therefore, be applied, at a minimum while Independent Parallel Approaches

Failure Modes	Proposed Safety Requirements	Rationale
	Improved HMI: SR18 Finavia shall implement a means allowing for clear display to controllers when major changes of the ATIS occur (e.g. blinking or distinct highlighted) *SR19 Finavia shall investigate whether a procedure shall be developed for controllers to repeat such major changes to arriving aircraft* ***EMM-SR01-05 all applicable in relation to this failure mode. Cf. descriptions above.***	are in use. Furthermore, major changes shall be displayed at controller display for their attention – and it should be investigated whether a procedure should be developed for controllers to repeat such changes to arriving aircraft. An investigation is required as the benefit of such procedure could be the increased assurance that pilots are aware of the changes, while the disadvantage is the increased use of frequency space (e.g. leading to frequency congestion).
D Air equipment failure  	Equipment performance: SR20 Aircraft operators shall ensure that aircraft equipment is certified in accordance with regulations (JAR) Training of pilots in contingency situations – cf. SR 2. Avoiding stuck mic – cf. SR 15. Reducing false TCAS alerts: SR21 Finavia shall introduce in the AIP that only the TA function of TCAS shall be activated (if equipment allows) while Independent Parallel Approaches are operated ***EMM-SR01-05 all applicable in relation to this failure mode. Cf. descriptions above.***	Note from DOC 9643: "Aircraft using the LLZ course signals are subject to errors from several sources, including the accuracy of both ground and air equipment, and the ability of the pilot / autopilot to follow the navigational guidance (Flight Technical Error (FTE)). It is, therefore, essential that the FTE is measured at each installation and that the number of false deviation alerts are kept to a minimum." Even though many radios today have "time-out" timers that automatically shut a radio off after being on for a few minutes, this is not of use during Independent Parallel Approach Procedures where response time is much shorter. During the application of the Independent Parallel Approach procedures, the number of TCAS alerts may increase due to the reduced separation. TCAS may not be able to perform normally during operation of Independent Parallel Approaches.

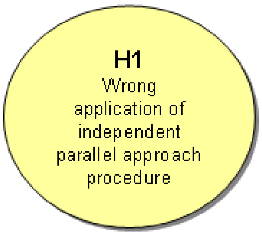
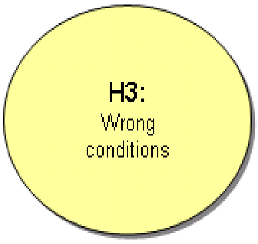
Failure Modes	**Proposed Safety Requirements**	**Rationale**
E Other  	Weather condition display for ATCOs: SR22 Finavia shall implement means to display clearly for the Supervisor the criteria for operating / suspending the procedure – allowing for timely reaction – including: • weather criteria • equipment performance requirements • staffing criteria SR23 Finavia shall display clearly the procedure for activation and termination of the Independent Parallel Approach Procedure	The application of Independent Parallel Approaches shall be suspended under certain adverse weather conditions (wind shear, turbulence, downdrafts, crosswind, thunderstorms) as the deviations to the track might be such that safety is impaired. A timely suspension of the procedure reduces the potential for safety impact. Note from DOC 9643: “ATS authorities should establish criteria for the suspension”. “Consideration should be given to the weather characteristics at each individual aerodrome.”
	Avoidance of traffic on active runways: SR24 Finavia shall ensure that procedures are in place for vehicles operating on manoeuvring area SR25 Finavia shall ensure that vehicle drivers are properly trained in the procedures for operating on manoeuvring area *SR26 Finavia shall investigate the possibilities for implementing additional stopping means*	During Independent Parallel Approach operations, the horizontal separation is reduced and traffic density is high. This leaves very little room for manoeuvres. Runway crossings shall be limited if not prohibited unless deemed necessary (including the hot spot where crossing is slow due to up-hill). Vehicle drivers shall be trained and fully aware of the possible safety effects.
	Avoidance of penetration of airspace: SR27 Finavia shall advise balloon operators that balloons are prohibited when Independent Parallel Approaches are applied SR28 Finavia shall advise Malmi Aerodrome that flying above a defined* altitude is prohibited when Independent Parallel Approaches are applied Increase general awareness cf. SR 6 & 7.	By purely prohibiting the flying of balloons, VFR at Malmi above at certain* altitude etc the problem relating to penetration of airspace should be nearly eliminated – if pilots observe the rules. It is important, though, to be able to reach these airspace users – proper channels for distributing awareness and briefing shall be sought. ** Finavia to define this altitude* Sanctions could be considered if some pilots blatantly break the rules.
	Medical helicopter: SR29 Finavia shall develop a procedure for handling the medical helicopter while Independent Parallel Approaches are in use SR30 Finavia shall train ATCOs in such procedure ***EMM-SR01-05 all applicable in relation to this failure mode. Cf. descriptions above.***	The medical helicopter has 1st priority.

Table O-1: Proposed safety requirements

APPENDIX P: LIST OF PARTICIPANTS

Helsinki - Vantaa, 13 and 14 December 2005:

Name	Position	Organisation
Mr Raine Loujus	Deputy Chief, Air Traffic Control	Finavia
Ms Jenny Eklund	Controller	Finavia
Mr Pasi Olli	Controller	Finavia
Mr Manne Koponen	Controller / Procedure Designer	Finavia
Mr Pekka Peräkylä	Captain	Finnair
Mr Patrick Mana (13 December only)	Safety Expert	EUROCONTROL – DAP/SAF
Ms Dorte Wang	Project Manager	Integra Consult A/S
Mr Pär Prahl	Safety Expert	Integra Consult A/S
Mr Stefan Reib	Moderator	Integra Consult A/S

APPENDIX Q: REFERENCES

Ref. No.	Title	Ref.
1.	Safety Assessment Methodology (SAM)	Eurocontrol SAF.ET1.ST03.1000-MAN-01
2.	Safety Assessment of ATM Procedures (SAAP)	Eurocontrol
3.	Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (SOIR)	ICAO Doc 9643 AN/941
4.	Independent approaches to parallel instrument runways – EFHK procedures	Finavia (cf. also Appendix R)
5.	ESARR 3: Use of Safety Management Systems by ATM Service Providers	Eurocontrol
6.	ESARR 4: Risk Assessment and Mitigation in ATM	Eurocontrol
7.	ICAO Annex 11: Air Traffic Services	ICAO
8.	ICAO Doc 4444: Procedures for Air Navigation Services – Air Traffic Management	ICAO
9.	ICAO Annex 14: Aerodromes	ICAO
10.	EFHK operational handbook (HLOK)	Finavia
11.	Safety Case: New Tower Helsinki – Vantaa; December 2005	Integra Consult A/S

APPENDIX R: FINAVIA – DRAFT INDEPENDENT PARALLEL APPROACH PROCEDURE

Independent approaches to parallel instrument runways – EFHK procedures

1. General

This document describes the working procedures for independent approaches to EFHK parallel runways 04 / 22 left and right.

These procedures are part of EFHK ATC´s development of the simultaneous approaches. The first stage of this development started in April 2005 (dependent parallel approaches). The aim of developing procedures is to conclude implementation of the EFHK 3rd runway (04L/22R) and its capacity.

Procedures described in this document will later be attached to Helsinki ATC´s Operative Handbook (HLOK).

Specific requirements concerning procedures are also described in check lists on each working position.

The safety assessment document for these procedures will be included in Appendix A.

2. The runways in use

The runways in use are assigned according to the principles of EFHK operational handbook (HLOK).

When parallel approaches are in operation:

a) Arriving traffic from IAF LAKUT is positioned to runway 04L/22R.

b) Arriving traffic from IAF PEXEN, PVO, ORM and INTOR is positioned to runway 04R / 22L.

In the case of the traffic forecast from the CFMU not being divided equally to both runways, the EFHK APP shift supervisor allows the use of the other runway for specific IAFs. When using parallel runways 22, arriving traffic from IAF ORM may also use rwy 22R for landing and in case of parallel 04 arriving traffic from IAF PEXEN may also use rwy 04L for landing. These changes require the coordination between EFHK APP shift supervisor and EFES ACC supervisor. They will decide and implement the relative database changes to the Maestro.

3. Technical requirements for independent parallel instrument approaches according to Doc 9643

a) Requirement: Where runway centre lines are spaced by less than 1525 m but not less than 1310 m, SSR equipment with minimum azimuth accuracy of 0,3 degrees (one sigma) and an update period of 5 seconds or less is required.

EFHK: Runway centre lines are spaced by 1350 meters and the accuracy and performance of the SSR equipment meets the minimum requirements.

b) Requirement: ILS approaches are being conducted on both runways.

EFHK: Dependent and Independent procedures are only with ILS approaches (Non – precision approaches not allowed). All EFHK ILS equipments have co-located DME's.

c) Requirement: The missed approach track for one approach diverges by at least 30 degrees from the missed approach track of the adjacent approach.

EFHK: Missed approach procedures meet the requirement.

d) Requirement: An obstacle survey and evaluation is completed, as appropriate, for the areas adjacent to the final approach segments.

EFHK: Survey and evaluation has been done by AIS department.

e) Requirement: A "No Transgression Zone" (NTZ) at least 610 meters wide is established equidistant between extended runway centre lines and is depicted on the radar display.

EFHK: No NTZ established yet.

Note: Runway spacing allows 650 meters wide NTZ, but how to determine "Normal Operating Zone" (NOZ) for each ILS?)

f) Requirement: Each pair of parallel approaches has a "high side" and a "low side".

EFHK: 04 L and 22L are determined to be a low side. The intermediate altitude of 04R and 22R´s ILS is 1000 ft higher and is determined to be the high side.

g) Requirement: Communication system's (Schmid) *priority call* - feature is in use. This feature is needed to guarantee the fastest possible phone coordination between the ARR and TWR controller.

EFHK: Schmid system has this capability.

Note: This is proposed difference from ICAO DOC 9643 Chapter 2.2.1.1 i)

4. Procedures

It is possible to execute independent approaches to parallel runways 04L/04R or 22L/22R at Helsinki – Vantaa airport when the requirements from the paragraph 3) of this document are met and under the following conditions:

1. Aircraft are advised that independent parallel approaches are in force. This information is normally provided through an ATIS broadcast.

2. Radar vectoring is used to intercept the ILS localizer and ILS approaches are being conducted on both runways.

3. Separate radar controllers are responsible for the sequencing and spacing of arriving aircraft to each runway.

4. Separate radar controllers monitor the approaches to each runway and ensure that when the 1000 ft vertical separation is reduced:

- aircraft do not penetrate the depicted NTZ; and

- the applicable minimum longitudinal separation between aircraft on the same ILS localizer course.

5. When an aircraft is being vectored to intercept the ILS localizer course, the final vector shall enable the aircraft to intercept the ILS localizer course at an angle not greater than 30 degrees and to provide at least 1.0 NM straight and level flight prior to ILS localizer course.
   The vectors shall also enable the aircraft to be established on the ILS localizer course in level flight for at least 2.0 NM prior to intercepting the ILS glide path.

6. A minimum of 1000 ft vertical separation or a minimum of 3.0 NM radar separation shall be provided at least until 12 NM from threshold and until aircraft are established:

- Inbound on the ILS localizer

- Within the normal operating zone (NOZ).

Note. The 12 NM is a proposed difference from ICAO DOC 9643 Chapter 2.2.1.5

7. EFHK TWR working positions TWR E and TWR W shall be manned with EFHK APS / RAD qualified personnel.

8. TWR COR working position shall be manned.

9. Communication system is operating normally and the priority-call feature has been tested.

10. LVP –procedures are not in use. Other weather limitations criteria have to be established.

5. High side – Low side – principle

When vectoring aircrafts on simultaneous parallel approaches (dependent or independent) a minimum of 1000 ft vertical separation or 3.0 NM radar separation shall be provided until both aircraft are established inbound on the ILS localizer course.

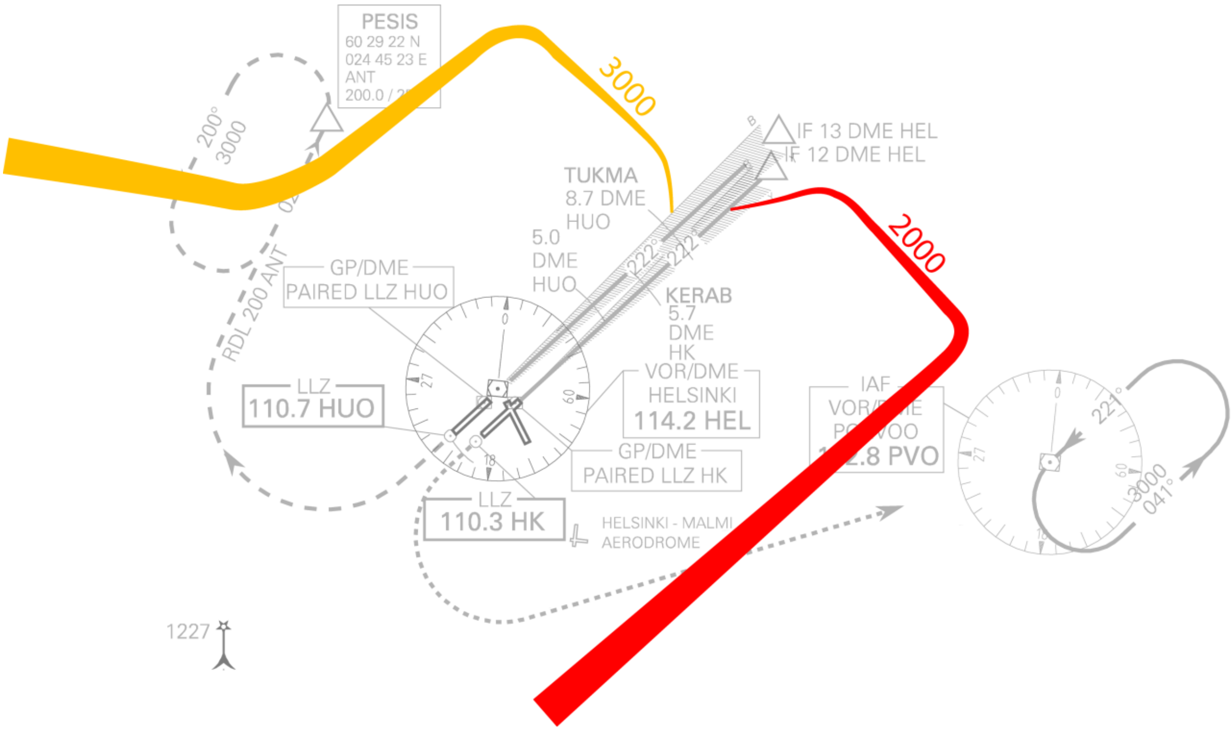
Each pair of parallel approaches has a "high side" and "low side". At EFHK "low side" is determined to be the left of the parallel runway (04 L and 22 L). This is because EFHK parallel runways are staggered and this determination allows shortest possible finals.

The ILS procedures intermediate altitude of the "high side" is determined to be 1000 ft higher than the intermediate altitude of the "low side". The flight procedures have 1000 ft vertical separation until the "high side" passes the FAP and starts the decent on glide path.

The traffic of the "low side" shall be vectored to establish on the ILS localizer maintaining intermediate altitude to a point at least 3 NM laterally behind the FAP of the "high side".

This procedure ensures the minimum separation of 3 NM or 1000 ft until both / all aircraft are established on the ILS localizer.

Picture 1. "High side" and "low side" for EFHK runways 22 L and 22 R.



6. Tasks of each ATCO position

6.1 RADAR EAST and RADAR WEST tasks (RAD E and RAD W)

RAD E or RAD W gives the standard arrival clearance for arriving traffic. The traffic is cleared via the EFHK internal TMA sectors (using either radar vectors or RNAV STARS). After the arriving traffic is separated with departing traffic the RAD E or RAD W hands the traffic to separate arrival controllers (ARR E or ARR W).

Arriving traffic from IAF Lakut will use rwy 04L or 22R. Traffic from any other IAFs will be positioned to rwy 04 R or 22L. If the traffic flow requires IAF ORM (22 parallel) and IAF PEXEN (04 parallel) traffic may also be positioned to 22 R or 04L respectively, depending on runway capacity. The Maestro sequencer does not require database changes, however the runway in use for the specific aircraft needs to be changed. Also telephone coordination is required between the respective controllers (EFES, if outside the TMA – EFHK APP – EFHK TWR).

When changing the runway for landing after the first **arrival** clearance, the new clearance should also include the LLZ frequency of the new runway. (*first arrival clearance = RNAV STAR or heading and runway from Tampere / Tallinna ACC or 1st clearance by EFHK RAD when traffic from St. Petersburg ACC*). This instruction concerns whether the change of the runway is done by the controller or from a request of the pilot.

RTF: "***FIN 123 RWY 04R FOR LANDING, check LLZ frequency 111, 5***"

RAD E / RAD W do not make the final sequencing decisions. They will transfer the traffic according to standard vectoring procedures. E.g. Parallel 22 procedures in use; via downwind heading, with same altitude and speed. (Parallel 22: H040, 5000ft, IAS 210kts)

6.2 ARRIVAL EAST and ARRIVAL WEST tasks (ARR E and ARR W)

Arrival controllers make the final sequencing. Arrival controller of the "low side" is always the determinant side.

ARR W is responsible for controlling traffic to runway 04L /22R (low side 04 parallel).

ARR E is responsible for controlling traffic to runway 04R /22L (low side 22 parallel).

The traffic of the "low side" shall be vectored to establish on the ILS localizer maintaining intermediate altitude to a point at least 3 NM laterally behind the FAP of the "high side". These localizer intercept points are depicted on radar displays. When vectoring traffic via these points there is always the required minimum separation until aircraft are localizer established.

Low side traffic must be cleared to 2000ft when using 22L and 2300ft when using 04R. Traffic must be in level flight or close to cleared level when turning base leg. Specific RTF is required to achieve this; "….***expect base turn after reaching 2000 ft*** …" or "…***expedite reaching 2000 ft*** .."

High side traffic must be vectored sufficient distance behind the FAP to enable the required period of level flight before GP.

When an aircraft is being vectored to intercept the ILS localizer course, the final vector shall enable the aircraft to intercept the ILS localizer course at an angle not greater than 30 degrees and to provide at least 1.0 NM straight and level flight prior to ILS localizer course.

The vectors shall also enable the aircraft to be established on the ILS localizer course in level flight for at least 2.0 NM prior to intercepting the ILS glide path.

A minimum of 1000ft vertical separation, or a minimum of 3NM shall be provided at least until 12 NM from the threshold and until aircraft are established:

a) Inbound on the ILS localizer course
b) Within the Normal Operating Zone (NOZ)

Note. EFHK would like to extend the distance from threshold separation minima for their independent approaches. EFHK want to use 12 NM (as opposed to 10NM as current procedures allow) for independent parallel approaches. This is because of the increased range from touchdown required due to high side glide path point.

Responsibility with regards to separation of arriving traffic on each runway is the responsibility of the respective arrival radar controller until the aircraft has landed, or has executed a missed approach procedure.

Radar monitoring is the responsibility of the Arrival Radar controllers and shall not be terminated until:

a) Visual separation is applied;
b) The aircraft has landed or, in case of a missed approach, is at least 1NM beyond the end of the runway and adequate separation with any other traffic is established.

Switching of responsibility of monitoring / radio contact to the TWR controller

Responsibility of separation remains with the arrival radar controller until the arriving traffic has landed, however the TWR controller is responsible for separation of arriving traffic from departing traffic.

Note. EFHK would like to extend the responsibility of the TWR controller. At EFHK when parallel independent procedures are in use the TWR controller will also be APP Radar qualified. EFHK would like to change the monitoring responsibility to the TWR Radar controller when aircraft are within the Tower Area of responsibility as listed in HLOK (below CTR 1300ft)

Switching of radio contact of arriving traffic should occur at 4NM from threshold.

6.3 TWR EAST and TWR WEST tasks (TWR E and TWR W)

Both TWR W and TWR E positions must be manned with EFHK APS / RAD qualified personnel when parallel independent approaches are in use.

Switching of responsibility of monitoring to the TWR controller

Responsibility of separation remains with the arrival radar controller until the arriving traffic has landed, however the TWR controller is responsible for separation of arriving traffic from departing traffic.

Note. EFHK would like to extend the responsibility of the TWR controller. At EFHK when parallel independent procedures are in use the TWR controller will also be APP Radar qualified. EFHK would like to change the monitoring responsibility to the TWR Radar controller when aircraft are within the Tower Area of responsibility (CTR - surface to1300ft) as listed in HLOK.

TWR controller is responsible in the event of arriving traffic carrying out a missed approach procedure or deviating from the localizer with regards to their own non arriving traffic.

6.4 TWR COR tasks

TWR COR position must be open and manned when parallel independent approaches are in use. The controller must be EFHK ADI / TWR qualified.

Tasks and area of responsibility

Area of responsibility:

a) No defined area of responsibility.
b) Primary task is to assist TWR E controller.

Radio Callsign:

a) Uses TWR callsign only within the rights assigned to it from the TWR E controller

Tasks:

a) Assist TWR E controller with regards to coordination between TWR E and other controller positions.
b) Uses ground movement radio frequency with the TWR callsign only with rights assigned to it from the TWR E controller.
c) All clearances involving all runways are obtained from TWR E controller and relayed by TWR COR.
d) Assist Apron Control and other TWR positions with regards to towed and taxiing traffic.
e) Assist TWR E controller with strip management.
f) Assist TWR E controller with regards to airfield light selection.

7. Controllers responsibilities when aircraft deviate from the LLZ or penetrate the NTZ

7.1 Responsibility of separation

Responsibility with regards to separation of arriving traffic on each runway is the responsibility of the respective arrival radar controller until the aircraft has landed, or has executed a missed approach procedure.

The TWR controller is responsible for separation of arriving traffic from departing traffic.

Radar monitoring is the responsibility of the ARR controller unless within the Tower Area of responsibility (CTR - surface to1300ft) as listed in HLOK in which case it is the TWR responsibility.

7.2 Actions to be taken when aircraft penetrate or threaten to penetrate the NTZ

The appropriate monitoring controller is responsible for instructing an aircraft to return to the correct localizer course should the aircraft be observed to deviate towards the NTZ.

If an aircraft penetrates the NTZ the appropriate monitoring controller of the adjacent approach will also instruct their aircraft to immediately climb and turn to an assigned altitude and heading in order to avoid the deviating aircraft.

Any heading instruction shall not exceed 45 degrees track difference with the ILS localizer course. Due to parallel approach obstacle assessment surfaces (PAOAS) criteria, the air traffic controller shall not issue the heading instruction to an aircraft below 400ft above the threshold elevation. When outside of PAOAS area 1000ft minimum obstacle clearance minima must be observed.

If the deviating or affected aircraft is in radio contact with the TWR controller then the ARR controller must always use the priority call feature on the Schmid telecommunication system to instruct correctional manoeuvres.

Note. This is a proposed difference from ICAO DOC 9643 Chapter 2.2.1.1 i)

Examples of telephone phraseology:

”TÄSSÄ ARR, KÄSKE FIN 123 VÄLITTÖMÄSTI YLÖSVETOON” **tai**

”TÄSSÄ ARR, KÄSKE FIN 123 VÄLITTÖMÄSTI TUTKAOHJAUSSUUNNALLE 015 JA NOUSEMAAN 2000 FT”

Example of radio phraseology when traffic is 400 ft or above the threshold elevation:

”FIN 123 TURN LEFT HEADING 015 IMMEDIATELY AND CLIMB 2000 FT TO AVOID TRAFFIC (deviating from adjacent approach)”

“ FIN 123 KAARRA VASEMPAAN OHJAUSSUUNTAAN 015 VÄLITTÖMÄSTI JA NOUSE 2000 JALKAAN VÄISTÄÄKSESI LIIKENNETTÄ (harhautuu viereisestä suuntasäteestä)”

Example of radio phraseology when traffic is below 400 ft from the threshold elevation:

”FIN 123 TURN CLIMB TO 2000 FT IMMEDIATELY TO AVOID TRAFFIC (deviating from adjacent approach), TURN LEFT HEADING 015”

“ FIN 123 NOUSE 2000 JALKAAN VÄLITTÖMÄSTI VÄISTÄÄKSESI LIIKENNETTÄ (harhautuu viereisestä suuntasäteestä) ja KAARRA VASEMPAAN OHJAUSSUUNTAAN 015”

7.3 Actions to be taken when aircraft fails to intercept the localizer or deviates from the localizer outside of the NTZ area- no loss of standard separation.

When an aircraft fails to intercept the localiser for the specified runway and minimum separation is not immediately in danger, the aircraft is instructed to return to the localizer.

Example of radio phraseology:

”FIN 123 YOU HAVE CROSSED THE LOCALIZER RWY 04L, TURN LEFT IMMEDIATELY AND RETURN TO THE LOCALIZER” “CHECK 04L LLZ FREQUENCY 111.9”

“FIN 123 OLET LÄPÄISSYT KIITOTIE 04L SUUNTASÄTEEN, KAARRA VASEMPAAN VÄLITTÖMÄSTI JA PALAA SUUNTASÄTEESEEN” ”TARKISTA 04L SUUNTASÄTEEN TAAJUUS 111.9”