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Training Needs Analysis for NH90 air and ground crews in Sweden

Abstract

Sweden has acquired a new multirole helicopter based upon NH90. In order to support the procurement of a suitable training media suite for both air and ground crews, the Defence Materiel Administration (FMV) decided to investigate the actual training needs. The Swedish Defence Research Agency (FOI) was contracted to analyze the future training needs by conducting a so-called Training Needs Analysis (TNA) for both air and ground crews. The resulting documentation was to serve as a basis for selection of suitable training media. The TNA consists of two major phases where phase one is focused on establishing the training objectives resulting in the training needs and a set of technical requirements. Phase two involves mapping of the result from phase one to a selection of conceivable training media and a recommended training solution is obtained.

Keywords

Training Needs Analysis, TNA, training, helicopter, air crew, cockpit crew, ground crew, simulator, training media

Language English

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Summary

The Training Needs Analysis (TNA) is conducted for the Swedish HN90 air and ground crews in the Swedish Armed Forces. The TNA, which is based upon JSP 502 The Tri-Service Guide to Training Needs Analysis (TNA) for Acquisition Projects, consists of two major phases.

Phase one starts with the Operational and Technical Task Analysis (OTTA) resulting in a set of Operational and Technical Task Statements (OTTS), that is the tasks and duties that are to be performed by air and ground crews. The Training Gap Analysis (TGA) takes the student's entry level into account and produces the total training objectives. Finally the Technical Requirement Analysis (TRA) states technical requirements of vital importance for the ability to meet the training objectives.

Phase two, the Training Option Analysis (TOA), starts with determination of adequate and conceivable training media (TM). The goal is to establish a match between training media types and the requirements in the matrix from phase one. The results of the TOA together with certain aspects such as recommended type of visual system and need for motion cueing are added to the matrix and a recommended training solution is obtained.

For aircrew the Difficulty, Importance and Frequency analysis (DIF-analysis) shows that there is a considerable training need, as the majority of tasks falls into categories train or overtrain. The least amount of training, category initial training, is only sufficient for a very limited number of tasks. Furthermore, missions and tasks that are performed more infrequently require over training.

The task analysis indicates a substantial amount of within crew and outside crew interaction such as co-ordination, co-operation and collaboration that takes place during all phases of a mission. Most often this type of training is conducted as on-the-job training. We believe there are several reasons why there should be TM supporting the aircrew training. First of all, the simulator environment is safe and mistakes are allowed. Tasks can be practised as needed independently of weather and other external circumstances. Secondly, different "type situations" can be generated and practised facilitating the transfer of knowledge from the more experienced to the novice crewmembers. Thirdly, such TM gives opportunity to accommodate and maintain homogenous crew standards. Finally, it is an excellent tool for evaluation of new task concepts. Consequently, aircrew-TM is associated with high training effectiveness and an increased flight safety.

The fact that the Swedish NH90 has a number of complex subsystems, and a not so user-friendly man-system-interface, means that more time will be spent on learning how to operate the various subsystems than the actual acquisition of flying skills.

The training solution obtained in the TOA consists of TM for three types of training, type rating, recurrent training and mission training. Type rating and recurrent training is facilitated using computer aided instructions (CAI) together with a virtual maintenance trainer (VMT) for systems understanding and the part task trainer (PTT) for procedure training before entering the full flight simulator (FFS) level. The large benefit of the PTT in this stage is the opportunity for familiarization and preparation at the national training facility at the student's own pace. However, both the PTT and the FFS-T1 simulates the T1 variant and dos not reflect the specific Swedish NH90 functionality. As a consequence there will be a need for delta training on certain functionalities not suitable for on-the-job training (OJT).The preferred training solution is based upon acquisition of high fidelity TM such as cockpit procedure trainer (CPT) and rear cabin trainer (RCT). The CPT should be equipped with a large visual system, various sensors and an adequate tactical environment simulation to accommodate both for specific Swedish needs and preparations for international operations. The RCT must allow training of the entire rear cabin crew and when applicable also the troop. In addition, provision for connection between CPT and RCT will create a TM solution suitable for various types of mission training involving the entire aircrew. An advanced CPT may also be capable of providing training transfer regarding many of the tasks otherwise dedicated for the FFS level. Furthermore it is important

to ensure a more generalized networking capability allowing for connection to other types of simulators as needed on a national basis. The tactical training center, including the various types of TM, should be located in close proximity to daily operations in order to facilitate both scheduled and spontaneous use.

The different TM associated with this tactical training center does not necessarily have to be ready for training at the same time. Rather both the training center and it’s TM probably benefits from a stepwise development where the training needs are satisfied in time for they presence. This means for instance that the CPT can be completed before the RCT and the functionality of the RCT can grow over time. This way the TM functionality can benefit from the latest development in technology, which may lower the cost, increase fidelity and in some cases provide functionality that does not even exist today.

For ground crew the Difficulty, Importance and Frequency analysis (DIF-analysis) shows that there are no fundamental differences between the Swedish NH90's airframe and current helicopters that affects the daily inspections and SI. The training objectives for daily inspections and SI shows that maintenance engineers need spatial knowledge of where components are located, that they need to understand the function of the component and how it impacts helicopter performance and safety, and that they should be able to perform the correct maintenance actions and exercise appropriate judgment. However, the task complexity, time pressure, and mental workload of some tasks make the performance sensitive to distractions and stress. Although maintenance engineers obtain conceptual knowledge about human performance according to JAR-66, this is often not enough for improving the risk assessments during task execution. High reliability of risk assessments is only possible when integrated with automatic action sequences from exposure to a wide range of situations that require judgement during training. Whether the improved safety is warranted can only be determined by the Swedish Armed Forces since risk assessments of human performance and acceptable defects to some extent are included in the regular safety management.

The main difference between the Swedish NH90 and previous helicopters is in the complexity offered by integrated avionics systems where subsystems interact in providing system functions. Although managing and operating BIT is sufficient for many situations, it is usually far from covering the whole complexity. Considerable training is therefore required to develop the system understanding that is needed to judge BIT validity and interpret documentation and test systems during fault isolation. Especially, for the experienced B2 engineer who usually lack to the necessary computer experience to understand and interact with integrated avionics systems. A VMT that visualizes the full effect of interacting subsystems is required to develop the extensive system understanding that is needed to interpret what registered system parameters say about component function and subsystem interactions. Without such a VMT there is a risk for delays in fault isolation that may reduce helicopter availability until experts on fault isolation are locally available. If varied faults can be portrayed with animations of system behaviour, the VMT will provide a rich and varied environment with considerable explanatory value. Only the Swedish Armed Forces can determine whether these capabilities are warranted or if they expect experts with extensive system understanding to be locally available.

The recommended ground crew training solutions for the type rating course consists of one VMT at the national training centre. Finally, there should be 12 CAI licences at the national training centre to cover the annual training need.

Acknowledgement

We would like to thank FMV for the opportunity to conduct this TNA.

We would also like to thank all Subjects Matter Experts for their keen and ambitious participation.

1 Introduction

1.1 Background

Sweden has acquired a new multirole helicopter based upon NH90. The intention is to use this helicopter for a variety of mission types in various environments which naturally require appropriate equipment and highly skilled crews. In addition, the helicopter is equipped with new advanced technology and provides increased flexibility. As a consequence training may be more efficient if distributed to a set of training media (TM) in combination with on-the-job training.

In order to facilitate procurement of a suitable training media suite the Nordic Standard Helicopter Program (NSHP) decided to investigate future training needs. The Swedish Defence Research Agency (FOI) was contracted to conduct a so-called Training Needs Analysis (TNA) for both air and ground crews. The resulting documentation was to serve as a basis for selection of training media in the procurement process. The initial TNA was delivered to NSHP in May 2004. This joint training media effort was later cancelled and training had to be organized through a national initiative. FOI was asked by the Defence Materiel Administration (FMV) to make an updated TNA version for Swedish use only.

1.2 Objectives of the training needs analysis

The overall objectives of the TNA are:

- Via performance of an "Operational and Technical Task Analysis" (OTTA), a "Training Gap Analysis (TGA) and a Training Requirement Analysis (TRA)" arrive at the inputs needed to start a Training Option Analysis (TOA). The Training Media elements to be considered in the TOA are in most cases of generic origin.
- Via the TOA conclude which of the TM are needed in order to fulfil the Swedish NH 90 training needs and requirements.
- Study and conclude which of the Swedish NH 90 training needs that cannot be covered by the use of these Training Media elements.
- Identify possible and feasible changes in the technical and functional TM requirements which would improve the way that the TM suite fulfils the training requirement.

1.3 Objectives of the report

This report contains the complete documentation for both phases of the TNA, such as training objectives, training needs, technical requirements, and training option analysis. The document is intended to serve as a basis for selection of suitable training media for both air and ground crews and includes methods, data, analyses, results and recommendations.

This revised report is based upon the TNA previously conducted for the NSHP consortium in year 2003-2004, titled *Training Needs Analysis for NH90 Air and ground crews in Finland, Norway and Sweden* (Levin, 2004). This updated report is compiled especially for Sweden and revised to include the most recent information available. The work has been conducted at the Swedish Defence Research Agency (FOI) under contract of the Swedish Defence Materiel Administration (FMV).

1.4 Information and directives

Upon initialization of the project FMV presented a set of constraints and assumptions directing the TNA work. In addition FMV has given written and verbal instructions and constraints as the project has evolved.

Initial information applicable for the revised TNA:

- There is an expectation that two tactical training facilities (TTF) for aircrew use will be needed. However, the actual distribution of training media is likely to be determined after a cost effective analysis has been performed on data compiled by the training provider.
- Four Part Task Trainer (PTT) units will be delivered as a part of the initial helicopter contract
- A contract with HFTS will provide a number of training hours in a FFS of variant T1 (intended for cockpit crew). This solution is valid for a limited number of years and must not be regarded as a long term solution at this point.

1.5 Remarks

This report has partially been updated to reflect current mission objectives and crew configurations.

The mission content and hence mission flow charts have been revised. However, the document has not been changed to reflect all aspects of the mission types intended for the Nordic Battle Group or other types of international operations. Still, the TNA is expected to be valid since the focus has been on the actual training tasks included in the various mission types which mean that the training objectives per se are unaffected and remain applicable for various types of future missions. For example: a Typical CSAR mission intended for an international operation can be accomplished by combining tasks listed under SAR and TTT. Consequently, training of a typical international CSAR mission should be easily accomplished providing the particular TM supports both SAR and TTT as described in this TNA.

Tactical Coordinator (TACCO) is used in this document to represent the roles and duties of the Tactical System Operator, Weapon System Operator and Air Mission Commander (AMC) when performed from rear cabin consoles.

“Initial training” as used in this document refers to type rating / ab-initio training and not to the training conducted at the developer’s facility as a part of the initial H/C contract.

2 Methods

This chapter offers an overview of the selected approach to performing a Training Needs Analysis. The ambition was to treat air and ground crew as equally as possible. The basic analysis and presentations of results are therefore very similar. However, some differences were inevitable due to the nature of operations and differences in prerequisites. The differences are described as the various methods are discussed.

2.1 The TNA guide

When FOI was asked to consider conducting the TNA the first step was to look for a suitable guideline to the work. It turned out that although many TNAs had been conducted, very few had documented the methodology. The “JSP 502 The Tri-Service Guide to Training Needs Analysis (TNA) for Acquisition Projects” was therefore selected since it seemed to fulfil the requirements. This guide, developed for the Armed Forces in the United Kingdom, is not a standard and should not be contracted against. The guide was used as a baseline in the process of determining the scope of the TNA and to formalize the commitment in the Statement Of Work (SOW). Like most guides it is of general character. This means that it describes what need to be done but not necessarily how to do it. Although the project set out to comply with the guide some tailoring was necessary.

2.2 The TNA process

The TNA is preceded by the scoping study, which comprises all the activities and preparations that have to be conducted before the “real” TNA work can be initiated. The TNA is then separated into two major phases of where phase one is focused on establishing the training objectives resulting in the training needs and a set of technical requirements. Normally, phase two involves mapping of the result from phase one to a training media suite offered by the industry. In this case the training media suite is partially based upon a selection of adequate and conceivable generic training media types. Naturally a cost effectiveness analysis cannot be accomplished. The final result is a recommended training solution. Figure 2-1 shows an overview of the entire TNA process.

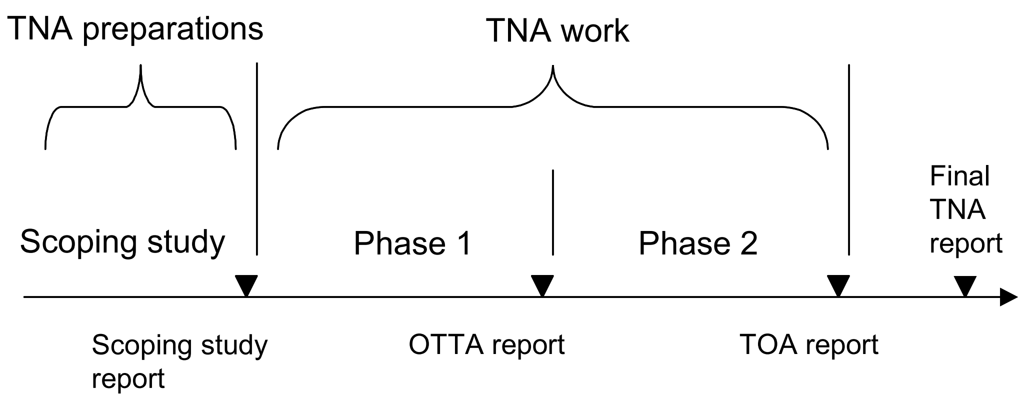

Figure 2-1 An overview of the TNA-process

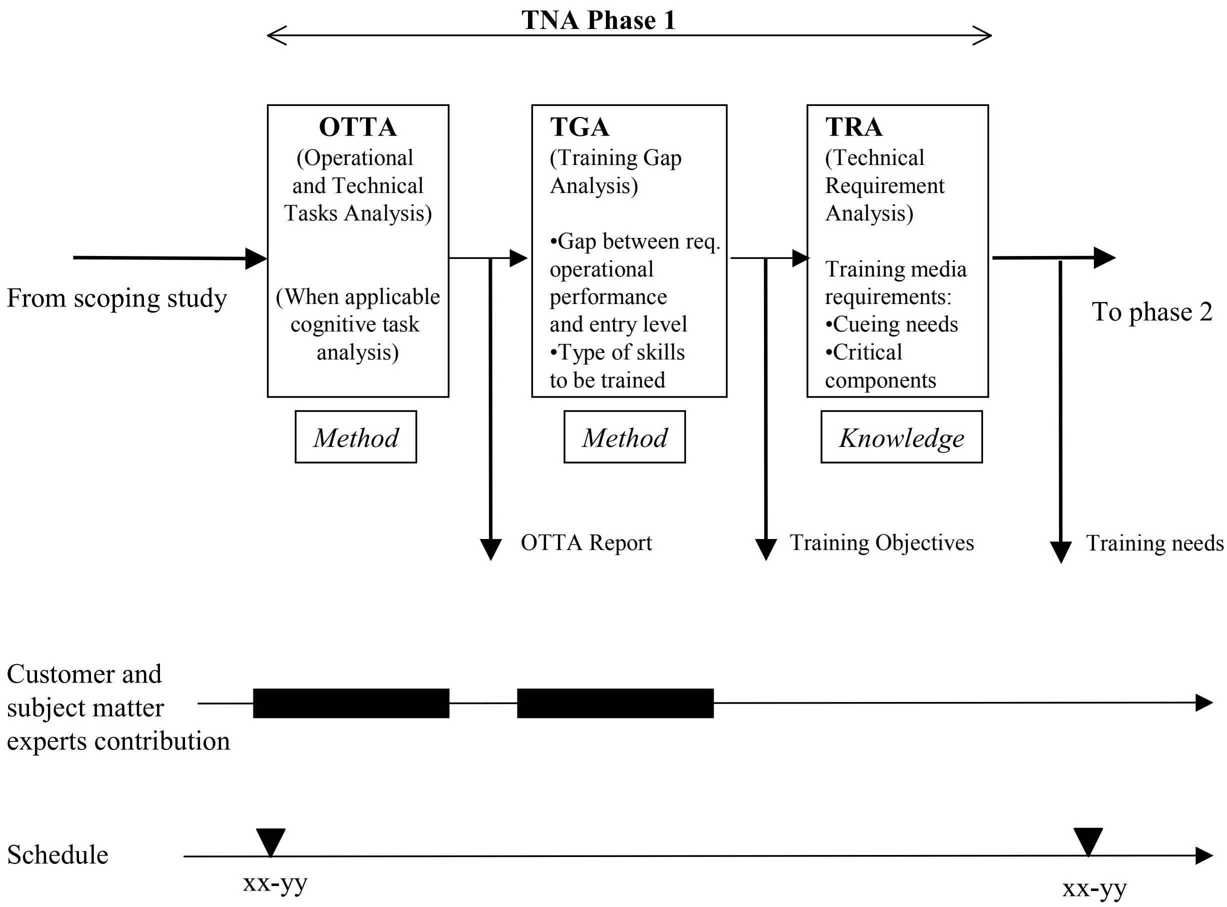

Figure 2-2 An overview of TNA Phase 1

Phase one, shown in Figure 2-2, consists of three separate parts – an Operational and Technical Task Analysis (OTTA), a Training Gap Analysis (TGA), and a Training Requirements Analysis (TRA). The purpose of the Operational and Technical Task Analysis (OTTA) is to identify important tasks and duties performed by air and ground crews during and between the Swedish NH90 helicopter missions. The results of the analysis are Operational and Technical Task Statements (OTTS) that describe the tasks and duties to be performed by each air and ground crewmember before, during, and after a mission of a particular type. The output from the OTTA is fed to the Training Gap Analysis (TGA), which serves to determine how the introduction of the Swedish NH90 impacts training requirements for air and ground crews. Together the OTTA and TGA form the basis for defining the end result, which are the training objectives for the Swedish NH90 air and ground crews. Finally, the TRA is intended to state the technical requirements of vital importance for the ability to meet the training objectives.

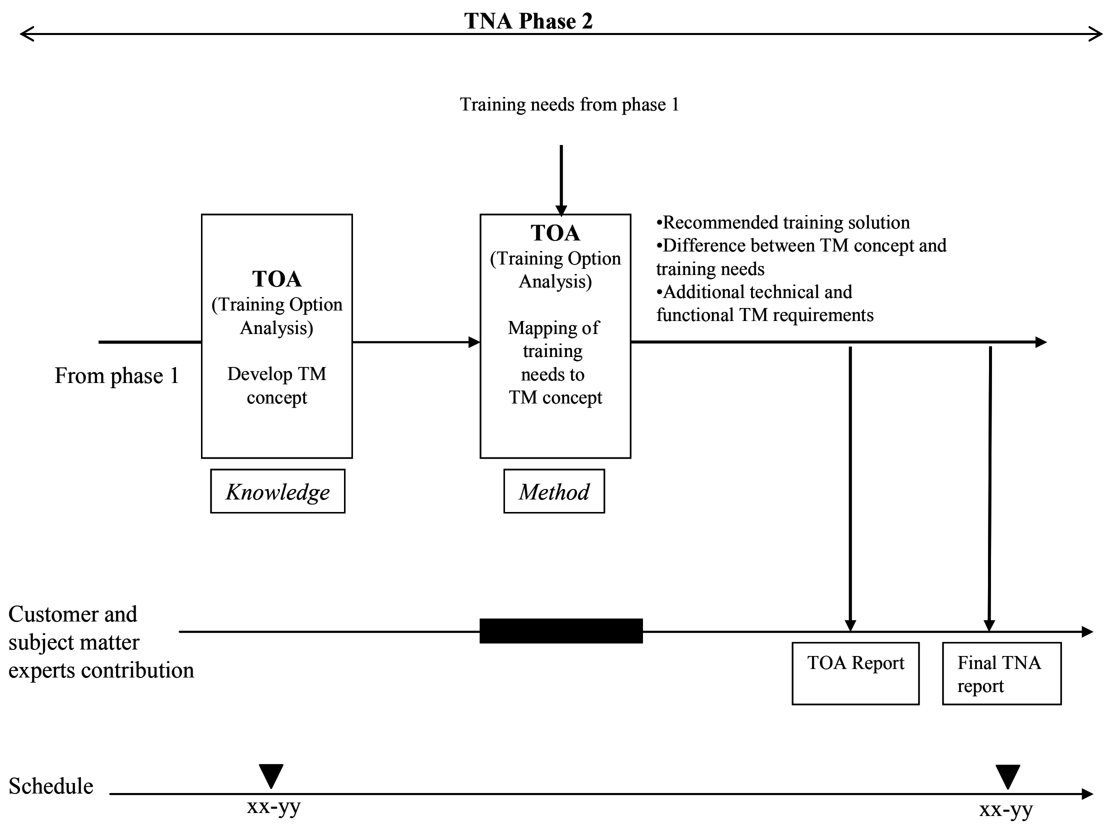

Figure 2-3 An overview of TNA Phase 2

Phase two, shown in Figure 2-3, consists of the Training Option Analysis (TOA). The first part of the TOA process is Training Media definition. In this case a feasible Training Media suite has been defined based upon common TM types with generic properties; a further definition is listed in chapter 3.4.4. The second part of the TOA process is mapping of this TM Suite against the training needs identified in the OTTA. The final result is a recommended training solution for both air and ground crew.

2.3 Operational and Technical Task Analysis (OTTA)

The purpose of the Operational and Technical Task Analysis (OTTA) is to identify important tasks and duties performed by air and ground crews during and between the Swedish NH90 helicopter missions. The results of the analysis are Operational and Technical Task Statements (OTTS) that describe the tasks and duties to be performed by each air and ground crewmember before, during, and after a mission of a particular type. The task inventories also include, for each duty and task, a description of the operational circumstances and standard to which they must be performed. Finally, training categories (priorities) for each task are established, based upon the task's difficulty, importance, and frequency (DIF).

2.3.1 OTTA-process

Initially, it is important to determine an appropriate level of detail for the OTTS, that is the tasks that the air and ground crews are expected to perform, and to develop a plan for acquisition of the information necessary for the analysis. The next step is to select a method for the actual analysis and to define a structure for organization and presentation of the OTTS. Finally, the DIF-analysis is applied to the identified OTTS providing a rough estimate of the amount of training needed.

The intention was to use a set of documents identified in the scoping study, such as the mission and task lists, as a baseline for the OTTA. However, in some cases this information turned out to be insufficient or incomplete which lead to requests for additional information as the analysis progressed. The basic plan for obtaining the additional information was to conduct interviews with Subject Matter

Experts (SME). In addition a number of visits to military bases and schools were made. The project team also joined aircrews practicing real mission flight situations to analyze aircrew tasks.

Since the tasks performed by aircrew are closely related to mission types, a mission-oriented method was selected. A mission subtype is a more specified type of mission. For example, “SAR in open water” is a subtype to mission type “SAR”. After examining the mission subtypes it became obvious that most mission types could be described as having a generic start and finish with a mission specific core, as illustrated in Figure 2-4. This approach resulted in the mission flow charts from which the OTTS were extracted. A benefit from keeping the mission specific OTTS tied to the mission subtype is the opportunity for investigation and reports on a mission subtype level.

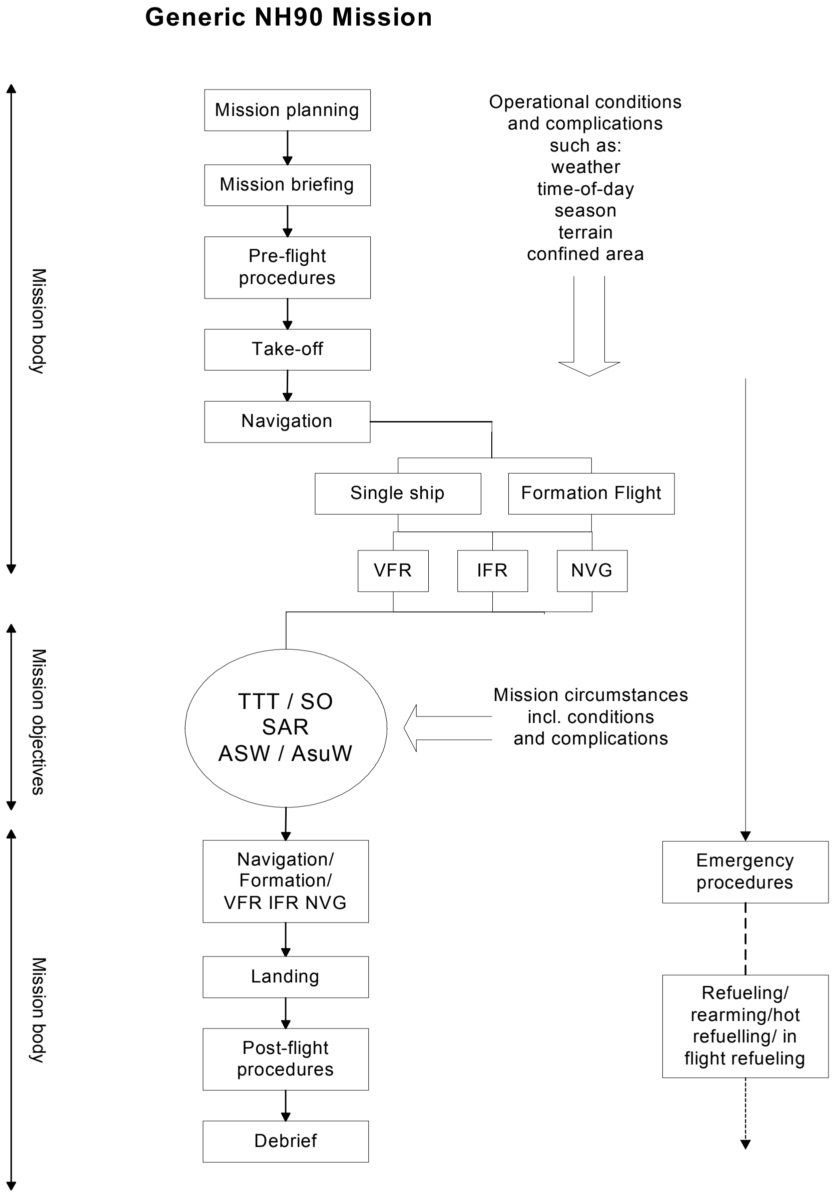

Figure 2-4 A generic NH 90 mission

The OTTA process, shown in Figure 2-5, was performed in three steps. First, the various mission types and mission were defined based upon (1) operational and technical training task lists, which include all types of missions to be performed by the Swedish NH90, (2) information from the Scoping Study, and (3) input from Subject Matter Experts (SMEs). Secondly, the mission subtypes were subject of a task inventory resulting in the duties and tasks to be performed by each air and ground crewmember before, during, and after a mission of a particular type. The task inventories also include, for each duty and task, a description of the operational circumstances and standard to which they must be performed. Finally, training categories (priorities) for each are were established, based upon the task's difficulty, importance, and frequency (DIF).

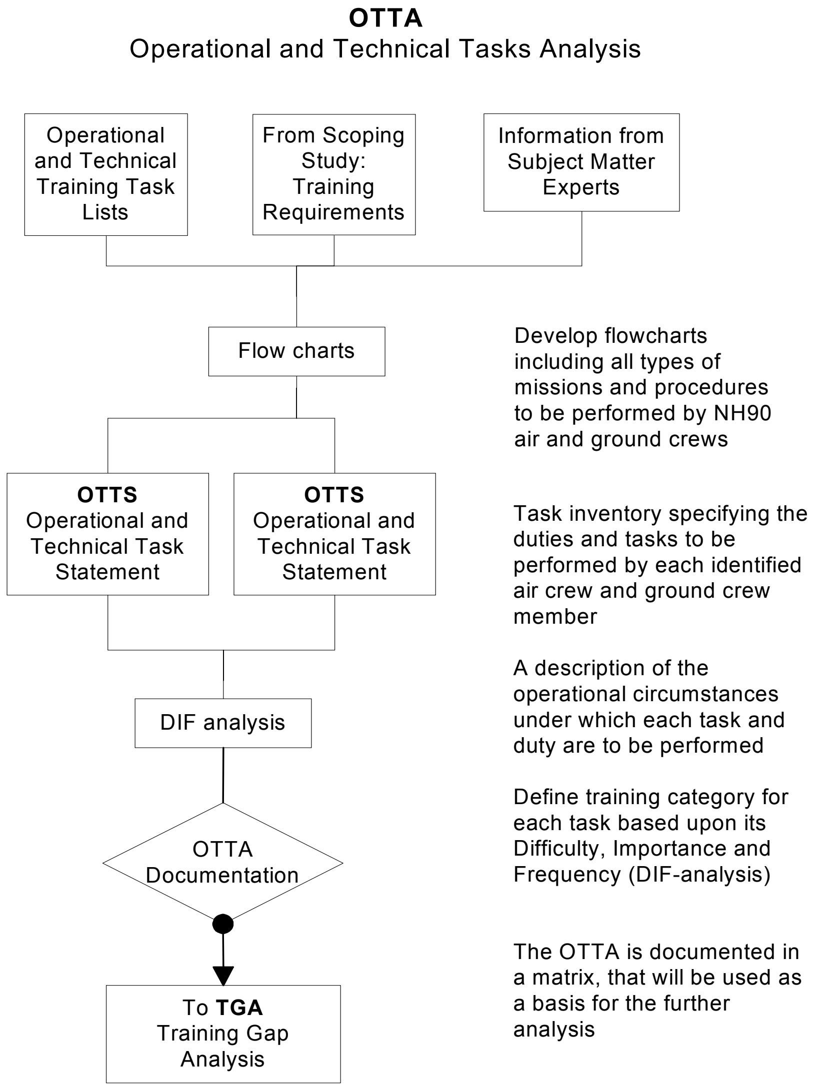

Figure 2-5 An overview of the OTTA process

Since some maintenance tasks on the Swedish NH90 are performed by the industry and some by the Swedish Armed Forces, an investigation was conducted of how the maintenance is organized within the Swedish Armed Forces and the personnel categories responsible for each task. The investigation consisted of reviewing planned maintenance activities and discussions with SMEs. Maintenance tasks performed by the Swedish Armed Forces were then subject to a more detailed analysis. However, since the Swedish NH90 is not yet operative there was considerable variation in the amount of information available about the tasks, which is reflected in the analysis. For example, specific information was only available for daily and safety inspections in the form of preliminary checklists. The checklist items were classified according to AECMA 1000D to obtain the overall character of the content and rated by SMEs using the DIF scales (Appendix C). Concerning fault isolation, experiences from the Swedish JAS39 fighter aircraft was used as an example of fault isolation on integrated avionics systems. Finally, SMEs provided some general information about the other tasks.

A detailed description of the training objectives for the ground crew tasks along with recommended training media can be found in Levin et al. (2004). The training objectives consider that maintenance engineers need spatial knowledge of where components are located, that they need to understand the function of the component and how it impacts helicopter performance and safety, and that they should be able to perform the correct maintenance actions and exercise appropriate judgment. CAI is the recommended training media for spatial knowledge of where components are located and understanding of component function. Concerning the actual performance of maintenance actions, CAI is required for basic knowledge about *what* to do and VMT for an understanding of *how* to perform the action and verify function. Use of the real helicopter for training is limited to application of the complete checklists and practise of tasks steps with more than an initial training need.

2.3.2 Hierarchical and Cognitive Task Analysis

Since the tasks performed by air and ground crews are structured procedurally, at least at an overall level, a Hierarchical Task Analysis (HTA) was used to describe the procedures of information exchange and operations that are used to achieve task goals (Kirwan, 1992). The HTA covers the technical course of events, overt actions, information exchange, responsibilities, rules, crew interaction, typical events, etc. The advantage of HTA is the combined description of how information is used spatially and temporally (Miller & Vicente, 2001).

The result of the HTA is a description of a task in terms of operations - things which people do to attain goals, and plans – statements of conditions when each of a set of operations has to be carried out to attain an operational goal. The HTA is only a broad approach to task analysis and leaves to the analyst to define the detail of subtasks (sub-operations), in this case the level of the OTTS. Re-describing goals into sub-operations should only be undertaken when necessary. Figure 2-6 shows an example of a HTA for a general Search and Rescue (SAR) mission.

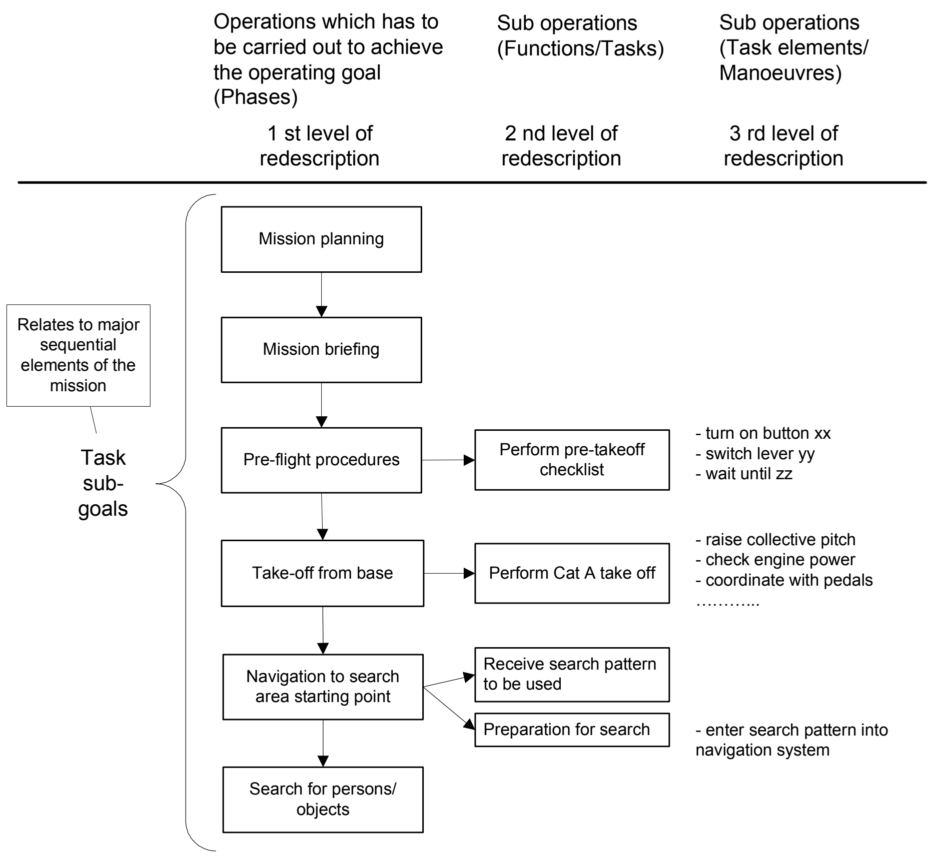

Figure 2-6 An example of a HTA for Search and Rescue (SAR) missions where the overall goal is broken down into subgoals and operations.

Due to practical reasons, such as the limited time available and lack of information since the Swedish NH90 is not operative, the analysis is stopped at the second level of sub-operations, that is functions/tasks. The reason for continuing further is doubtful even if more information had been available since that level of detail is not expected to contribute to the overall TM selection process.

The result of the HTA, that is the mission flow charts, contain a certain “time line” that corresponds to a combination of operations from level 1 and selected sub-operations from level 2.Consequently, a number of level 2 sub-operations, which have been identified in the analysis, are not considered to have a notably significance for the further analysis. Figure 2-7 shows an example of a HTA result for a SAR mission.

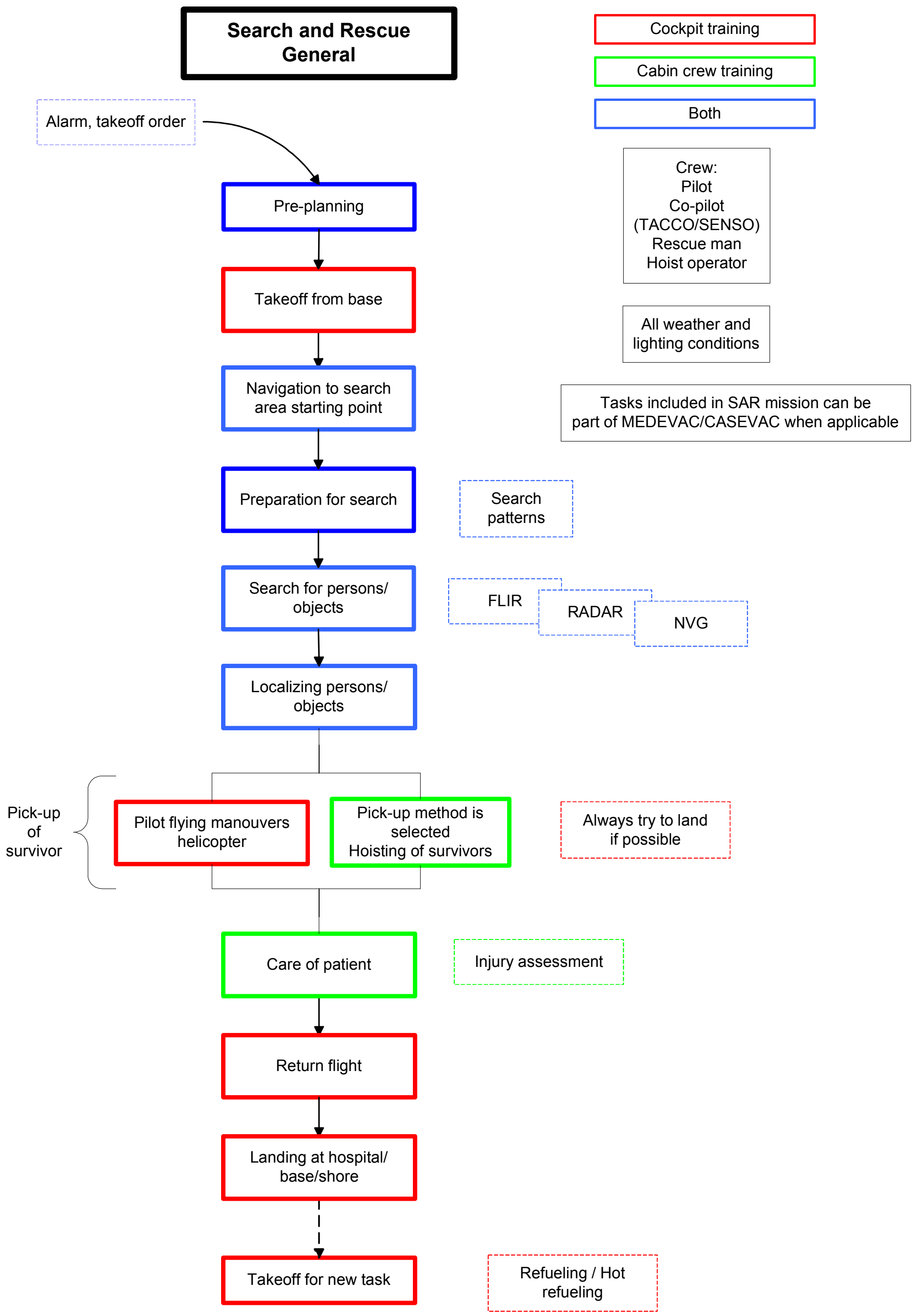

Figure 2-7 An example of a HTA result for a SAR mission.

The compiled knowledge and experience of air and ground crew task performance gives efficient solutions for known situations. However, it is often not possible to predict all situations in advance, such as during SAR missions and fault isolation. For these unexpected situations, a Cognitive Task Analysis (CTA) is needed to understand the knowledge, thought processes, and goal structures that underlie observable task performance (Schraagen et al., 2000). An example of a CTA for the pick-up event during a SAR mission is shown in Figure 2-8. Since the CTA is more or less a study of (the) expertise in task performance, the results are directly applicable to training design.

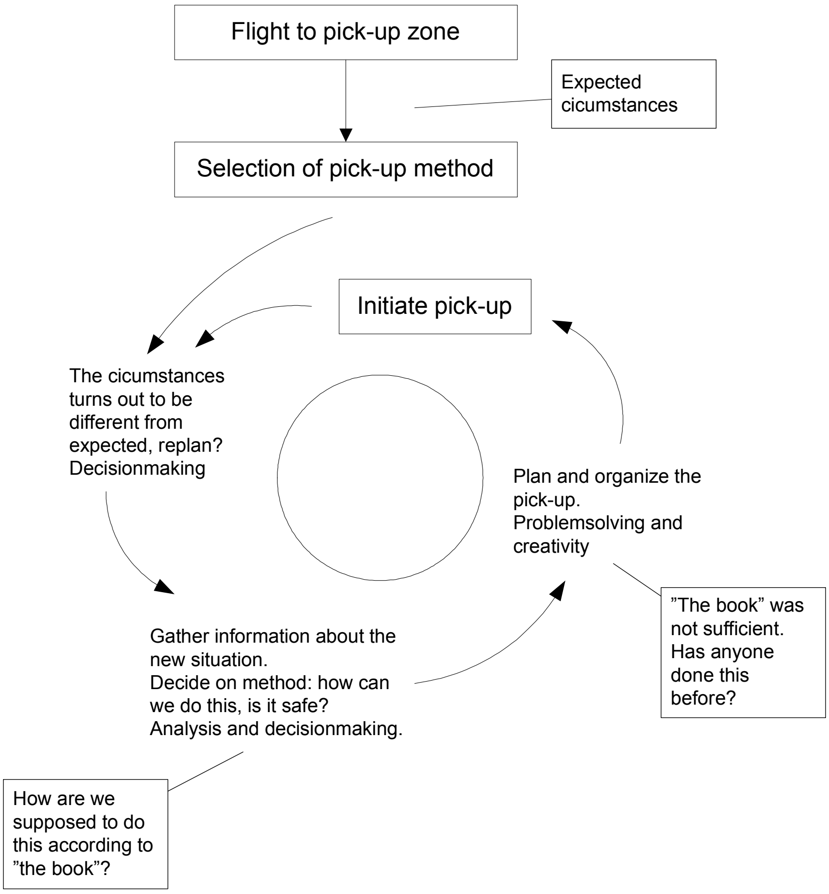

Figure 2-8 An example of cognitive task analysis of a SAR mission.

The examples above indicates that the decision making process is an explicit event occurring in different steps. This is likely to be the case for the pick-up task since the decision is made within the crew and there are a number of specific questions that need to be answered. The crew will take their time to make a judicious decision. However, in other cases the decision process may be more immediate and consist of a number of mental processes occurring simultaneously.

Both the HTA and CTA started with studies of written documentation about the job, such as training material, in order to gain familiarity with the job/tasks and the special vocabulary used. Semi-structured interviews were then made to retrieve more detailed information from SMEs. In addition, the project team joined aircrews practicing real mission flight situations. Generally, the short time available for the study has restricted the opportunities to interview a large number of SMEs, which may have an affect upon the validity of the results.

2.3.3 Difficult, Importance, Frequency - analysis

The Difficulty, Importance, Frequency (DIF) method was used to assess the magnitude of training needed for each OTTS (US Army, 1997). The indicators for the levels of Difficulty were slightly modified to comply with flight safety aspects.

The DIF method requires rating of how difficult and important tasks are and how frequent they are performed. A small acceptable sample size, ease of administration, and gross recommendations makes the DIF method suitable for the present phase of the TNA. Once the ratings are compiled, they are used to identify the training needs with the decision tree shown in Figure 2-9. Tasks that are difficult and important and are performed infrequently require more training. Jobholders only need ***initial training*** for tasks that are easy to perform or occur frequently, such as daily inspections and VFR-flight. When tasks are more difficult and infrequent then jobholders must be able to demonstrate proficiency in performing the task according to the standard required, such as in fault isolation, navigation during difficult weather conditions, and systems handling. Recurrent training, indicated as ***train***, is needed for proficiency in these tasks. Finally, ***overtraining*** is needed for tasks that are very difficult and infrequent since jobholders must react instantly and perform automatically, such as in hover and emergency procedures. Representative training environments are needed for proficiency in these tasks.

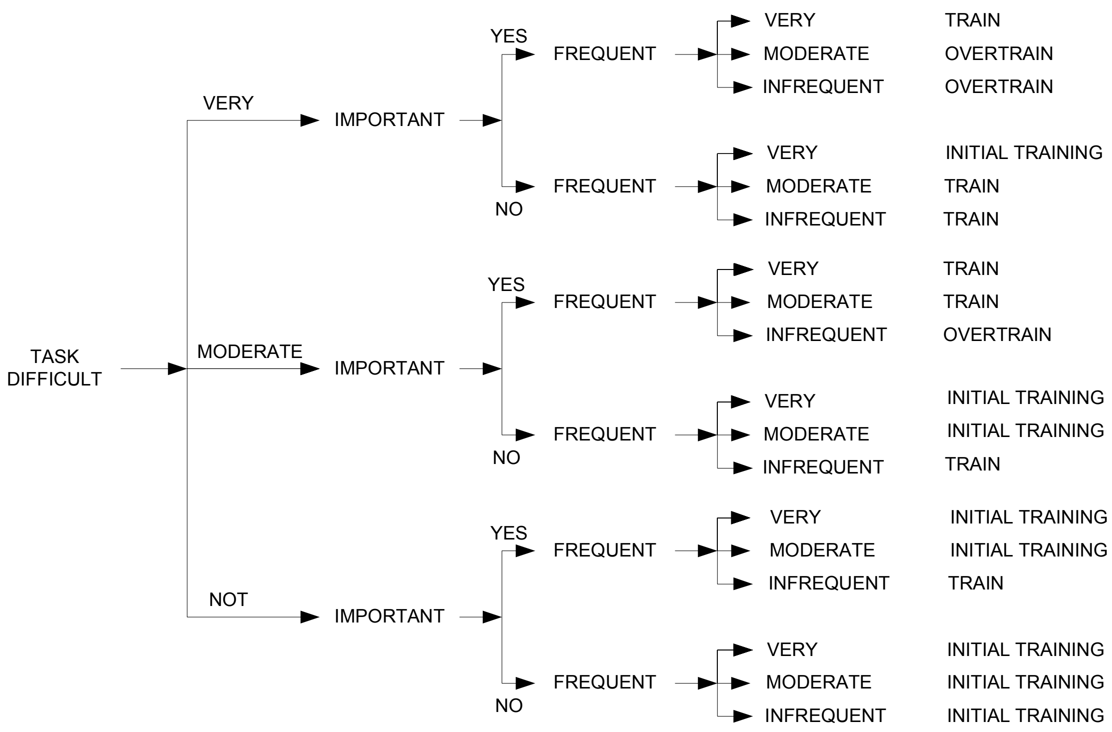

Figure 2-9 An expanded DIF Model (adapted from US Army, 1997)

Although the difficult, importance, and frequency scales can be refined to allow more specific estimates, the levels shown in Figure 2-9 were sufficient for the TNA. More information about the scales used can be found in Appendix C. Table 2-1 shows the ratings that were used for the DIF scales.

Table 2-1 Ratings for the DIF analysis scales

Difficulty	Importance	Frequency	Training
Very Difficult = VD	Important = I	Very Frequent = VF	Over Train = OT
Moderately Difficult = MD	Not important = NI	Moderately Frequent = MF	Train = T
Not Difficult = ND		Not Frequent = NF	Initial Training = IT

For example, when applying the DIF analysis to a TTT-mission and sub-operation *normal take off* there is a match for *medium difficult* with the statement: *requires some concentrated effort,* a match for *important* with the statement *task performance failure may lead to severe injury or unacceptable high damage to equipment (flight safety),* and a match for *very frequent* since *normal take off* is performed at least once every 2 weeks (normal take off is common for other mission types). Following the tree in Figure 2-9 reveals that the training need for *normal take off* will be classified as *train.*

In addition to the DIF analysis, air crew SMEs were asked to state the most critical (difficult) operations/sub-operations for each sub mission type. The SME was also asked to rate the criticality/difficulty on a scale from one to ten, ten being the most difficult. A deeper analysis was then conducted on this rather limited number of statements.

The HTA, as indicated in Figure 2-7, shows that the mission tasks are performed by various personnel categories and most often in parallel. The HTA also revealed a substantial amount of interaction both within crew as well as outside crew. It seemed useful to analyse the nature of interaction and how frequent it occurs, thus scales were added for the aircrew categories involved. The different types of interactions analyzed are: within crew (intra crew), with other crews (inter crew) and with other units/officials/personnel (extra crew). Table 2-2 shows the ratings that were used for the crew interactions, for definitions see Appendix B.

Table 2-2 Ratings for crew interaction

Category involved in the task	**Within crew (intra crew)**	**Outside crew (inter and extra crew)**
Cockpit crew (C) Rear cabin crew (R) Air crew (A)	Co-ordination (C Co-operation (O) Collaboration (L) Information exchange (I)	Co-operation with other units (C) Information exchange with other units (I)

More scales were also added for analysis of ground crew task, since the DIF method only covers a limited number of aspects that affect task performance. Based on previous experiences with military platforms, scales were added for:

- **Cooperation:** See Appendix B
- **Experienced risk for injury:** Risk assessment is important for many critical tasks. Training may therefore be needed of possible hazards and proper decision processes to identify relevant aspects for risk assessment.
- **Time pressure:** Time constraints on task completion may create additional stress, reversion to skill and rule based behaviour, and limits the possibility to cope with novel situations. Repeated training may therefore be necessary for acceptable performance and an understanding of suitable coping strategies.
- **Mental workload:** Information assimilation, situation assessment, and decision-making place cognitive demands on jobholders, especially when performed under time pressure. Tasks that require increased mental workload for acceptable task performance may therefore have special training needs.
- **Estimated completion time:** The estimated completion time gives some understanding of task complexity and also indicates whether SMEs have the same understanding of the task.

Table 2-3 shows the ratings that were used for the additional ground crew scales. Only two or three levels were used for all scales to simplify the analysis, except for mental workload where SMEs were free to enter any value between 0 and 100%. Although seemingly without restrictions, all SMEs only used the 10% increments for convenience. The few scale levels limit the analysis to averaging scales over SMEs and using thresholds to filter important items.

Table 2-3 Ratings for the additional ground crew scales

Cooperation	Experienced risk for injury	Time pressure	Mental workload	Estimated completion time
Yes = Y	High = H	High = H	0-100	Seconds
No = N	Medium = M	Medium = M		
	Low = L	Low = L		

The following sections show the results of applying HTA, CTA, and DIF methods to the Swedish NH90 missions.

The result of the OTTA is documented in two matrices (one for air and ground crew respectively). Table 2-4 shows an example of the aircrew matrix for SAR in archipelago or fjords

Table 2-4 An example from the aircrew OTTA matrix for SAR in archipelago or fjords

Mission subtype	Training objective		Category involved	Teamwork	External	Difficulty	Importance	Frequency	Training need
SAR in archipelago/ fjords	Mission pre-planning		A	C/I	I	MD	I	NF	OT
	Flight and navigation to rescue area	PF controls helicopter	C	O/I	I	MD-VD weather dependent	I	MF	T/OT
		PF supervises instrumentation	C	O/I	--	ND-MD (VFR/IFR)	I	MF	IT/T
		PNF performs navigation	C	O/I	--	MD-VD weather dependent	I	MF	T/OT
		PNF handles radio communication	C	O/C/I	I	VD	I	MF	OT
		TACCO/System operator supports PNF in navigation	R/A	O/I	I	MD-VD weather dependent	I	MF	T/OT

2.4 Training Gap Analysis (TGA)

The purpose of the Training Gap Analysis (TGA) is to determine how the introduction of the Swedish NH90 impacts training requirements for air and ground crews. Important goals of the TGA are to (1) identify any differences in the type of training required by experienced and inexperienced jobholders, (2) define the gap between the new operational performance required and the entry level, (3) define the type of skills to be trained, and (4) define a set of Training Objectives (TOs) for the Swedish NH90 air and ground crews.

2.4.1 TGA process

For the training gap analysis, a definition of the entry and exit level of training is required. Important aspects to be considered are standardized training levels, current training strategies, and types of helicopters already in use in the Swedish Armed Forces.

Most of the work has been conducted in cooperation with air and ground crews in active service within the Swedish Armed Forces. The work has mainly taken the form of:

- in-depth interviews with SMEs regarding current training programs and future training plans and operational standards
- visits to training facilities and operational helicopter units
- an inventory and study of current training syllabuses for both pilots and technicians
- study of the Swedish NH90 technical design

The compiled information was analyzed together with the results from the OTTA phase in order to complete the TGA goals, that is defining the Training Objectives.

The training objectives consist of the OTTS as defined in the OTTA matrix and additionally the overall aircrew training objectives as stated in chapter 3.2.5.

2.5 Training Requirement Analysis (TRA)

The purpose of the Training Requirement Analysis (TRA) is to state technical requirements of vital importance for the ability to meet the training objectives.

2.5.1 TRA process

The TRA is providing a set of technical requirements needed in order to meet each training objective. These requirements can be described as critical training media components. Examples of such components are:

- a subsystem/model that must be present
- the functionality of a subsystem/model
- the fidelity of a subsystem/model
- the cueing needs

The tasks identified in the OTTA are the baseline for the technical requirements analysis as shown in Table 2-5.

Table 2-5 An example of TRA results for air crew

Training objective	TRA result
Mission pre-planning	L3 Provision to use the same mission planning equipment as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate work space. Case studies.
PF controls helicopter	L2 Complete simulation of H/C and avionics subsystems. Databases supporting archipelago/fjords
PF supervises instrumentation	L2 Complete simulation of H/C and avionics subsystems
PNF performs navigation	L2 Complete simulation of H/C and avionics subsystems. Databases supporting archipelago/fjords
PNF handles radio communication	L2 Complete simulation of H/C and avionics subsystems. Provisions for simulation of external communication with e.g. ATC, hospital, rescue coordination center, ships as simulated by the instructor
TACCO/System operator supports PNF in navigation etc.	L2 Complete simulation of H/C and avionics subsystems. Complete simulation of rear cabin consoles and associated functionality. Databases supporting archipelago/fjords.

The fidelity levels used in the TRA are:

- Level 3: Same functionality as in the real H/C, same visual appearance, same visual cueing, same haptic cueing, same aural cueing and similar vestibular cueing.
- Level 2: Same functionality as in the real H/C, similar visual appearance, similar visual cueing, similar aural cueing and similar haptic cueing.
- Level 1: Similar functionality as in the real H/C, similar visual appearance, similar visual cueing and similar haptic cueing

2.6 Training Option Analysis (TOA)

The purpose of the Training Option Analysis (TOA) is to:

- Determine the TM elements needed in order to fulfil the training needs and requirements.
- Determine the training needs which cannot be covered by the use of Training Media elements.

The result of the TOA is a recommended training solution.

2.6.1 TOA process

The first part of the TOA process is to determine a feasible TM suite. The capabilities of a typical Training Media Suite are mapped against the training objectives and the technical requirements determined in the TRA, as shown in Table 2-6.

Table 2-6 An example of TOA result for air crew where X = can be used for task, R = recommended for task, P=Preferred for task, O = not feasible for task, NP = functionality not provided, N/A = functionality not applicable, A = this TM has been dedicated for the task, and E = task can exclusively be trained.

Training objective	**FMTF**	**FFS-T1**	**CPT**	**RCT**	**PTT**	**OJT**
Mission pre-planning	X	NP	R	N/A	NP	X
PF controls helicopter	X	X-	R	N/A	X-	X
PF supervises instrumentation	X	X	R	N/A	O	X
PNF performs navigation	X	X	R	N/A	NP	X

3 Air crew

3.1 Air crew OTTA

The purpose of the Operational and Technical Task Analysis (OTTA) is to identify important tasks and duties performed by air and ground crews during and between the Swedish NH90 helicopter missions. The results of the analysis are Operational and Technical Task Statements (OTTS) that describe the tasks and duties to be performed by each air and ground crewmember before, during, and after a mission of a particular type. The task inventories also include, for each duty and task, a description of the operational circumstances and standard to which they must be performed. Finally, training categories (priorities) for each task are established, based upon the task's difficulty, importance, and frequency (DIF). The result is presented in.

In the process of defining the OTTS, that is conducting the mission inventory, it became very clear that in the case of helicopters there are no real ”typical” mission types. On the contrary, the characteristics of the missions are the atypical content, such as the great variations in external circumstances, and unexpected events and changes occurring during the missions. However, we believe that there is enough commonality to describe a set of standardized mission types, which contains the obvious tasks and events (operations/sub-operations).

Due to the large variations in mission realization, the training objectives cannot be based solely on the mission inventory and DIF analysis. Instead, all circumstances affecting the mission execution and training must be considered in order to define the total training objectives. Such circumstances include:

- Contextual factors under which the missions are performed. For example weather situation and area of operation.
- External interfaces for communication. For example sending messages to the tactical commander or communicating with a ship that's in an emergency situation.
- Organizational context. For example planning and execution a of a joint operation
- Realization of the operative duties. For example organization of the military branches or length of missions and shifts.
- The teamwork skill level (intra as well as inter and extra crew)
- Time pressure, flight safety, risk for injury, and mental workload when performing a task.
- Learning environment, such as training philosophies and training organization.
- Necessary abilities needed for developing critical skills.

The factors listed above are not derived directly from the OTTA, but they are all of valid interest and must be taken into account when defining the training objectives.

3.1.1 Air crew OTTS

In the mission oriented approach, enclosed in Appendix D are the OTTS described in the form of mission/submission flowcharts.

Note: The mission content and hence mission flow charts have been revised. However, the document has not been changed to reflect all aspects of the mission types intended for the Nordic Battle Group or other types of international operations. Still, the TNA is expected to be valid since the focus has been on the actual training tasks included in the various mission types which mean that the training objectives per se are unaffected and remain applicable for various types of future missions. For example: a Typical CSAR mission intended for an international operation can be accomplished by combining tasks listed under SAR and TTT. Consequently, training of a typical international CSAR mission should be easily accomplished providing the particular TM supports both SAR and TTT as described in this TNA.

The set of charts shows a brief summary of the mission types and mission subtypes:

- Pre-flight and general handling and In-flight non-mission specific
- SAR general, Air Coordinator, SAR in archipelago/fjords, open water and over land
- TTT mission subtypes, typical TTT mission
- Special operation and an example of task sub-goals for mission subtype “hostage rescue operation”
- ASW, ASuW
- Other operations, such as transportation of material and personnel

Consequently an OTTS can consist of a task typical for a specific mission subtype or a task of more general nature occurring during any type of mission. The OTTA matrix has obtained a certain structure much resembling the content of flowcharts in set two and three above. For simplicity the first mission subtype described, that is SAR in archipelago, lists all occurring activities while the following SAR mission subtypes only lists the differences from the first mission subtype. The TTT mission tasks include all applicable insertion and extraction types, which are not likely to be used within the same mission. For those reasons some tasks may be under or over represented in the matrix and any statistical analysis performed on the material in its original design would lead to erroneous conclusions. It is important to keep in mind that the OTTS are **only a selection from possible suboperations** at re-description level 1 and 2.

If the Swedish NH90 is configured with a rear cabin console for TTT and SO missions, the helicopter could evolve into a platform where the TACCO performs command and control tasks (the former TACCO-ground concept).

3.1.2 DIF analysis

The content of the mission flow charts were further analyzed in order to obtain a basic understanding of the task characteristics. In addition to the DIF method, expected amount of teamwork and need for external communication were included. The entire DIF analysis matrix is shown in Appendix E.

There is a complication to the DIF analysis for the frequency dimension in those cases when a particular submission is the primary mission type for one squadron, and thus conducted quite often, while it is a secondary mission type for another squadron and thereby performed less frequent. For this DIF analysis, the ratings for SAR submission are based on the assumption that: SAR missions are performed by the crews that normally are involved in the ASW, ASuW and TTT missions

The fact that the frequency analysis is based on how often a sub-operation is performed according to fixed time interval turns out to be another inconvenience. In reality the missions may not be performed on such a regular basis, some mission types are performed more often during a certain time of year, such as rescue of mountaineers, and some mission types may be practised more frequent during (joint) training exercises. In addition, the frequency analysis does not take into account the length of missions and thus the amount of on-the-job training (OJT) obtained. In this DIF analysis, the number of missions was averaged on a yearly or half year basis. Finally the DIF analysis cannot handle the fact that a task is rated completely different depending on the external circumstances such as weather. This resulted in multiple ratings and thus multiple training needs for a majority of the tasks.

DIF analysis results

Since statistical analysis of the source material may led to erroneous conclusions, as discussed in chapter 3.1.1, some adjustments were made. Mission type SAR is represented by mission subtype SAR in archipelago and mission type TTT is based on the TTT related OTTS except number 67 through 74 in the OTTA matrix.

Since the level of difficulty is dependent on the external circumstances, the difficulty rating often includes two options. For example, sub-operation *control of helicopter* may turn out to be of medium difficulty or very difficult depending on the weather situation. The majority of the sub-operations were rated as *Medium Difficulty* (MD) followed by *Very Difficult* (VD) and finally *Not Difficult* (ND). In order to obtain presentable statistics the worst case was assumed, that is the more difficult rating was kept.

The vast majority of sub-operations were rated as *Important* (I). There are probably two explanations for this. First only the important sub-operations were selected for analysis. Secondly this type of activities, that is flying a helicopter and performing missions, tends to belong in the *Important* category. The only exception is debriefing, which is rated as *Not Important* (NI). This is true from the perspective that conducting a debriefing will not hamper the mission since it has already been performed. However, avoiding to conduct a debriefing may very well hamper the next or future mission performance and must from that perspective be considered as *Important*.

The frequency varies from *Not Frequent* (NF) to *Very Frequent* (VF). These differences are caused by a number of factors such as:

- assigned number of flight hours per individual and crew
- the local circumstances such as area of operation
- schedule for operation, ship operations tend to be more frequent

The result of the DIF analysis is shown in Figure 3-1 to Figure 3-4. The analysis is based upon information obtained from the SMEs during the initial TNA. Swedish participation in international operations will have an impact on training curricula; hence the distributions shown in Figure 3-1 to Figure 3-4 most likely will change over time. The frequency for mission types SAR, ASW and ASuW will probably decrease even further leading to a larger training need, i.e. the OT category will increase. The bars represent the fraction of OTTS that corresponds to each category (labelled above the bar) out of all OTTS associated with the applicable mission type. The sums of each set of bars are always 1.0. Thus for scale D in mission type SAR, category ND (not difficult) is approximately 0.1 meaning that 10% of all OTTS for this mission type is rated as ND. The complete analysis is presented as an extension to the OTTS matrix in Appendix E.

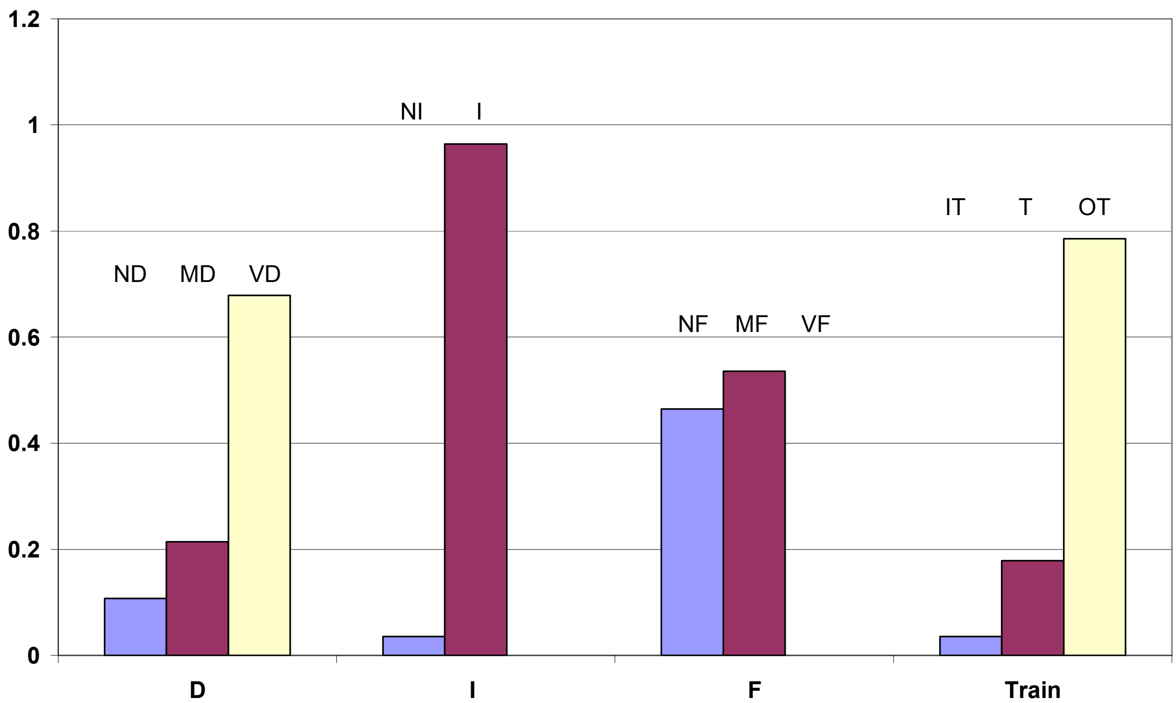

Figure 3-1 Training need for mission type SAR

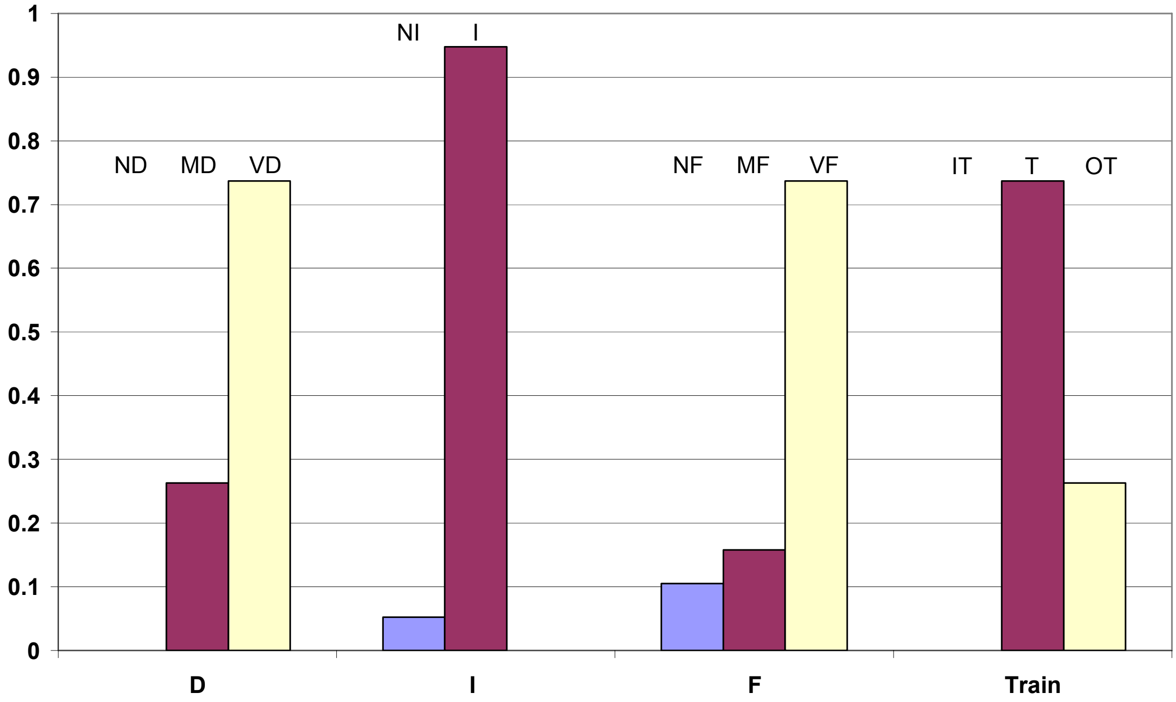

Figure 3-2 Training need for mission type TTT

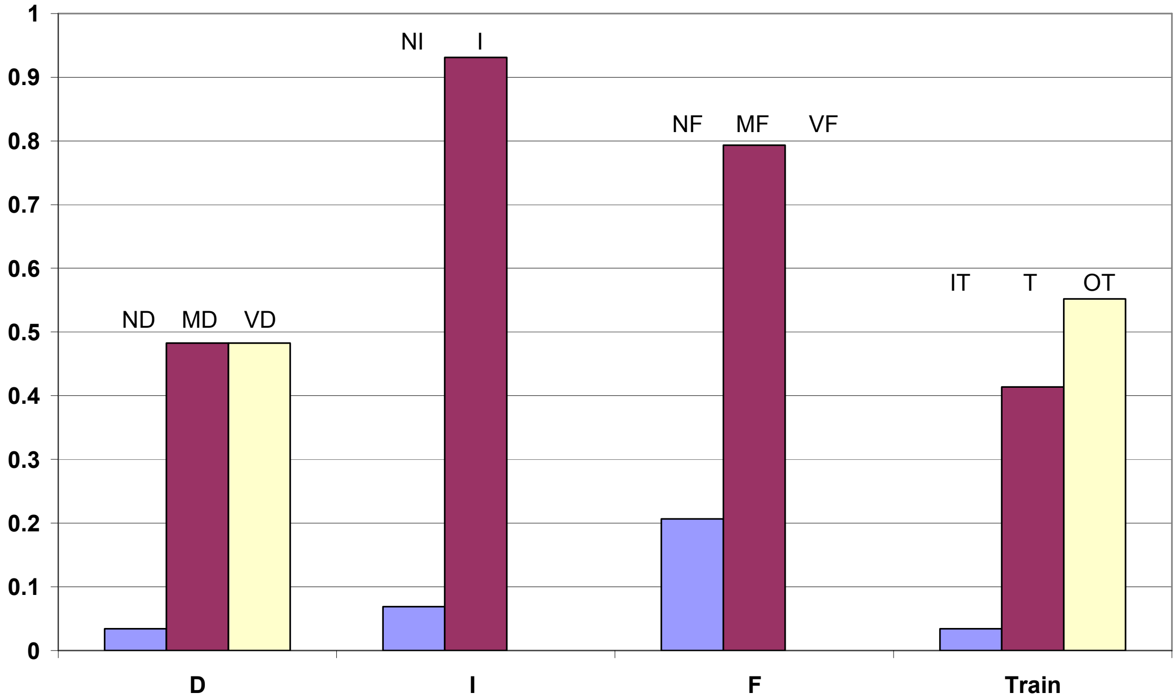

Figure 3-3 Training need for mission type ASW

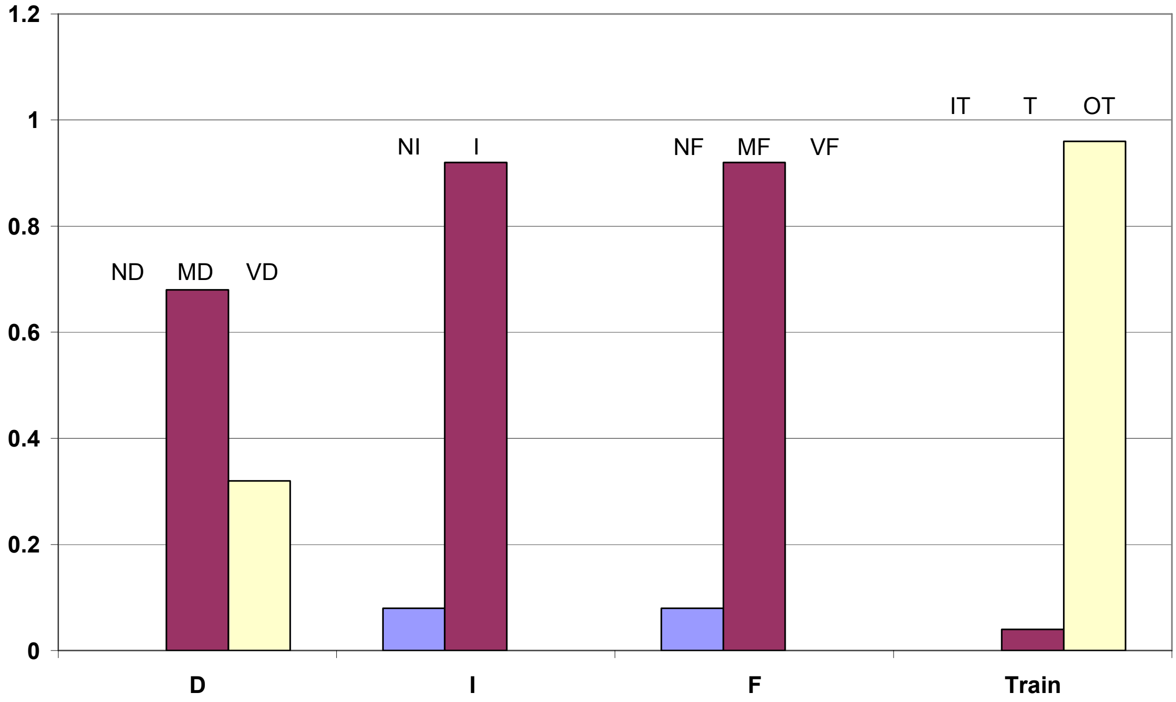

Figure 3-4 Training need for mission type ASuW

3.1.3 Contextual factors

In addition to the DIF analysis and for each sub mission type, the interviewee was asked to state the most critical (difficult) operations/sub-operations. The SME was also asked to rate the criticality/difficulty on a scale from one to ten, ten being the most difficult. A deeper analysis was then conducted on this rather limited number of statements.

The following list includes the most critical/difficult operations/sub-operations as stated by the SMEs:

- It became obvious that any operation/sub-operation rated as fairly easy (1-3) would become a 10 in bad weather and no light conditions. The external circumstances therefore have the largest impact on task difficulty, such as the pick-up of a survivor from a small boat.
- Planning of missions involving NOE flight and confined areas, such as TTT and SO, is both critical and difficult.
- Unexpected situations that occur during a mission that require careful decisions and/or problem solving. For example,
    - SAR: the survivor's situation/location or medical condition, which affects the selection of pick-up method
    - TTT: extra equipment carried by the troop or the condition of the ground at the embarkation site, which is important for the selection of loading method and site.
- To always being one step a head of upcoming events, that is to be prepared for whatever might occur in the near future. This applies to navigation in bad weather/IFR/NOE flight, as well as to taking the responsibility as pilot in command.
- Landing on a ship deck. Especially, in bad weather and no light conditions there is a risk for spatial disorientation.
- To be able to rest, sleep and stay alert during international operations

3.1.4 External interfaces for communication

The need for training of communication with external units is dependent on the amount of external interfaces as well as their functionality. In order to obtain a rough estimate of this need, each sub-operation was examined for presence of *co-ordination* (C) and *information exchange* (I). The analysis showed that a large number of sub-operations involve information exchange and a smaller number also involve co-operation. This is a clear indication of a substantial training need of extra cockpit, extra rear cabin and extra crew interaction.
The analysis is presented as an extension to the OTTS matrix in Appendix E. A mission-oriented view of external players and their interfaces is shown in Figure 3-7 to Figure 3-7. The TTT figure shows the interfaces within the Swedish organization and does not necessarily reflect the situation during international operations.

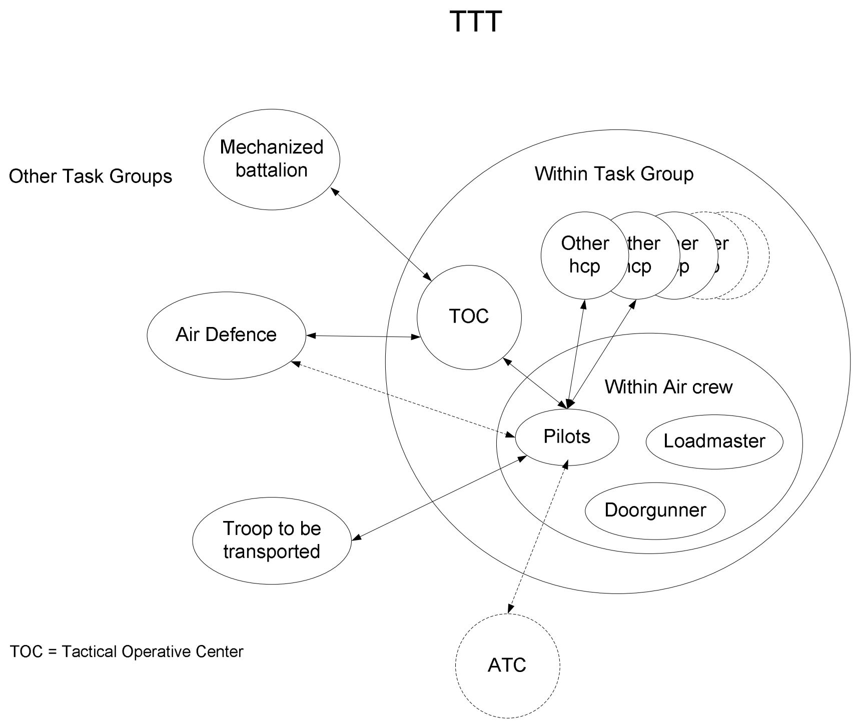

Figure 3-5. External interfaces for communication TTT

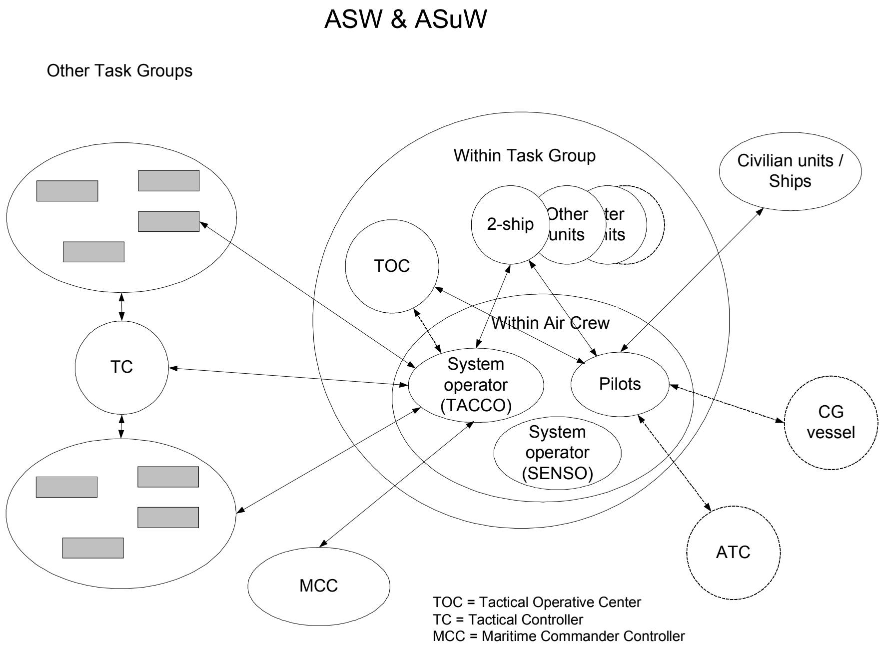

Figure 3-6. External interfaces for communication ASW/ASuW

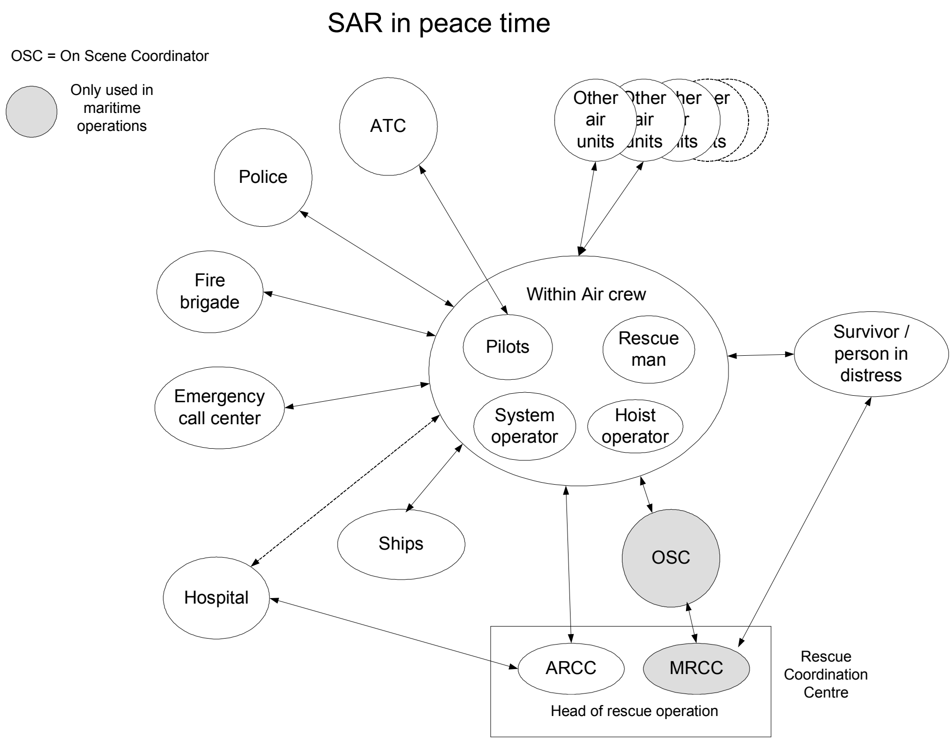

Figure 3-7 External interfaces for communication SAR

3.1.5 Organization

An organization has a tendency to develop its own culture, that is to define a set of unique values, operational standards and procedures. These different opinions on operation, the so-called cultural differences, become quite apparent when comparing the army, navy and air force views on mission content and crew configuration. This is applicable to all military branches but the consequences are expressed differently. For example, what used to be army, navy and air force helicopter activity is now integrated into one wing, which means there are intra-crew differences. Since these cultures are still in the process of being unified, the differences will be most pronounced during the on-going definition phase and the initial years of operation.

When an integration process is in place, the legacy is there and must be dealt with in order to secure a fast and safe introduction of the Swedish NH90, as well as the continuing development and logistics support.

From a training point of view, it is important to understand how the cultural differences affect the crew functionality. Cultural differences should be taken into account when organizing training since both intra- as well as inter-cultural differences (different backgrounds within the team and between teams) will make the missions more difficult to perform. If crewmembers from different organisational background are to solve a task collaboratively, they will have more difficulties to correctly and fully interpret one another. They will also have more difficulties understanding the things that are not said explicitly, that is reading between the lines. The Human Factors literature is clear on this point.

Instructors and the organizational legacy play an important role here. It is simply crucial to keep the experienced personnel “the people that know how to do things” within the organization until the introduction of the new system is finalized.

3.1.6 Teamwork skills

The need for teamwork skills is dependent on the amount of co-ordination, co-operation, collaboration and information exchange that takes place within cockpit crew (C), rear cabin crew (R) and aircrew (A). In order to obtain a rough estimate of this need, each sub-operation was examined for presence of co-ordination (C), co-operation (O), collaboration (L) and information exchange (I) (see Appendix B for definitions). The analysis showed that the vast majority of sub-operations involve information exchange and one or more of co-ordination, co-operation or collaboration. This is a clear indication of a substantial training need of within cockpit, within rear cabin and within aircrew interaction. The analysis is presented as an extension to the OTTS matrix in Appendix E.

3.1.7 Learning environment

The purpose of this section is to discuss the importance of a well-planned learning organisation that is working with the users, instructors and the training media available.

Naturally, it is important to identify the skills needed in order to develop an expertise in the different crew roles, as well as to use the adequate training media for practising the identified skills. However, the *identified skills* needed and *the best training media possible* do not work all by themselves. How the training media is used will clearly affect the training effectiveness and skill level obtained. An obvious aspect of the learning environment is the importance of instructors.

Typically, there are two types of training facilities:

1. Centralized facility for type rating and recurrent training of cockpit and crew and rear cabin personnel. The training is performed at Full Flight Simulators (FFS’s) or Rear Cabin Trainers (RCT) with professional instructors. Likewise the aircrew training (if it occurs at all) is performed at special aircrew training facilities with professional instructors.
2. Local facility for part task training of cockpit and rear cabin crew (in a RCT) including mission planning and debriefing. The training is performed at the local base with instructors trained within the actual branch of service.

Currently cockpit crew and rear cabin crew use training media separately from each other. A complex helicopter such as the Swedish NH90, with a large potential for variation in task distribution among aircrew, requires integrated (networked) training media with a focus on aircrew training.

Irrespective of training solution, an efficient learning environment is dependent on dedicated simulator instructors. Being an instructor should involve high status and financial rewards. The instructors should also remain in active flight duty. Apart from creating interesting and pedagogical simulator training scenarios, the instructors should be involved in debriefing of in air exercises as well as simulator training. They should function as an employed "mentor" for the rest of the squadron. The employment criteria for instructors should be a) documented experience and mission skill, b) documented pedagogical skills, and c) leadership/teamwork skills.

Mission debriefing is a very important learning tool for both individual skills as well as team performance to facilitate a full comprehension on the events occurring during the mission. For example, the cockpit crew may believe that a hoist operation went perfectly well although the cabin crew was in fact struggling with entangled lines. The main purpose of the debriefing is to focus on the learning aspects, that is:

- review the course of events
- reflect on the team performance and discuss what's important to focus on in future missions
- reflect on task distribution and discuss ways to support individual crew members
- feedback on individual crew members performance, a process for improvement of individual skills
- collecting a vast library of experiences and suggestions on improvements regarding the mission execution
- small misunderstandings in communication may lead to within crew irritation and need to be sorted out carefully on ground

Finally, an upcoming challenge will be the young students entering the program. The positive aspect is that they are already familiar with and quite skilled at managing computers and applications. On the other hand, they get "easily bored" and require more challenging training media and creative instructors.

3.1.8 Air crew skills and abilities

Each crewmember needs a number of abilities and skills depending on the role and mission type/task. Some of these skills are trained within the Swedish NH90 system, while others need to be acquired elsewhere. The ambition here is neither to cover all such skills nor to elaborate on crewmember personality traits and stress tolerance. Instead the discussion will comprise a set of applicable skills that must be enclosed in the training syllabus.

To become a skilled operator, the operator needs a) to practise and b) to have the specific abilities that are required (see below). Since these skills can only be trained to some degree, they also need to be considered in the selection of crewmembers. The skills needed by each crewmember depend on the functions they perform, which may vary with the mission type, number of crewmembers, and task organization. In addition, as the crew size increases, there is a greater need for collaboration and cooperation skills. The analysis is only based on observations and interviews with operators. The general skills required for all crewmembers are described first, followed by the specific skills for individual crewmembers.

Two abilities, **sustained attention** and **social ability** (communicative), are more or less important for **all** roles in the aircrew, but are often neglected. Sustained attention refers to the ability to perform well, mentally and physically, over longer periods when there are no breaks or rests that allow the operator to recover. Such periods may occur both within missions and when mission sequences are performed in close proximity. Sustained attention is especially important for crewmembers that are under high mental pressure. Social skill in this context primarily refers to how a well functioning crew is created through communication. This does not only mean technical aspects of terminology, procedures, discipline, speaking clearly, listening and understanding, but particularly the ability to “read” the state of the crew by analyzing what they say (often between the lines). Both the ability to constantly perform well over time periods (sustained attention) and social communicative skill may be difficult to improve since a substantial number of practice hours are required with a complete crew. Although the social ability is important for all crewmembers, it is crucial for the pilot in command and co-pilot.

There are three particular abilities that are relevant for specific crewmembers: **topographic spatial ability**, **working memory capacity**, **and auditory abilities**. Topographic spatial ability refers to the understanding of how a body moves in space relative to the aircraft and is important for the operator’s **situational awareness** (SA). The operator’s SA can be viewed as consisting of the three levels a) perceiving task relevant elements, such as altitude, terrain, other aircraft, display meters, radio messages etc., b) interpreting the perceived elements relative mission goals, such as selection of weapon, sonar mode and pick-up method and c) projection of future states, such as how the current flight path will contribute to exposure or estimation of time left in area (cf. Endsley, 1995). For example, the topographic spatial ability is important for the TACCO when visualizing the dynamics of target and terrain scenario in three dimensions. The operators are fully aware of the importance of the topographic spatial ability.

Working memory capacity, on the other hand, refers to remembering the information for immediate use and reflects what we are aware of at a given time from the immediate assimilation and processing of the information flow. The working memory capacity is important when completing simultaneous tasks that tap explicit information processing. For example, the working memory capacity is important for the TACCO when subjected to high workload from the processing of demanding tasks, such as target tracking. Finally, auditory ability refers to perception and interpretation of auditory information. For example, the auditory ability is important for recognition of critical sonar sounds. The topographic spatial skill can be improved with practice. The skill to assess and process large quantities of information (working memory capacity) and auditory skill, on the other hand, are often more difficult to improve with practice, that is a large number of training hours are needed to become skilled. The literature argues that an operator often needs approximately 10.000 practice hours to become an expert. The topographic spatial ability and working memory capacity are crucial for pilots, TACCO, and SENSO (in the role of assisting/collaborating with the TACCO). The auditory ability, as indicated above, is crucial for the SENSO.

The flight engineer’s technical skills are covered in the ground crew section. The door gunner’s aiming skills and the rescue man’s very specific abilities are not comprised by in the TNA.

3.1.9 OTTA Summary

The Difficulty, Importance and Frequency analysis (DIF-analysis) shows that there is a considerable training need, as the majority of tasks fall into categories *train* or *overtrain*. The least amount of training, category *initial training*, is only sufficient for a very limited number of tasks. Furthermore, missions and tasks that are performed more infrequently require over training.

The task analysis indicates a substantial amount of within crew and outside crew interaction such as co-ordination, co-operation and collaboration that takes place during all phases of a mission. Most often this type of training is conducted as on-the-job training. We believe there are several reasons why there should be TM supporting the aircrew training. First of all, the simulator environment is safe and mistakes are allowed. Tasks can be practised as needed independently of weather and other external circumstances. Secondly, different “type situations” can be generated and practised facilitating the transfer of knowledge from the experienced to the novice crewmembers. Thirdly, such TM gives opportunity to accommodate and maintain homogenous crew standards. Finally, it is an excellent tool for evaluation of new task concepts. Consequently, aircrew-TM is associated with high training effectiveness and an increased flight safety.

3.2 Air crew TGA

The purpose of the Training Gap Analysis (TGA) is to determine how the introduction of the Swedish NH90 impacts training requirements for air and ground crews. Important goals of the TGA are to (1) identify any differences in the type of training required by experienced and inexperienced jobholders, (2) define the gap between the new operational performance required and the entry level, (3) define the type of skills to be trained, and (4) define a set of Training Objectives (TOs) for the Swedish NH90 air and ground crews. The following sections describe the methods and results for the TGA.

3.2.1 Swedish aircrew training programs

TM is used in a planned and organized manner, that is there is always a training syllabus regulating the time spent on TM. The current cockpit crew training is limited to use of FFS. The primary training objectives are to achieve and maintain basic type specific skills (type rating and recurrent training). The training includes flight safety considerations, emergency handling, systems handling, decision-making, and in some cases technical systems understanding and CRM. Complete mission training and interaction/co-operation with the rear cabin crew is not included. Use of CBT/CAI and TM such as part task trainers is just becoming more common.

This section contains a brief description of a possible solution for the regular Swedish NH90 pilot training, that is for the student succeeding the initial fielding team. The tables are based on SME descriptions of current training programs, written training syllabuses and SME assumptions for the future training aiming at the Swedish NH90. However, this table is subject of change since the basic flight training including helicopter training is expected to be conducted by a non-Swedish supplier. The purpose of the tables is to establish an estimate of pilot entry level in terms of flight hours and experience with respect of missions and helicopter types (2-engine etc).

Phase	**Location**	**Type of A/C**	**Flight hours / Time frame**	**Exit level**	**Comment**
Basic flight school, (GFU)	TFHS in Ljungbyhed,	Scottish Aviation Bulldog	~ 60 ft h, 3 month	Basic flying skills	Corresponds to PPL on Airplane
Basic helicopter school, (GHU)	Malmen	Agusta A109 Military	148 ft h, 1 year	Basic helicopter skills. Basic hcp/ 2-engine / IR	Corresponds to PPLH and CPLH
Basic Tactical Training, (GTU)	Battalion	Agusta A109 Military	150 ft h, 1 year		
Flight academy, Tactical Program, (TAP)	Helikopterstr idsskolan, Malmen		1 year		Corresponds to ATPL
Type and mission specific training, (TIS/GFSU)	Squadron level	Swedish NH90	1,5 to 2 years	TR Swedish NH90 and mission specific training Exits as co-pilot	
Continued applied mission training, (FFSU) Pilot-in-Command Course	Squadron level	Swedish NH90	2 to 3 years	Continued applied mission training. Exits as pilot-in-command	

3.2.2 Skill acquisition

Although the training program may vary over time, there are several common elements. Figure 3-8 shows an effort to establish a “generic” pilot training flow. The intention is to facilitate the discussion of the various steps that occur in gaining proficiency when performing complex tasks, such as the Swedish NH90 missions. See Appendix B for definitions.

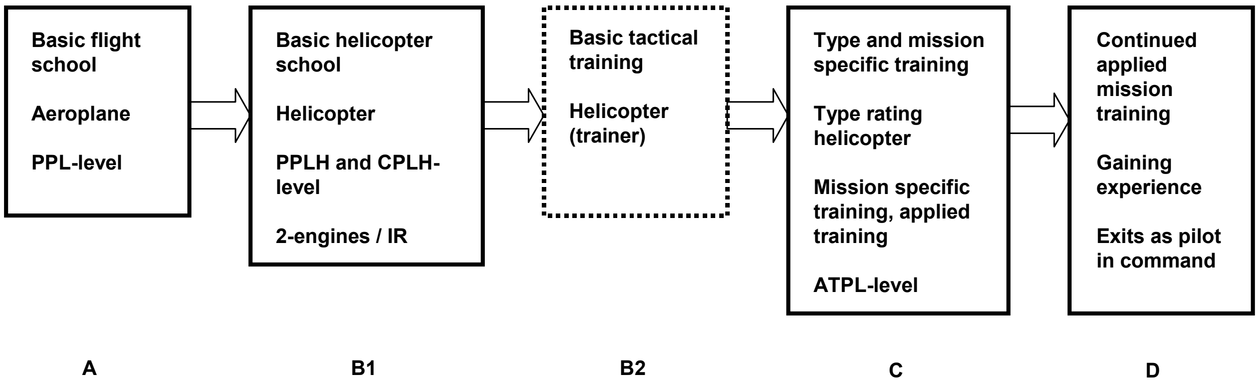

Figure 3-8 Generic pilot training flow

Phase A is the pilot’s first encounter with flight. He or she learns to maneuver a small airplane and obtains a basic understanding of the concept of flight. This phase is a formal training period with a fixed training syllabus.

Phase B1 is the pilot’s first encounter with helicopters, where he or she learns to maneuver a small lightweight helicopter. Upon completion, the pilot is transferred to a two-engine helicopter and learns how to fly IFR, among other things. This phase is a formal training period with a fixed training syllabus.

Phase B2 is where the pilot is taught basic mission training, that is basic tactics and contextual aspects of a mission. Usually this training is conducted directly after B1 and on a trainer, that is a helicopter that differs from the target platform. Such trainers are currently used in Sweden. However, depending on available resources/helicopters, this training may be performed directly on the target helicopter, in which case phase B2 is included in C. This phase is also a formal training with a fixed training syllabus.

Phase C is the type rating and mission training, where the pilot learns to fly heavy helicopter, in this case the Swedish NH90, in various mission types. The type rating is a formal step with a fixed training syllabus. Upon completion the pilot continues to fly missions in a multi crew and obtains mission skill and experience. This is a semi-formal training period dependant on external circumstances and events such as weather, season and opportunity to gain experience of different scenarios. The exit level is as co-pilot.

Phase D is continued mission training. Upon completion the pilot shall be able to take full responsibility of both machine and crew. While the most time is spent on gaining experience, there are some formal parts including deeper technical knowledge and CRM training. Completion of phase D is not tied to a specific number of flight hours or missions conducted; rather the requirement is a minimum number of years in this role.

The skills acquired during phase A to D are estimated as follows:
A During phase A the pilot learns how to operate a small fixed wing A/C in a safe manner. This includes for example basic flying skills and knowledge such as: take off and landing, navigation, how to operate the communication system and meteorology. Consequently, **conceptual** understanding is obtained and the main skills practised in this phase are **motor**, **perceptual**, and **procedural:**
Motor skills involve how to manipulate the vehicle controls; such as to learn what force need to be applied on the stick and pedals in order to perform certain maneuvers. With training, many task elements become more automated compared to the initial situation. They can then be performed with ease, almost instinctive, and without greater mental effort. This automation process is important, since it sets mental processing resources free, which can then be used for handling other task elements.
Perceptual skills involve how to monitor and interpret the instrumentation in various phases of the flight (where and when to look) and how to interpret and attend to auditory inputs.
Procedural skills involve how to perform the checklists, take off and landings, approaching procedures, emergency procedures, and planning.
Conceptual understanding comprises knowledge of the aviation domain in general. This includes acquiring a set of concepts about aviation – How can this machine actually fly? In what situations can I land? Understanding contextual factors, such as the effects of weather and lighting conditions on aviation.

The skills and knowledge acquired during this phase are at such a generic level that they can easily be applied in later training phases.

B1 During phase B1, the pilot learns how to operate a small helicopter in a safe manner. This includes again basic flying skills and knowledge. A majority of the content in phase A is repeated, especially regarding **motor**, **perceptual** and **procedural** skills. Naturally there is a continued development of the **conceptual** understanding of aviation and helicopters in particular.

B2 During phase B2, basic tactics and simple mission training is introduced and trained.

C During phase C, the pilot first learns how to operate the target platform (in this case the Swedish NH90) in a safe manner, that is type rating. Again the skills acquired are **motor, perceptual** and **procedural.**
Following the type rating is the mission specific training where previously obtained skills and knowledge from phase A, B1, B2 and C are put to practice in a mission context. In addition, there is now an aircrew to consider, which means that **teamwork skills** must be developed including an understanding of crewmember responsibilities and roles. The necessary teamwork skills consist of **coordination**, **cooperation** and **collaboration**. In this second part of phase C, a form of apprenticeship learning is used where the inexperienced crew members acquire knowledge from experienced crew members more or less by **incidental** learning (i.e. many times the teaching is not intentional). A large foundation of mission experience is built up. Finally, this phase is mainly a source for continued acquisition of **procedural** skills and especially **conceptual** understanding and **teamwork skills**. The degree of interaction affects the number of training hours needed in order to acquire teamwork skills

D During phase D, the pilot is being prepared for the crew chief responsibility. Continued **incidental** applied training is performed together with elements of scheduled courses. For example, courses in CRM aspects, such as leadership training, and deeper technical systems understanding. **Decision-making skills** are acquired in real life complex situations, and all the skills and knowledge obtained in previous training are used to solve the tasks. This step provides the necessary training for pilots to be able to take on the role as crew chiefs and fly as pilot in command. The training is mainly directed towards **conceptual** understanding. Missions and their variations are trained extensively and experience is gathered from the situations that occur.

3.2.3 Experienced versus inexperienced crew member

The crewmembers entering the Swedish NH90 systems will have two different backgrounds:

- The inexperienced crewmember with none or limited experience on similar helicopters and mission types. That is, pilots that have passed phase B1 or B2 as described in the previous section.
- The experienced crewmember with a great deal of experience from other similar helicopters. That is, pilots that have passed phase C or D as described in the previous section on other helicopter types.

Both inexperienced and experienced crewmembers will start their type rating in phase C followed by mission specific training. Both categories will have to acquire motor, perceptual, procedural and teamwork skills together with conceptual understanding of the missions. However, they will face two different kinds of obstacles:

- The inexperienced crewmember will probably encounter larger difficulties in learning the teamwork skills and the conceptual understanding required to become a skilled crewmember as compared to the experienced crewmember. Thus, those areas are expected to demand more practice hours.
- The experienced crewmember will be able to re-use a great deal of previously acquired teamwork skills and conceptual understanding of the missions. Therefore, these areas do not need to be practised to the same extent as for the inexperienced crewmembers. On the other hand, since it is likely that the experienced crewmember has automated most motor and procedural skills, such as how to handle the radio, these skills must be completely re-learned. Re-learning is much more difficult than to learn from scratch and will require considerable training. The learning effects on perceptual skills are harder to predict. However, much is relatively similar and will probably not create any particular difficulties.

Furthermore, the missions will probably be performed in relatively stressful situations. When a stressful situation is at hand, the effect of previous knowledge (the tendency to revert to “old” habits) is more pronounced, that is it becomes even more difficult for the experienced crewmember to override old procedural skills. The training syllabus for type rating and mission training must consider these differences in performance. The time spent on learning the procedural and motor skills must vary according to individual needs. No additional training equipment is expected to be needed.

On a general level, the experienced crewmember will perform better than the inexperienced, especially if the experienced crewmember is focused on the procedural skills that need to be re-learned.

Table 3-1 shows a summary of training objectives for inexperienced versus experienced members.

Table 3-1 Training objectives for inexperienced versus experienced

Air crew member	Training Objectives	
	Additional for inexperienced	Additional for experienced
Pilots	More practice hours on team work skills and the conceptual understanding of a mission	More practice hours on re-learning automated motor and procedural skills
TACCO	More practice hours on team work skills and the conceptual understanding of a mission	More practice hours on re-learning automated motor and procedural skills

Left pilot	More practice hours on team work skills and the conceptual understanding of a mission	More practice hours on re-learning automated motor and procedural skills
Flight Engineer	More practice hours on team work skills and the conceptual understanding of a mission	**Some** practice hours on re-learning automated motor and procedural skills
SENSO	More practice hours on team work skills and the conceptual understanding of a mission	More practice hours on re-learning automated motor and procedural skills
Loadmaster Doorgunner Hoistoperator	More practice hours on team work skills and the conceptual understanding of a mission	No difficulties expected
Rescue man	More practice hours on team work skills and the conceptual understanding of a mission	No difficulties expected

3.2.4 Entry and exit level

The expected entry level for the Swedish NH90 is shown in Table 3-2.

Table 3-2 Entry level for air crew entering phase C:

Type of personnel	Theoretical Knowledge / Practical Skills
Aircrew	
Pilots	Basic skills to handle and operate a multiengine helicopter day and night. Basic mission skills in NOE, sling load, IFR rating
TACCO (System operator)	Basic air navigation Academic mission skills
Left pilot	Basic Technical skills, Qualified Avionics or Airframe / Engine Maintenance Technician, Basic navigation skills Academic mission skills
Flight Engineer	Basic technical skills, Qualified Avionics or Airframe / Engine Maintenance Technician, Academic mission skills
SENSO	Academic mission skills
Loadmaster Doorgunner Hoistoperator	Basic helicopter technique, Academic mission skills
Rescue Swimmer	Academic mission skills

The exit level from phase C must correspond to the new operational performance. The statements below are expected to satisfy the new operational requirements.

An individual crewmember shall be able to perform all the tasks and duties comprised in all applicable types of missions and submissions at any given time without prior training. Specifically,

a crewmember shall be able to perform both primary and secondary mission types, special operations excluded, provided that the crewmember has received proper type rating and mission training for the particular mission type or subtype.
The mission shall be performed in a safe manner
The mission shall be performed according to the operational standards established.
The crewmember shall be able to utilize the complete system within the defined mission envelope and under the for the Swedish NH90 applicable mission circumstances in order to reach the mission objectives.

This definition of exit level has been used in defining the total training objectives and technical requirements on training media.

3.2.5 Overall training objectives

A mission can be anything from a check flight conducted by one pilot and a flight engineer to a several hour long search for a potential submarine involving the entire aircrew. Nevertheless, all missions have in common that in order to succeed; all crewmembers must be able to perform their duties in a safe and correct manner. Naturally, mission success relies on that the training objectives meet the mission objectives. The mission success pyramid in Figure 3-9 illustrates how the training objectives, training content and training effort change as the student is reaching a higher experience level. Initially, focus is directed towards individual skills acquisition without interference from the crew. As the trainee becomes increasingly familiar with the system, the entire crew is gathered, and the focus shifts towards acquisition of teamwork skills.

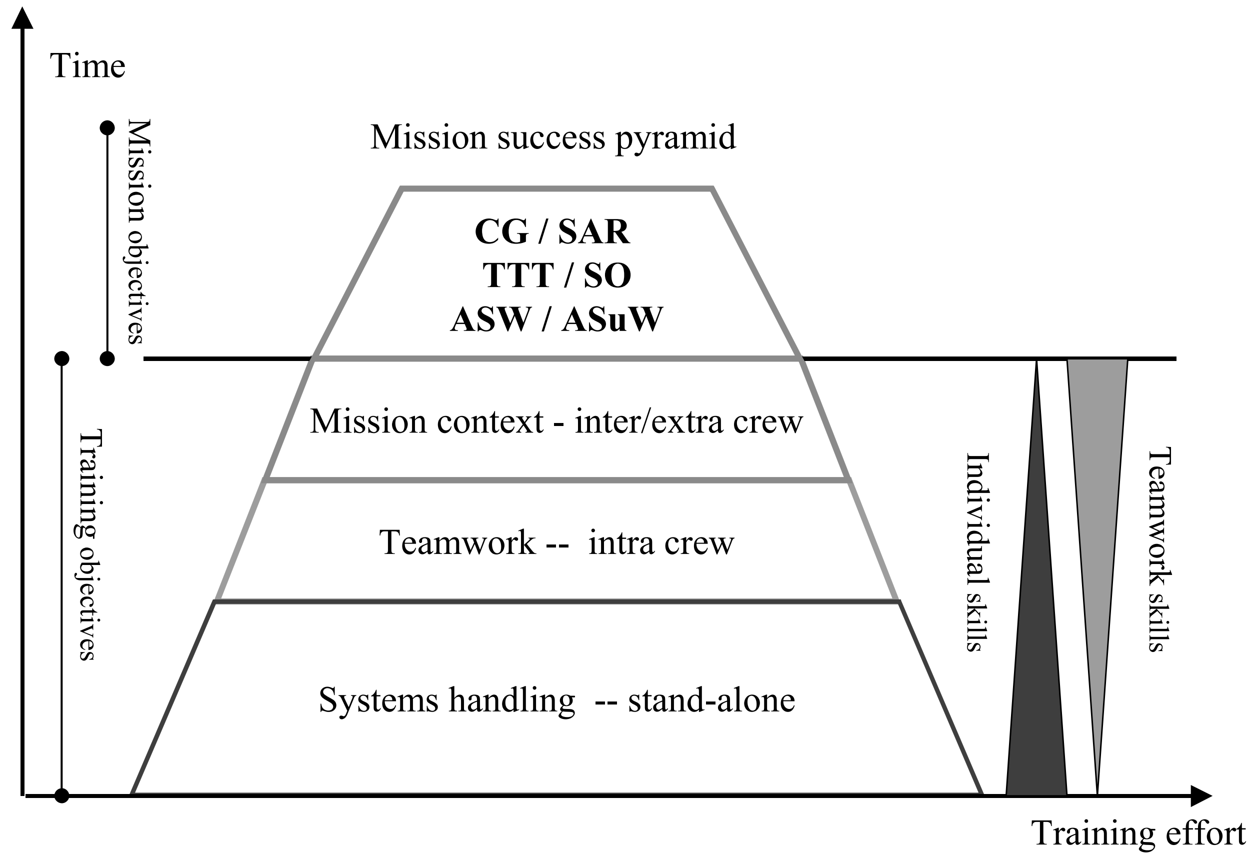

Figure 3-9 The mission success pyramid illustrates changes in training content over time

Systems handling refers to the skill to operate and make use of onboard systems, that is being able to manoeuvre and control human-machine interfaces and instrumentation. The skill level obtained reveals how well an operator can take advantage of and utilize the provided functionality. Especially important is safe operation, which means systems handling with intention of ensuring flight safety and system safety. This level also deals with the deeper technical understanding of the subsystems and their intended functionality. Such systems handling requires a large amount of individual training. Systems understanding mean a deeper insight in the underlying functionality, how systems are integrated and the flow of information between systems.

Teamwork, which applies to cockpit crew, rear cabin crew and aircrew, includes the knowledge of the different roles and duties and the ability to work together to achieve a common goal.
Mission context applies to the deeper conceptual understanding of a mission, the actual real world problem solving and gaining experience of the different situations that might occur, as well as extra crew co-operation and information exchange.

The mission objectives and the accompanying mission content for the Swedish NH90 operations (sub-operations) have been illustrated in the mission flow charts, see Appendix D. The overall training objectives are listed in Table 3-3.

The analysis of the mission flowcharts reveals an extensive need for individual training as well as within cockpit crew, rear cabin crew and aircrew training.

Type rating requirements for helicopter cockpit crews are stated in JAR-FCL. However, the standard does not cover NH90 type specific requirements and areas of utilization. It is therefore necessary to determine all training objectives needed for a complete type rating as well as missions training. JAR-FCL 2 and 4 should be used together with tasks determined in Appendix E.

Table 3-3 A listing of the overall training objectives

Training objective	**Must be able to operate and utilize / conduct and understand**	**Applies to**
Systems handling and deeper technical systems understanding	**Safe operation (**flight safety and system safety**):** • Emergency procedures • Safe flight envelope	Cockpit crew
	Flight and vehicle subsystems • Swedish NH90 flight mechanics • Flight control system • Engine and fuel management system • Hydraulic control system • Electrical systems and APU • Landing gear, brakes steering • Ice protection system • Environmental control system • Lighting system	Cockpit crew
	• Hoist control systems • Other rear cabin equipment	Rear cabin crew
	Avionics subsystem (core avionics) • Control and Display System • Navigation System • Plant Management System • Communication and Identification System - Radio, - Data link systems, - IFF	Air crew

	Sensor subsystems: • Weather radar (cockpit crew) • Tactical radar • FLIR • Sonar/sonobouys • Obstacle warning system	Air crew
	Tactical and weapon subsystems: • Electronic warfare systems • Countermeasures • Weapons • Stores	Air crew
	• Mission system • Swedish mission system	
Mission circumstances	**Time of day:** • Day, dusk and night (NVG) **Weather:** • According to the design criteria for Swedish NH90 (VFR, IFR) **Climate:** • Temperature - 40 ° to + 35 ° • Humid coastal areas, dry inland • Varying snow characteristics, thickness of layer up to 200 cm, snowstorms • Moderate to heavy icing • Variations in atmospheric vertical profile (wind and temperature) **Terrain:** • Open water/Archipelago • Large amount of small lakes • Mountains and flat terrain • Treeless terrain, broken farming areas and some heavy populated cities **International operation environment** **Confined area, NOE flight** **Ship operations**	Air crew
Mission context	**Conceptual understanding of the various mission types that are to be performed:** • Mission planning • A typical mission as stated by "the book" • Mission variations • High mental workload situations (stress) • Methods to solve new events/situations • Operate in 2-ship or multi-ship configurations (inter crew) • Extra crew communication / information exchange • Fault isolation / workarounds • Mission debriefing, lessons learned	Air crew
Teamwork skills	• Know the own roles and duties as well as those of the other crewmembers • Coordinating skills, that is to work separately to achieve a common goal	Cockpit crew, rear cabin crew, aircrew

	• Co-operating skills, that is to work together to achieve a common goal • Collaboration skills, that is to work jointly together to achieve a common goal • Joint operations, cooperation with other units within or outside of the task group • Crew resource management knowledge	

3.2.6 Types of training

In order to determine the actual training need the student's entry level must be considered. Assume there are two types of students, those who have mission experience from similar types of H/C and those who have not. In generalized terms the type of training needed can be categorized in two groups: type rating and recurrent training. The definition of the training objectives showed that the training content could be categorized as ab-initio (from the beginning), periodical training and mission training as shown in Table 3-4.
The individual training has strong elements of part task training while the mission training is more oriented towards teamwork.

Table 3-4 Types of training

Types of training	**Training content**	
Type rating	Ab-initio training	Individual/Crew training
	Mission training	Individual/Crew training
Recurrent training	Re-qualification (periodical)	Individual/Crew training
	Mission training	Individual/Crew training

A further description of typical training content is listed in Table 3-5.

Table 3-5 Training content

Training Content	**Must be able to operate and utilize / conduct and understand**	**Training objective**
Ab-initio training	Flight Safety	Emergency procedures Decision making processes
	Learn how to use the H/C systems	Systems understanding "Learn how to fly the H/C type" Precise systems handling
	First encounter of type	Pilots with relatively few flight hours
Re-qualification training	Flight Safety	Emergency procedures Decision making processes
	Demonstrate proficiency in use of H/C systems	Precise systems handling
Mission training (can also be referred to as applied training)	Learn how to use the H/C systems for specific missions with large variations in mission circumstances (type rating)	Previously learned skills and knowledge are applied to real mission situations
	Demonstrate use of H/C systems for specific missions with large variations in mission circumstances (recurrent training; periodic check-up)	Previously learned skills and knowledge are applied to real mission situations

3.2.7 Total training need

The training objectives state the total training need. The amount of training that is to be conducted using TM is determined by:

- Number of flight hours per individual crewmember and crew
- Risk level
- Type of mission and mission circumstances
- Required proficiency level
- System complexity and HMI
- Operational circumstances

Number of flight hours per individual crewmember and crew
Lots of OJT means less need for TM. However, far from all training objectives can be met by OJT only.

Risk level
Certain types of missions may involve high-risk activities. These particular tasks are much better off trained in a simulator. For certain types of maneuvers, such as some emergency procedures, TM may be the only place to conduct training in a safe manner.

Type of mission and mission circumstances
An important aspect is the complexity of a mission. Military budget limitations, busy schedules, considerations to civilian need etc. results in rare occurrence of large exercises. Another aspect that is hard to control is the weather situation. TM can be used to effectively and sufficiently create and simulate large scenarios with numerous players including enemy threats, variations in area of operation and any requested weather/light/seasonal condition.

Required proficiency level
TM can be used to obtain and maintain the required proficiency level.

System complexity and human machine interface (HMI)
A more complex system and less user friendly interface requires more need for training. The Swedish NH90 is not operative, which means that there is no real experience of the usability of the system. However, through discussions with SMEs and by performing CAI lessons it has become quite clear that the Swedish NH90 has a complex user interface. In other words it is not intuitive and unfortunately quite cumbersome to operate. Utilization of units such as the DKU is a prerequisite for flight and requires adequate skills in order to ensure fast and safe operation. From a training point of view, skills that are already obtained can be maintained by OJT, but initial training should be performed on TM rather than the real H/C. The reason for this is twofold. First, it saves valuable flying hours that can be spent on gaining experience of different tasks and missions. Secondly the learning will be safer and more efficient when performed in a less complex environment. Figure 3-10 illustrates how system functionality and HMI in combination with the operators and mission circumstances all affect the outcome, in this case the mission result. The figure does not include the important man-man interactions.

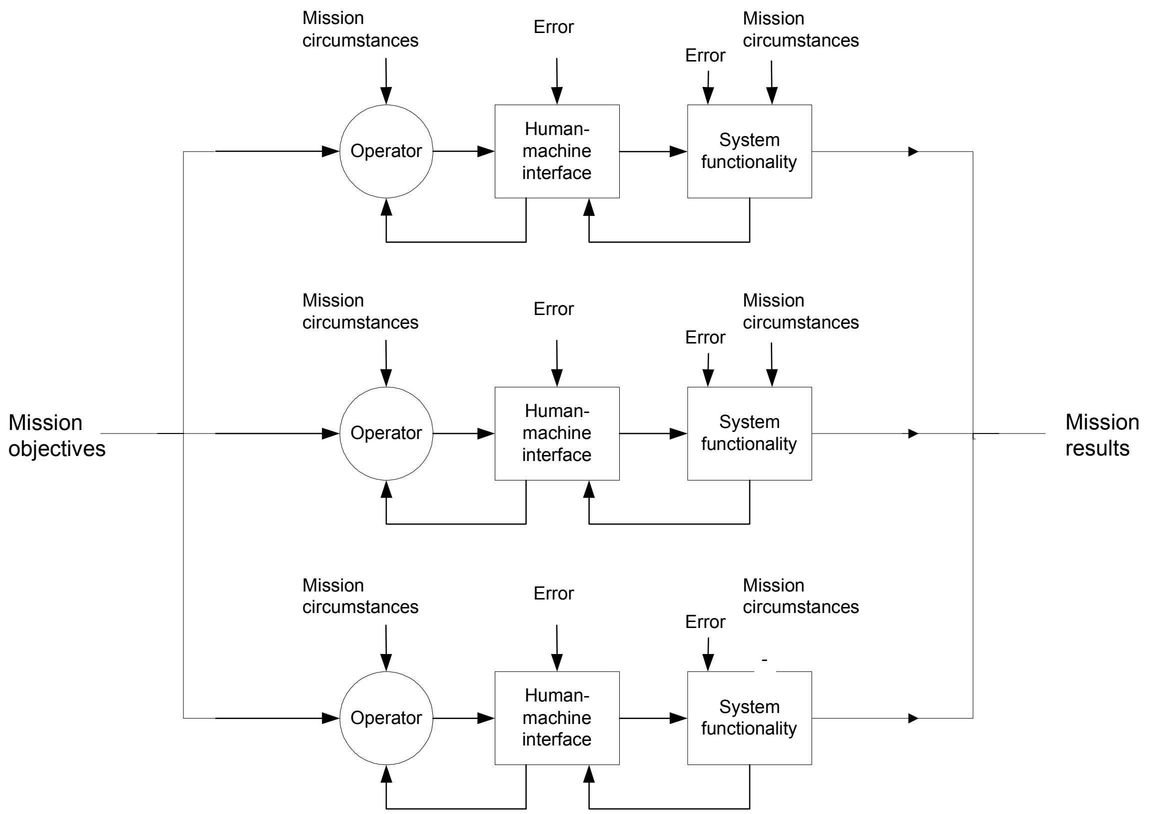

Figure 3-10 System effectiveness framework

Operational circumstances
Practicing missions versus performing real operations clearly affects the quality of the OJT. If the possibilities to perform mission during real conditions are poor TM must be used as a supplement.

3.3 Air crew TRA

The aim of the TRA work is to state technical requirements of vital importance for the ability to meet the training objectives.

3.3.1 TRA per type of training

As defined in 3.2.6, there are two types of training: type rating and recurrent training and three major types of training content: ab-initio training, re-qualification training and mission training (can also be referred to as applied training). These types of training content represent different stages in the crewmembers skill acquisition process and are therefore associated with different TM requirements on pedagogical tools and fidelity levels.

The ab-initio training is where the crewmember acquires the basic knowledge and skills on how to perform the various Swedish NH90 tasks. The type of skills and knowledge that need to be acquired are systems handling, for example selection of radio frequencies and waypoint navigation, and systems understanding, for example the engine start-up process. *It is important that each task and task element is performed in the same manner as in the real H/C*. In other words the TM for ab-initio must be representative of the H/C system and subsystems with respect of:

- functionality and behaviour (a complete simulation of H/C subsystems including all possible configurations)
- spatial location of displays, buttons and levers
- force feedback, tactile, motion, visual and aural cueing
- sensor information
- emergency procedures and malfunctions

Consequently, it is not recommended to conduct regular task training, except familiarization, on a TM, which is simplified with respect of above stated requirements. The likely result is negative transfer of training and an erroneous behaviour in air.

The mission training, on the other hand, is focused on the mission and crew aspects (cockpit crew, rear cabin crew or aircrew) and is generally less sensitive to the ability to perform each task exactly as in the H/C. The purpose of the mission training is to accomplish mission skills, which include how to perform a specific mission type, crew interaction, decision-making, problem solving, new concepts etc. The goal is not to learn how to perform a certain task such as start up of engine or take off from ship. The majority of the mission training is conducted after the crewmember has finished the ab-initio phase.

While the ab-initio training is focused on *learning how to perform a certain task* the mission training is concerned with *applying the task in a mission context*. Both types of training content are important and absolutely necessary in order to obtain high system effectiveness.
The requirement on TM can be explained in terms of fidelity of cueing, which is lower for the mission training.

3.3.2 TM fidelity levels

The Swedish NH90 will be used for a large variety of missions that are to be conducted during a likewise large variety of mission conditions. Consequently, simulation of the helicopter platform and the operational environment can become quite a challenge. A simplified but functional method is to divide a simulator in two major parts, modelling of the vehicle and simulation of the external environment in which the vehicle operates. The fidelity of a simulator/simulation states how successful the modelling is in simulating/replicating the real world situation. Different types of cueing are usually among the most difficult to replicate and accordingly the most expensive simulator components. It is therefore necessary to determine the minimum fidelity needed for each training need/training objective.

The purpose of the TRA is to elaborate on the TM functionality and “fidelity” needed in order to meet the training objectives. For this TNA three different fidelity levels were defined:

Level 3: Same functionality as in the real H/C, same visual appearance, same visual cueing, same aural cueing, same haptic cueing, and similar vestibular cueing.

Level 2: Same functionality as in the real H/C, similar visual appearance, similar visual cueing, similar aural cueing and similar haptic cueing.

Level 1: Similar functionality as in the real H/C, similar visual appearance, similar visual cueing, and similar haptic cueing.

In this context the word “Same” means *very high effort to replicate.*

In this context the word “Similar” means *lower effort* to replicate, that is reduced fidelity in one or more of the applicable subsystems. For example: reduced FOV for a display system, vibration platform and dynamic seat instead of 6-DOF motion system, touch screen instead of hardware buttons and knobs, spring loaded cyclic and collective instead of H/C hardware etc.

Level 3 (L3) complies with JAR-STD-1H.030 Level D. This level comprises the highest effort to replicate all types of cuing present in the real flight. For example a large FOV visual system allows the pilot to use the same visual information (with respect of FOV) as in the real world situation.

Level 2 (L2) corresponds to a simulator with lower requirements on the fidelity of cueing. The precise cueing needs depends on the training objective, as is stated in Table 3-6. This level does not correspond to any of the JAR-STD-1H.030 levels.

Level 1 (L1) corresponds to a simulator with low requirements on fidelity of cueing as well as vehicle simulation. In other words, this device is more generic.
This is a lower requirement than JAR-STD-1H.030 Level A.

3.3.3 TRA per mission type, summary

The TRA is based on long experience of flight training simulators, SME interviews and discussions with other experts on simulation.

Withdrawal of any of below listed requirement will impair one or more of the:

- ability to meet the overall training objectives with TM
- effect of training
- ability to perform the important intra crew training
- ability to practice decision-making
- ability to use TM for tactical development
- motivation for training
- flexibility in TM use
- training under typical mission conditions

Table 3-6 Summary of TRA per mission type (L1, L2 and L3 as defined in 3.3.2)

Mission subtype	Technical Requirement
SAR in archipelago/fjords and open water	• L3. Provision to use the same mission planning equipment as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate working space. • L2. Complete simulation of H/C and avionics subsystems • L3. Complete simulation of rear cabin console and associated functionality. • Provisions for simulation of external communication with e.g. ATC, hospital, rescue coordination center, ships as simulated by the instructor • L3. High resolution visual display system. • Applicable visual objects, sea states, ship wake, rotor wash, applicable dynamic objects, weather effects, seasonal varieties, TOD-simulation • Databases supporting archipelago/fjords • L3. Sensor database: High resolution and coding of applicable objects including small objects, PIW • Visual system for hoist operators • Rear cabin mock-up with hoist • Visual objects such as runways, landing decks etc • Debriefing Station • Databases supporting open water (large gaming area) • Case studies
SAR over land mountainous terrain	• High resolution databases supporting various types of land use and mountainous terrain • L3. Sensor database: High resolution and coding of applicable objects including small objects
SAR over land flat terrain	• High resolution databases supporting various types of land

	use and rough terrain • L3. Sensor database: High resolution and coding of applicable objects including small objects
ACO	• L1. Similar functionality as in the H/C. Provision for interaction with several air units, ships and rescue coordination center. Case study
TTT	• L3. Provision to use the same mission planning equipment as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate working space. • Case studies • L2 Complete simulation of H/C and avionics subsystems • L3. High resolution visual display system and database. • L3. Database supporting various types of terrain/urban areas. • Detailed simulation of applicable visual and dynamic objects, terrain features, weather effects, seasonal varieties, TOD-simulation • Sensor databases supporting various types of terrain/urban areas • Visual system for rear cabin, hoist operator/load master and door gunner • Provisions for simulation of external communication with e.g. other air units, ground units, troop etc • Complete simulation of rear cabin console and associated functionality • Rear cabin mock-up. • Debriefing Station
ASW/ ASuW	• L3. Provision to use the same mission planning equipment as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate working space. • Case studies • L2. Complete simulation of H/C and avionics subsystems. • L3. Complete simulation of rear cabin consoles and associated functionality. • Provisions for simulation of external communication within task group e.g. two-ship, tactical commander, other units such as ships etc as simulated by the instructor • L2. Visual display system (high resolution only needed for identification of targets) • Applicable visual objects, sea states, ship wake, rotor wash, applicable dynamic objects, weather effects, seasonal varieties, TOD-simulation. • Databases supporting archipelago/fjords/open water • L3. Sensor databases supporting archipelago/fjords/open water. High resolution and coding of applicable objects including small objects • Debriefing Station • L3. Post analysis equipment (technical analysis)
SO	• L3. Large variations in database contents, detailed simulation of terrain features and objects. Rapid database creation. Large gaming area.

	• Rear cabin mock-up. • Provisions for simulation of external communication within task group e.g. two-ship, tactical commander, other units such as troop etc as simulated by the instructor or in the case of troop that actually might participate in the scenario • Mission rehearsal capabilities.
International operations	• Rapid database creation L3. Large variations in database contents, detailed simulation of terrain features and objects. Rapid database creation. Large gaming area. • Rear cabin mock-up. • Provisions for simulation of external communication within task group e.g. two-ship, tactical commander, other units such as troop etc as simulated by the instructor or in the case of troop that actually might participate in the scenario • Provisions/device/facility for training of specific communication syntax • Wargaming
Common requirements	• Vibration system • Sound system for both cockpit and rear cabin crew

3.3.4 Systems understanding

Training objective *systems understanding* is different in that the "tasks" are more directed towards acquiring theoretical knowledge than practicing skills. Instead, the objective is to obtain a mental model of the H/C functionality in order to interpret and rationally handle unexpected or rare events.

Systems understanding is rather difficult to accomplish using simulators, textbooks or drawings. Some kind of pedagogical tool to visualize and animate the helicopter subsystems would be beneficial. Computer Aided Instructions (CAI) and the Virtual Maintenance Trainer (VMT) can therefore play an important role for the air crew as well as for the ground crew. Depending on how CAI/VMT is structured, it can either be used as a tool for initial training / recurrent training or as a knowledge base to continuously utilize at the home base.

3.4 Air crew TOA

The purpose of the Training Option Analysis (TOA) is to:

- Determine which of the TM elements that are needed in order to fulfil the NH 90 training needs and requirements.
- Determine which of the Swedish NH90 training needs that cannot be covered by the use of existing Training Media elements.
- Identify possible and feasible changes in the technical and functional TM requirements that would improve the way that the TM suite fulfils the training requirements.
- Perform a limited training risk analysis.

The result of the TOA is a recommended training solution.

3.4.1 Use of training media

High crew skill level and correct performance is essential for mission success. This requires a substantial amount of training, which can be obtained using a real helicopter platform and a simulator facility in combination.

Using the real helicopter platform as the only training device would perhaps be an attractive solution but it has a number of side effects, not to mention safety concerns. Besides, a simulator facility can provide a training environment that far extends the capabilities generated in a real flight situation.

Examples of areas benefiting from using a simulator are:

- high risk situations; potentially dangerous tasks such as training of emergency procedures
- training cost; many types of tasks and system understanding can be taught in a more cost-effective trainer
- aircrew training of is much more effective (and safer) to conduct in a TM that allows for interaction between cockpit and rear cabin crew
- joint training exercises; otherwise expensive and hard to manage
- high mission complexity; where high mental workload is caused by many concurrent activities
- functionality is not limited to actual platform capabilities, training can be enhanced using in-built pedagogical tools, which increases training effectiveness
- provides opportunity for self-rehearsal and training on a module basis rather than being exposed to the whole system at once
- any training situation can easily be re-created and repeated
- since the Swedish NH90 is not operative, TM provides opportunity to further define and develop crew responsibilities and tasks
- crew member performance can be developed and evaluated more reliably
- reduces tear and wear on the actual H/C hardware
- familiarization and training of rear cabin personnel such as coordinator, troop, medical
- mission rehearsal

The relatively low number of H/C acquired affects the opportunity for OJT for both air- and ground crews and further stresses the need for TM.

3.4.2 Visual system cueing needs

Dome versus collimated display

It is of interest to stress a couple of aspects regarding the selection of visual system. Both the technical (physical properties) and the subjective perceived qualities are of importance. A classic example of a technical limitation is when a fighter pilot simulator equipped with a vertical FOV of 60° is used for dogfight. The tracking task gets difficult to perform as the targets easily move outside of the fairly narrow FOV. The subjective rating, i.e. the perceived quality of a visual system, is dependent on a number of factors such as, type of display system, display resolution, database resolution, database content, image generator, database modeller and maintenance/trimming. It is therefore not possible to come up with an easy quantification and comparison between systems. Instead it is preferred to supply an understanding of the technical properties needed and thus some of the training objectives include a more thorough description.

There are really two issues: the feasibility of any display system and the selection between dome and collimated display.

Traditionally, a dome/cube etc. has provided a large FOV but at a lower resolution. The collimated display has some FOV restrictions, but a sharper and brighter image. For a number of years the effort has been directed towards achieving bright and high-resolution projectors for dome displays. This is still an on going effort and whether the technology is mature or not at the moment must be evaluated carefully. A demonstration of the actual capabilities is always preferred upon selection of visual system, since it is simply not possible to determine the feasibility of a visual display system from reading a specification. This type of subsystem, which is both important and fairly expensive with an amount of subjective opinion, should be demonstrated to the customer before signing the contract or be left open until a critical milestone is passed.

The nature of good speed and height cueing is often discussed and the most expensive system does not necessarily present the best cueing. The key element to acceptable database cueing is probably a combination of various factors but especially the contribution from pattern, database resolution and shadows. That is, qualities that is present in the real world situation. In this case the result may very well be dependent on type of IG and the modeller skill level.

The second issue regards some of the reasons behind industry/customer selection of display systems in the recent years. If we were to select a display system for a fixed wing fighter operation, we would worry about large FOV and make sure that the air targets are easy to spot. The situation is totally different for rotary wing, which operates very close to ground at a much lower speed. Thus the cueing needs are very different. Fixed wing is not as dependent on "ground cues" for speed and height perception as compared to rotary wing. Fixed wing applications often end up with a dome and additional target projectors. Rotary wing, on the other hand, has favoured collimated displays providing a better depth cueing, which contributes to height and speed perception.

The actual need is dependent on the training objectives. The method provided, as illustrated in Figure 3-11, is intended facilitate the selection of a preferred display system. Basically, two questions have to be answered, that is how much field of regard is used and to what extent does the parallax error affect performance.

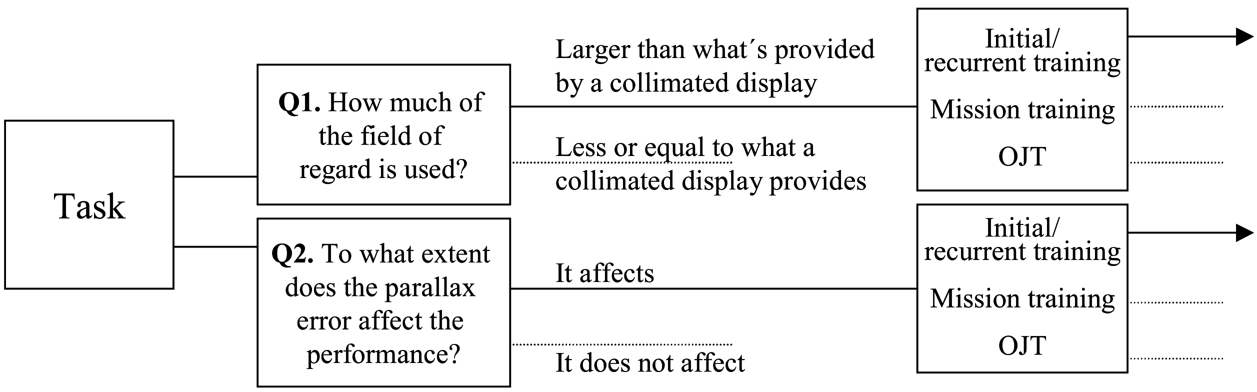

Figure 3-11 Display system decision process

Interpretation of the figure:
For each task to be analysed ask question Q1 and Q2:
Box Q1: if the answer is "Larger than what's provided by a collimated display" continue to the box with training options.
Box for training options: if the answer applies to "Initial / Recurrent training" the task has been identified as sensitive to visual system type.
Box Q2: if the answer is "It affects" continue to the box with training options.
Box for training options: if the answer applies to "Initial / Recurrent training" the task has been identified as sensitive to visual system type.

Task dependent:	It is important to design for the equivalent FOV in the simulator. How much of the whole field of regard in the H/C is used by the pilot for manoeuvring? To what extent does the parallax error affect the performance of this task?
Training objective:	It is important to generate the correct cueing needs. Is this task to be trained in the simulator? If yes, during which phase initial/recurrent training or mission training?

Conclusions:

- If a task can be trained successfully on the job the need for simulator training is decreased.
- If the task is performed as mission training in the simulator the fidelity requirements are lower to begin with.
- If the task is safety critical and performed as initial/ recurrent training, the simulator must be designed to accommodate this training.

The use of field of regard shows some individual variations. Some people claim they use mostly the central vision while others seem to be more heavily dependent on the peripheral vision. This statement is not to confuse with the task specific need to move and look around to obtain information from out the window. In general, it is safe to claim that the larger the better applies to a visual display system. Research has indicated that a FOV around 100° may be enough to introduce motion cues effectively. Between 100° and up to 150° the sense of motion increases but not drastically. The region above 150° is not well investigated but may have substantial effect on the sense of motion. There is some evidence supporting the theory that triggering of motion is area dependant.

The parallax error, which is expected to be up to 15°, is important when the cockpit crew work together with the same visual information and there is a real need for correlation. This may for instance affect some of the mission training objectives such as ASW/ASuW tasks related to weapon delivery. A task that will comply with question 1 and 2 is ship landing especially on smaller decks. Since ship landing is a safety issue it must be prioritized and thus, from this perspective, the dome solution is in favour.

Visual system requirements per training objective
The requirements on the visual system are dependent on the training objectives. Is the pilot going to use the simulator as a simple ground reference or is the simulator actually going to be used for low level flight? For the TNA it is assumed that the simulator will be used for flight at all altitudes in all different types of weather during all mission conditions. Thus the fidelity level needed is L3 as specified in chapter 3.3.2. For this analysis (and for each task) the worst case is assumed, i.e. the toughest condition from the visual system point of view.

Appendix E has been extended in order to comprise selection of collimated display versus dome solution including field of view and resolution requirements. An explanation to the visual system selection columns in Appendix E is shown in Table 3-7. With visual system means, visual Out-The-Window display system.

Table 3-7 An explanation to visual system selection columns in Appendix E.

X	means, system can be used for task
P	means, system is preferred for task
E	means exclusive, i.e. this system is the only feasible for training
N/A	means Not Applicable. More specifically it means on or more of the following: • A visual system is not used for the task (For example as during mission planning or IFR-operations) • The discussion is not applicable (For example activities performed by rear cabin crew)
Resolution	For the analysis three levels of system resolution (from IG to eye) are used: High resolution (Hres), Medium resolution (Mres) and Low Resolution (Lres) H res = state of the art today
FOV	For the analysis three levels of FOV are used: Large FOV (Lfov), Same as Direct Proj system (260Hx105V) Medium FOV Mfov, Same as Collimated system (200Hx60V) Small FOV (Sfov), Same as for PTT (150Hx60V)

In general TM always benefits from a visual system since it makes the training more realistic and interesting. Naturally, the fidelity requirements are different depending on task and crew member.

Pre-mission: A visual system is not needed. (Depending on in which phase the various activities are performed a visual system may be beneficial even during pre-mission. However, type of visual system is not likely to be relevant in those cases.)

Pre-flight and Ground Handling: The visual system may be used occasionally to verify system functionality. Examples are verification of correct navigation system initialization and performing checklists. Type of visual system is not likely to be relevant.

PF controls helicopter:
This means that the pilot is manoeuvring the helicopter at any altitude ranging from a couple of meters above ground to maximum flight altitude. The flight can take place anywhere within the specified area (or perhaps limited by the mission type). *Likewise, the weather situation can be anything within the specified operating conditions*. For example, although the fly out of a SAR mission often is performed IFR, VFR flight may occur and sets high requirement on display/database solution in order to succeed with the task. In this particular case he pilot needs speed and height cueing. *These cues are obtained from the various database features, objects and their patterns, and thus the collimated solution is in favour. In addition the collimated display option are equipped with calligraphic light channels, which further enhance the out-the-window cueing such as spatial orientation, navigation and return to ship.*
Manoeuvring requires M fov in order to obtain the necessary cueing.
The task PF controls helicopter during SAR is likely to consist of an initial transportation phase followed by a search phase and again transportation back to base. The requirement on database is lower for the transportation phase but increases for the search and pick-up phases.
There may be special areas of interest that need to be modelled carefully in order to obtain the expected training value.

PNF performs navigation:
TM is not intended to teach the art of navigation; rather it is a means for realistic transportation to location. Nevertheless there are requirements on features, both fidelity and location, in order to make the task worthwhile performing.
The size of the FOV is on the other hand not critical but a M fov is beneficial for those cases when the navigator needs to look around in order to regain situation awareness.
The navigation cues are obtained from the various database features, objects and their patterns, and thus the collimated solution is in favour. In addition the collimated display option are equipped with calligraphic light channels, which further enhance the out-the-window cueing such as spatial orientation, navigation and return to ship.

Visual search
TM is not intended to teach the art of visual search; rather it is a means for presentation of realistic training tasks such as decision-making related to the various types of search objects that may occur in the applicable search areas. The search cues are obtained from the various database features, objects and their patterns, and thus the collimated solution is in favour. In addition the collimated display option are equipped with calligraphic light channels, which further enhance the out-the-window cueing such as spatial orientation, visual search, navigation and return to ship.

Landing and hovering:
Landing and hovering require in general L fov in order to guarantee training value. This is due to the need for external and often relatively close references when the task is performed.

3.4.3 Motion system cueing needs

The need for motion cueing is presented as an extension to the OTTS matrix in Appendix E.

Table 3-8 An explanation to motion system need columns in Appendix E.

Y	motion cueing is needed
B	motion cueing is beneficial
N	motion cueing is not needed

Limited motion cueing can be generated using a dynamic seat. Providing the FS with a dynamic seat is therefore an alternative to extensive use of FFS.

The contribution of motion cueing to helicopter flight simulation has been studied and is presented in a separate report (Levin, 2003).

3.4.4 TM overview

The content of this paragraph is based upon both specific existing TM as well as generic types. In general, it is important to train in an environment that contains the phenomena present in the real flight situation. The reasons for this are 1) to avoid negative transfer of training 2) ensure access to the components necessary for effective training of motor and procedural skills. The effects of excluding vibration systems are limited, although it would contribute to the realism in simulation, the ability to increase mental workload, and the overall opinion on training.

Although not explicitly stated it is assumed that all TM are equipped with user-friendly instructor operator stations IOS (def) capable of setting up and controlling various types of scenarios. CPT, FFS-Swe and RCT are all expected to be equipped with debriefing utilities. The Swedish mission planning system is expected to be utilized and the result from planning (DID-data) will be transferred to TM types CPT, FFS-Swe and RCT.

The Swedish tactical environment is expected to be based upon computer generated forces as well as instructor controlled entities to ensure maximum flexibility and the interaction necessary to fulfil the training objectives. More specifically the tactical environment must contain a variety of features and functionality including:

- Swedish terrain including various types of land use and coastal regions
- Swedish entities such as Swedish operational helicopter types and ships etc.
- Swedish underwater simulation and entities
- Simulation of other entities to be found in the Baltic and Nordic sees
- Other entities and terrain as required for preparation and training for international operations

Full Mission Training Facility (FMTF)
This TM is intended for aircrew training and consists of a cockpit crew simulator connected to a rear cabin trainer. A FMTF can be obtained either by combining a FFS-Swe and a RCT or a CPT and a RCT. The analysis presented in Appendix E (column FMTF) is based upon a connection between a CPT and RCT.

Full Flight Simulator for variant T1 (FFS-T1)
This TM is equivalent to the German T1 and corresponds to FFS training (JAR-STD 1H level C-) provided by HFTS.

Full Flight Simulator (FFS-Swe)
This TM has a fidelity corresponding to JAR-STD 1H level D, except for motion buffets, and is also capable of high fidelity simulation of all aspects of the Swedish NH90 including:

- Swedish mission system
- Swedish sensors and weapons
- Swedish tactical environment
- Capability for connection to RCT for aircrew training

Cockpit Procedure Trainer (CPT)
This TM is designed to simulate most aspects of the Swedish NH90 including the Swedish mission system, Swedish sensors and weapons, and a Swedish tactical environment. The CPT consists of a replication of most cockpit hardware, complete simulation of all onboard systems including emergency procedures, a fairly large visual system but no motion or vibration system. This TM can be connected to a RCT for aircrew training.

Computer Aided Instructions (CAI) and Virtual Maintenance Trainer (VMT)
CAI is under development and will be delivered as a part of the NAHEMA contract. The discussion here is based upon a review of the sample CAI lessons provided to FMV. These lessons seem to be an effort to "make the H/C subsystems come alive". However, the pedagogical value is rather poor. In fact, the few animations included are more for "show off" than a real contribution to explaining the sub system functionality. Nevertheless, CAI has a potential to become a valuable tool for aircrew initial training with respect of:

- systems understanding
  - introduction to the H/C and it's subsystems
  - explaining the basic subsystem functionality
- limited systems handling
  - learning (interactively) how to utilize subsystems

The examples on CAI that has been presented for FOI seem to be most suitable for initial training.

A VMT would be valuable for both systems understanding and systems handling. Both CAI and VMT should be an integral part of academics classes for aircrew.

Rear Cabin Trainer (RCT)
This TM is based upon a complete replication of the rear cabin. It consists of a rear-cabin mock-up with visual systems, hoist, door gunner simulator, and a replication of both hardware and software for the rear cabin consoles in the Swedish NH90. This way the different roles of the entire rear cabin crew may be trained including hoist operator, loadmaster and other personnel. The RCT may be configured for certain mission types, for example

- if TTT is to be simulated the rear cabin consoles are removed and a RCT-type1 is obtained
- for ASW and ASuW the mock-up is not necessary and a RCT-type2 is sufficient

The analysis presented in Appendix E (in column RCT) is based upon a complete RCT, i.e. a combination of a RCT Type 1 and 2.

RCT-Type 1
The value of this type of TM is subject of debate since it is often not obvious that certain training objectives can be satisfied using the RCT. In some cases training in the RCT is quite sufficient for learning a task in other cases only parts of a task is feasible to practise. Nevertheless, the RCT, preferably connected to the CPT, is providing some unique qualities which makes training valuable even if a particular task can only be trained to a lesser degree:

- provides a safe and forgiving environment
- task can repeated as necessary
- tasks can be trained at the crews own pace
- minimized tear and wear on the actual helicopter
- provides part task training of critical tasks
- large flexibility in scenario and mission circumstances
- aircrew syntax can be practised and developed as necessary for the mission

One must remember that training of a particular task in a RCT definitely not means that the task is excluded from practice in the real helicopter. In most cases the best training effectiveness is probably obtained if a task is trained in the RCT first and then repeated/practised using the real helicopter. The ultimate benefit from using a RCT is the increases in skill level obtained since time spend in air can be concentrated to missions with larger difficulty.

Exclusion of RCT-Type1 means that a majority of training objectives for TTT and SAR is affected. The lack of rear cabin hardware and visual system for hoist operator/door gunner/load master means that the training objectives regarding theses categories can only be fulfilled using OJT. Table 3-9 shows the consequences of less training spent in a simulated environment:

Table 3-9 Training objectives affected by reduction of RCT

Task (Training Objective)	Crew member/role	Consequence
Hoisting handling	Hoist operator	OJT
Hoisting, decision making	Air crew	OJT and less effective training
Hoisting teamwork	Air crew	OJT and less effective training
Protection of H/C, handling	Doorgunner	OJT and less effective training
Protection of H/C, decision making	Air crew	OJT and less effective training
Protection of H/C, teamwork	Air crew	OJT and less effective training
Loading/unloading troop, handling	Loadmaster	OJT
Preparation for landing, handling	Loadmaster	OJT and less effective training
Preparation for landing, teamwork	Aircrew	OJT and less effective training
Special operations/TTT	Air crew	No mission rehearsal

RCT-Type 2
This TM is based upon a complete replication of both hardware and software for the rear cabin consoles in the Swedish NH90.

In some cases as for ASW and ASuW the RCT is the only available TM and thus becomes increasingly important when:
- high skill level is required and the user interface is complex
- few opportunities for in air training
- great difficulty/high cost associated with arrangement of complex scenarios, for example access to practising against real submarines

This TM is probably the most challenging with respect of fidelity. Simulation of the underwater environment, sonar and other ASW related characteristics can be made as simple or complex as the user requires. It was out of scope for this TNA to scrutinize this issue. However, it is recommended that the fidelity level required is determined together with the end customer in order to ensure a common understanding and an assessment of the scope of work.

Part Task Trainer (PTT)
This TM will be delivered as a part of the initial helicopter contract. The PTT is primarily intended for familiarization with NH90 cockpit crew member stations and may be used for training on the CORE system HMI during normal operations. Although the focus is on individual training, crew training is accomplished by combining two separate PTT units. The PTT can either be used in self-paced or instructor-led mode. The crewmember stations are simulated using touch sensitive computer screens thus creating a virtual cockpit layout combined of a selection of controls and displays. In order to

increase realism in operation and maneuverability replicated hardware for CCU and DKU will be provided.

The provided (PTT) is based upon the NH90 TTH variant T1 and thus does not reflect all aspects of the Swedish NH90. This TM must be regarded as an advanced extension of CAI suitable for familiarization of NH90 in general and basic avionics systems handling of the T1 configuration in particular.

The PTT software is derived from an engineering simulation initially developed for NH90 HMI design and validation purposes. This means that the focus on SW development has been directed towards the appearance on the interfaces as opposed to a genuine simulation of the actual helicopter functionality. As a consequence, the flight-loop is simplified but since the HMI is still representative skill acquisition is expected to occur in selected areas. The PTT is also running on low-cost computer hardware which means that performance may differ in certain situations. It is important to be aware of these existing limitations and their nature should be carefully determined in order to avoid instances of negative transfer of training.

The PTT consists of: a TTH simulation capable of replicating some aspects of the basic helicopter functionality. Hence the PTT is intended to provide training transfer in selected areas regarding basic helicopter and TTH mission utilities. More specifically the PTT covers functionality regarding Flight, Vehicle, Avionics and Sensor subsystems including:

- Introduction to general handling and systems familiarization
- Hands off flight management
- Vehicle management system
- CORE systems interfaces and configuration
    - MFD DKU management
    - Basic systems setup
    - Landing, communication and navigation systems management
    - Virtual cockpit environment with multiple touch sensitive screens roughly replicating the spatial arrangement within the H/C cockpit
    - HMI illustration of warning concept
- TTH sensor:
    - FLIR, WXR

The PTT can be used for training of:

- introduction to NH90 concept
- basic helicopter management
- cockpit/core familiarization
- skills acquisition on the utilization of MFD and DKU
- degradation and warning management
- checklists

PTT does not support:

- Aural cueing
- Motion or vibration system
- Instrument flying procedures
- Visual system or NVG
- Debriefing facility
- Tactical procedures
- Complete emergency procedure training

The provided functionality satisfies some of the training objectives for systems handling and mission training. The use of touch screens, except for MFD and DKU, and the fact that the spatial locations of cockpit equipment have been compromised means that additional training of systems handling in an environment with “realistic” cockpit replica is needed (CPT or FFS). For most training objectives addressed in Appendix E additional training in an environment providing full A/C system functionality, tactical system simulation and adequate cueing is needed (CPT, FFS, or OJT).

Other training media

There are some situations when other types of training media or pure “classroom training”(when no specific training media is used) are quite adequate and even preferred. Such situations are when conceptual knowledge is to be taught, such as preparations for international operations and case studies for ACO missions. Preparations for international operations include both acquisition of knowledge of the conditions on-site and high skill level regarding the various mission types to be performed. One example of an area which will differ and that do require specific training is the syntax used when communicating with other units. This type of skill does not require high fidelity H/C simulation and can preferably be trained in a facility allowing for multiple users.

3.4.5 Technical requirements versus training types

3.4.5.1 Training media requirements ab-initio/ re-qualification training

Ab-initio/ re-qualification training sets the highest requirements on TM. Accurate simulation of H/C systems and cueing environment is a necessity. It is important to learn the correct procedures and behaviour (motor and procedural skills) from the beginning.

For cockpit crew (training media requirements from TRA):

- 6 - DOF motion system
- FOV as in the real H/C
- Detailed sensor databases including NVG
- Cockpit replica / GFE
- Real time behaviour
- Sound system
- Detailed and accurate simulation of all H/C subsystems
- Instructional and debriefing facility

Above requirements are, according to the previously stated fidelity levels, corresponding to Level 3. Looking at the TM suite the best-fit simulator is a FFS-Swe. However, a majority of the tasks can successfully be trained on the CPT. The PTT can be used for familiarization and part task training covering many of the individual training tasks.

For Ab-initio/ re-qualification training the requirements on visual cueing/fidelity level is high, which means that discussion on type of visual display system to be used, that is collimated displays versus dome, is relevant.

For rear cabin crew (training media requirements from TRA):

- Vibration system
- Sound system
- Visual system for door gunner, hoist operator, loadmaster
- Detailed sensor databases including NVG
- Rear cabin replica/GFE consoles
- Real time behaviour
- Detailed and accurate simulation of all applicable H/C subsystems and rear cabin consoles
- Instructional and debriefing facility

Above requirements are, according to the previously stated fidelity levels, corresponding to Level 3. Looking at the TM suite, the best-fit simulator is the maximum configured RCT.

3.4.5.2 Training media requirements applied mission training (tactical training)

Applied mission training sets fairly high requirements on TM as well especially when a large and detailed gaming area is needed. However, since this devise is not intended for initial training the fidelity of cuing may be slightly reduced.

For cockpit crew (training media requirements from TRA):

- Vibration system
- Visual display system with large FOV
- Advanced tactical environment with a large number of entities
- Instructional facility with role players, external communication
- Real time behaviour
- Detailed and accurate simulation of all applicable H/C subsystems and rear cabin consoles
- Sound system
- Debriefing facility

Above requirements are, according to the previously stated fidelity levels, corresponding to Level 2. Looking at the TM suite the best-fit simulator is a CPT connected to a RCT.

For mission training the fidelity level for visual cueing is allowed to be lower. This means that discussion on type of visual display system to be used, that is collimated displays versus dome, is less relevant in this case.

For rear cabin crew (training media requirements from TRA):

- Vibration system
- Advanced tactical environment with large number of entities
- Instructional facility with role players and external communication
- Real time behaviour
- Sound system
- Visual system for door gunner, hoist operator, loadmaster
- Detailed sensor databases including NVG
- Cabin replica / GFE
- Detailed and accurate simulation of all H/C subsystems
- Debriefing facility

Above requirements are, according to the previously stated fidelity levels, corresponding to Level 3. Looking at the TM suite the best-fit simulator is a CPT connected to a RCT.

Generally, applied mission-training sets high requirements on TM, but the fidelity of cuing may be slightly reduced, as this device is not intended for initial training. However, in this application (i.e. for rear cabin crew) it is not feasible to reduce the environmental cueing at all.

For air crew (training media requirements from TRA):
The analysis shows an extensive occurrence of aircrew interaction for all mission types. This results in a need for teamwork training. The corresponding fidelity level is Level 2. Looking at the TM suite the best-fit simulator is a CPT connected to a RCT.

Finally, there is one mission subtype, Air coordinator (ACO) (On-scene air assets coordinator), which requires a large number of role players but only a generic H/C simulation (if any at all).

- Case study
- Role players
- Mock-up
- Communication system
- Generic H/C simulation

In this case the fidelity level is Level 1. TM is not needed for training. Case studies and role play is sufficient.

The result of the TOA is presented in Appendix E. For each training objective the feasibility of using a particular type of TM is illustrated using letter codes. Table 3-10 contains an explanation of codes used in the matrix. Codes used in visual and motion systems columns are to be found in Table 3-7 and Table 3-8.

Table 3-10 An explanation to TM columns in Appendix E.

Column	Letter	Explanation
Training need	T	Train
	OT	Over Train
	IT	Initial training
Category involved in task	C	Cockpit crew
	R	Rear cabin crew
	A	Air crew
		When 2 letters are marked: the first letter indicates then primary category involved.
Within crew	C	Co-ordination
	O	Co-operation
	L	Collaboration
	I	Information exchange
Outside crew:	C	Co-operation with other units
	I	Information exchange with other units
TM use	X	TM can be used for training of this task
	R	TM is recommended for training of this task
	P	TM is preferred for training of this task
	NP	Functionality is not provided with this TM
	N/A	Training is not applicable in this TM
	O	Task is not feasible to train in this TM
	E	Task can exclusively be trained in this TM
	NSR	No specific training requirement
	A	Task dedicated to FFS-T1
	- (means minus)	Is used together with above letters. For example: X- means that a particular training objective can be met to some extent but not completely.

3.4.6 Preferred and recommended TM solution

The TM solution that best fulfils the training objectives is presented here.

3.4.6.1 Training types

Type rating / Re-qualification training for cockpit crew

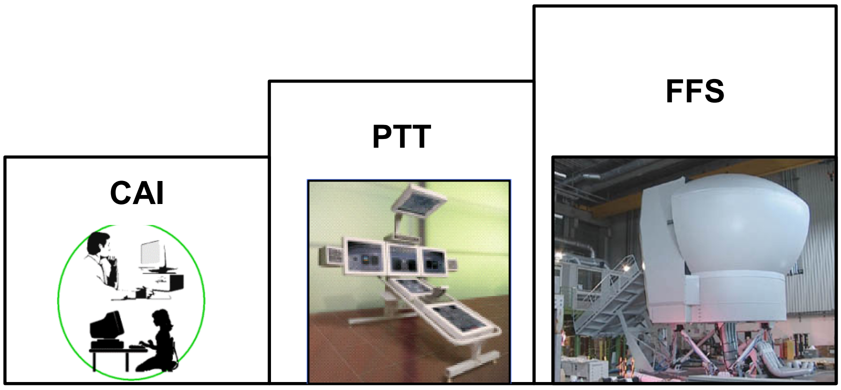

Figure 3-12. Steps in Ab-initio (Type rating) / Re-qualification training for air crew

The first part of the Type rating /Re-qualification is based on CAI/VMT for technical systems understanding and basic systems handling. The second part is based on the PTT for familiarization and standard procedure training. The last and most critical part including emergency procedures is conducted in the FFS-T1. The PTT is expected to be valuable in preparation for FFS-T1 training especially in the type rating phase. The PTT can be regarded as an advanced extension of the provided CAI lessons. Unfortunately, training in PTT and FFS-T1 is conducted using a TTH in the non-Swedish configuration. The result is a training gap and a risk for negative transfer of training which potentially could result in mistakes during operation of the real helicopter. It is strongly recommended that the final parts of Type rating / Re-qualification training are conducted on a TM representing the Swedish configuration. TM types CPT and FFS-Swe are intended to eliminate this gap between FFS-T1 and the Swedish NH90 functionality.

Ab-initio- / Re-qualification training for rear cabin crew

The first part of the Ab-initio/Re-qualification is based on CAI for technical systems understanding, basic helicopter systems handling and for acquisition of role specific knowledge such as properties of the underwater environment. The second and final part is covered using the RCT or RCT-type1 or 2 for systems understanding, procedure training, CRM etc.

Mission training (tactical training) for aircrew

When it comes to mission training the entire crew is involved and the best training effect is obtained if TM accommodates for a variety of sub-mission types. This becomes even more pronounced when planning/rehearsing for international or special operations. Comprehensive mission training is performed using a CPT combined with a RCT and associated support systems such as IOS, mission planning and debrief. If only some types of missions are to be trained the RCT may be configured to serve some mission types only, for example if ASW is to be simulated the cockpit mock-up is not needed.

3.4.6.2 Tactical training center

The tactical training center/centers should be located in close proximity to daily operations in order to facilitate both scheduled and spontaneous use.

The PTT is available at the tactical training center for repetition of basic flight, avionics system handling and CRM training as shown in Figure 3-13.

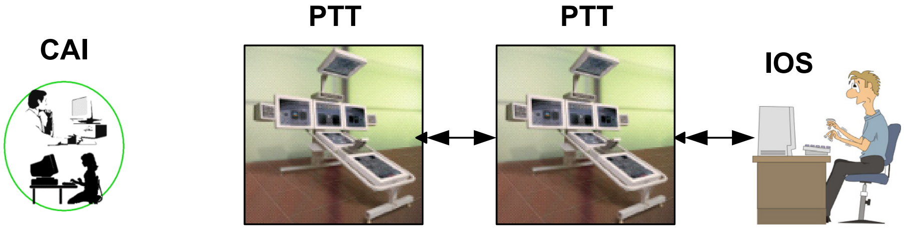

Figure 3-13. Equipment used for Ab-initio/Re-qualification training for air crew

Types of training: Ab-initio (Type rating) and re-qualification training for cockpit crew except FFS.
The preferred TM solution is based upon the use of national training center(s) and a FFS-Swe for ab-initio- / re-qualification training for air crew.

The reason for using the PTT in this phase of training is mainly based upon the following arguments:

- While the FFS involves high costs per flight hour, the PTT is already acquired and can be used as needed.
- The PTT can also be used when needed, i.e. it can be readily available upon request
- The PTT is available for repetition in between the limited FFS campaigns
- It is probably easier to teach most of the standard procedures in the PTT than in the FFS
- The lessons can be instructor led and used as a preparation for re-qualification in the FFS
- The student can practice and prepare at his/her own pace
- The combined mode is used for CRM training

Types of training: Ab-initio and re-qualification training for rear cabin crew.
The recommendation is to acquire a complete RCT and if desired distribute the parts as preferred to obtain one location with RCT-Type1 and another with RCT-Type2. This way the flexibility is present for future needs while at the same time the devices are placed to accommodate for the current training objectives.

Types of training: Tactical training and advanced systems handling and mission training for aircrew. Major mission types: TTT, SO, SAR.

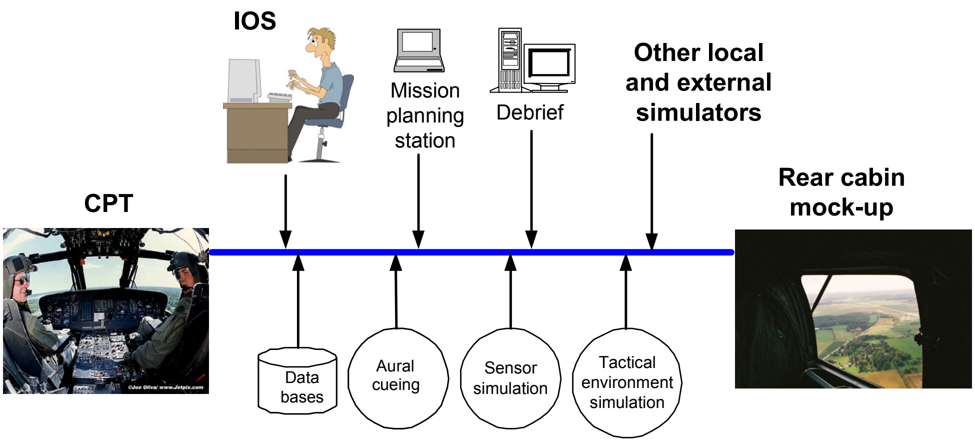

Figure 3-14. Solution for tactical training center type 1

Types of training: Tactical training and advanced systems handling and mission training for aircrew. Major mission types: ASW, ASuW

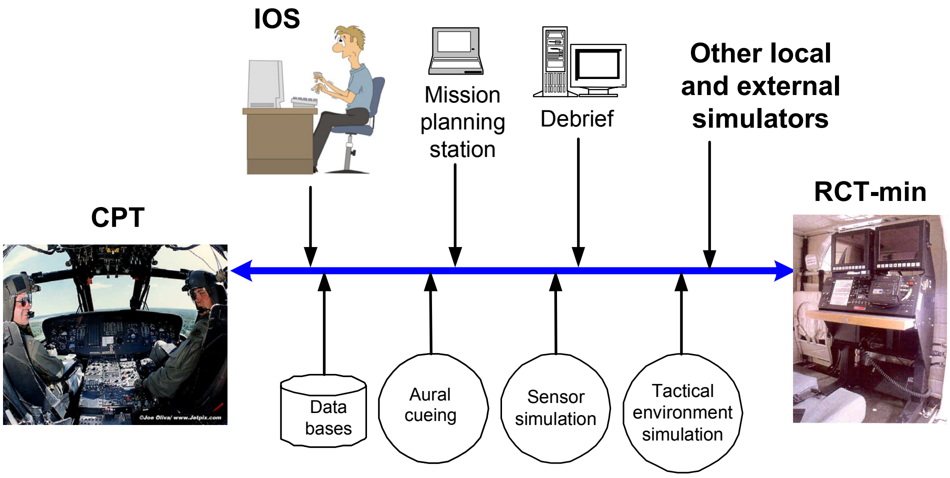

Figure 3-15 Solution for tactical training center type 2

The different TM associated with this tactical training center does not necessarily have to be ready for training at the same time. Rather both the training center and it's TM probably benefits from a stepwise development where the training needs are satisfied in time for they presence. This means for instance that the CPT can be completed before the RCT and the functionality of the RCT can grow over time. This way the TM functionality can benefit from the latest development in technology, which may lower the cost, increase fidelity and in some cases provide functionality that does not even exist today.

3.4.7 Recommended changes to TM

Changes in the technical and functional TM requirements that would improve the way that the TM suite fulfils the training requirements.

CAI

The present CAI solution is lacking the possibility to demonstrate the spatial and temporal relation between the various subsystems. Animated schematics would be a valuable method to illustrate these relationships. If this feature were to be incorporated CAI would be more interesting for recurrent and mission training. Examples of functionality that would benefit from visualization are:

- the information flow between the various computers and displays during different missions
- the H/C start-up sequence with respect of electrical, hydraulic, engine, transmission systems etc. and their interaction in chronological order
- the MFD display content as a result of flight mode and pilot selections

PTT

Additional functionality such as a visual system, debriefing capabilities, NVG, extended sensor simulation, Swedish configuration, more emergency procedures and a connection to the RCT (creating an aircrew trainer) would make the PTT a serious competitor to the CPT. However, the "low-cost" PTT approach may make such an upgrade hard to accomplish.

Other

It is important to ensure future capability to network the Swedish NH90 TM independent of location as well as other types of national or international simulators.

3.4.8 Limited training risk analysis.

Four major types of training risks have been identified 1) a task cannot be trained at all, 2) the resulting training solution is not cost effective, 3) a high skill level cannot be obtained and 4) flight safety is compromised. Although the four types of risks are not necessarily linked to each other improving one of them may have a negative impact on the others.

1) Most training objectives can be met to some degree, providing that those tasks that are not supported by TM can be practised in the helicopter (OJT). However, for some tasks OJT (as compared to using TM) is associated with one or more of the following statements: a less cost effective solution, reduced ability to create a large variability in mission content and an increased flight safety risk level. Tasks that cannot be trained in the helicopter are typically associated with emergency procedure training. Mission rehearsal like aircrew training for TTT and especially SO can also be complicated to accomplish using the real helicopter.

2) The training solution may turn out to be non-cost effective due to changes such as reorganization of training etc. The consequences of this type of events are difficult to predict. Fortunately a device such as the PTT is fairly easy to relocate. On the other hand the FFS is very difficult to move and the location must be selected carefully.

3) The training media must be representative of the H/C as discussed in Chapter 3.3. The TM must also provide training of applicable variants and versions. Compromising the TM functionality will lead to inefficient training, inability to obtain a high skill level, and in worst-case negative transfer of training.

4) The crew must be able to maintain a high flight safety level at all times. It is therefore essential that all crewmembers are aware of their roles and duties and knows what is expected from them. This type of knowledge and experience in teamwork and CRM is time-consuming to acquire in air and may impair the overall crew ability to maintain flight safety. Although new crewmembers entering into phase C directly from B, as described in Chapter 3.2.2, have the most to learn this type of skill is essential for recurrent training as well. The solution is to combine the individual training with aircrew training in a simulator environment. Thus deprivation of opportunity to conduct aircrew training may affect flight safety as well as the mission effectiveness.

The goal is to obtain a training media solution that fulfils the training objectives, but at the same time is achievable from a financing point of view. Consequently, there must be room for reductions and prioritizing regarding when and where to train and the contribution from OJT.

The essential difference between a FFS and a CPT is the motion system, which is associated with high cost. Although a 6 DOF motion is enhancing the overall perception of flight and facilitates the performance of certain manoeuvres the absolute need is very limited. Consequently, for most training objectives the FFS can successfully be replaced by a CPT. Remaining training objectives that still need to be performed in a FFS, such as emergency procedures, can in fact be procured separately.

The value of the PTT for Ab-initio (Type rating) / Re-qualification is related to the expected availability of FFS and cost per flight hours for PTT versus FFS. It is not caused by any additional and superior functionality in the PTT. The fact that the Swedish NH90 has a number of complex subsystems, and a not so user-friendly man-system-interface, means that more time will be spent on learning how to operate the various subsystems than the actual acquisition of flying skills. The large benefit of the PTT is the opportunity for familiarization and preparation at the national training facility at the student’s own pace before entering the FFS. It is expected that efficient use of the PTT before first flight in FFS will reduce the time needed in FFS for type rating.

Both the PTT and the FFS-T1 simulates the T1 variant and dos not reflect the specific Swedish NH90 functionality.

Training risk 1) As a consequence there will be a need for delta training on functionalities not suitable for on-the-job training (OJT).
Training risk 4) The result is a training gap and risk for negative transfer of training which potentially could result in mistakes during operation of the real helicopter.
It is strongly recommended that the final parts of Type rating / Re-qualification training are conducted on a TM representing the Swedish configuration. TM types CPT and FFS-Swe are intended to eliminate this gap between FFS-T1 and the Swedish NH90 functionality.

4 Ground crew

4.1 Ground crew OTTA

The purpose of the Operational and Technical Task Analysis (OTTA) is to identify important tasks and duties performed by air and ground crews during and between the Swedish NH90 helicopter missions. The results of the analysis are Operational and Technical Task Statements (OTTS) that describe the tasks and duties to be performed by each air and ground crewmember before, during, and after a mission of a particular type. The task inventories also include, for each duty and task, a description of the operational circumstances and standard to which they must be performed. Finally, training categories (priorities) for each task are established, based upon the task's difficulty, importance, and frequency (DIF).

Figure 4-1 shows how human performance in complex tasks, such as aviation maintenance, can be characterized by three levels of cognitive control (Rasmussen, 1986, Hacker, 1994). The sensomotoric level is characterized by sensomotoric and automatic performance that does not require any conscious intervention. Stored perceptual patterns and action sequences governs the control. Performance at the sensomotoric level is typical for the experienced maintenance engineer with the mechanical skill of using tools comfortably. The perceptual/rule-based level, on the other hand, is characterized by conscious recognition of typical situations, identification of appropriate action, and performing stored rules, such as when referring to guidelines. Finally, the intellectual/knowledge-based level is characterized by conscious and analytical processes using stored knowledge to assess the situation, make an appropriate decision, and plan execution. For example, fault isolation using symptoms, flight data, and documentation for diagnosis is mostly performed at the knowledge-based level. Thus, the information has different meanings at each level for the operator, although it is objectively the same information. Operators frequently operate at several levels at the same time depending on the current task and their experience. Since sensomotoric performance requires least cognitive resources and knowledge-based most, there is a natural process where task performance changes from knowledge-based towards sensomotoric with training and experience.

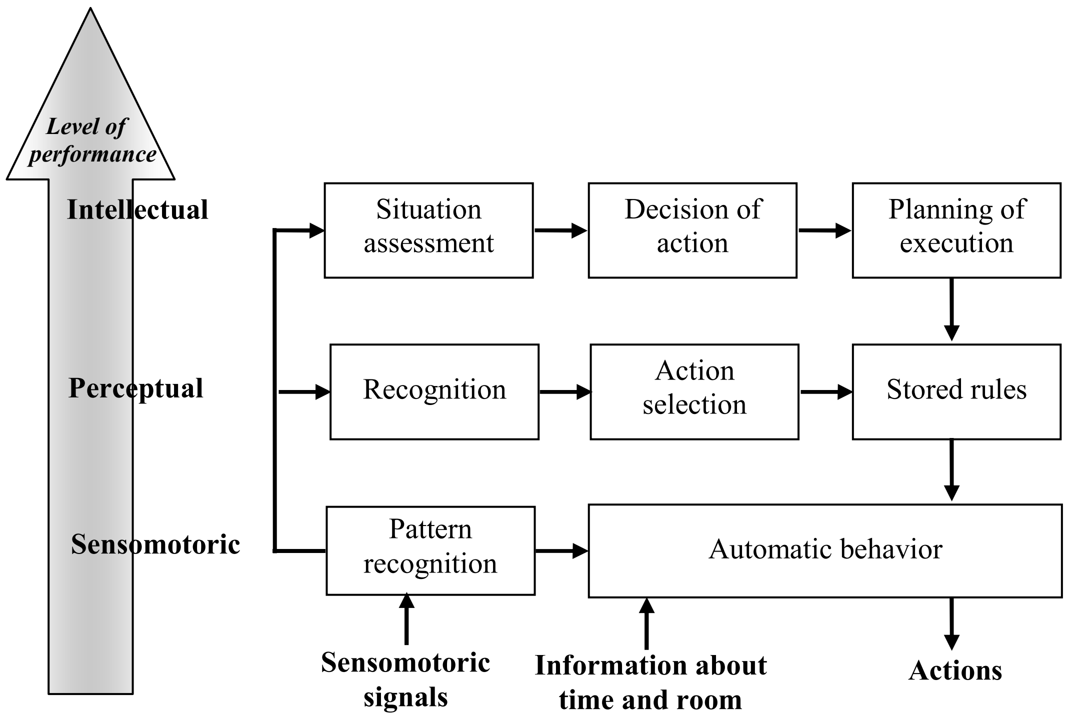

Figure 4-1 Cognitive control levels

The different types of information processing at each level create opportunities for different types of human error (Reason, 1990). At the sensomotoric level, action sequences may be performed when not intended since they are evoked unconsciously in familiar situations. Further, since the action sequences are learned as a unit, they are also sensitive to interruptions which may cause omissions of necessary attentional monitoring. Hobbs and Williamson (2002a) shows how the slip of unintended actions, which includes fumbles and trips, often compromises the maintenance engineers' health and safety. The memory lap of not performing an action, on the other hand, compromises the work quality. Fatigue and time pressure are the most common contributing factors to reduced work quality and equipment deficiencies contribute most to compromised health and safety. At the rule-based level, a good rule may be misapplied when deviations from the normal situation are not noticed, such as when activating hydraulics while other maintenance engineers are working on the aircraft. Finally, errors at the knowledge-based level mainly originate from resource limitations or an incomplete or inaccurate mental model of the problem space. Sensomotoric errors are often most common simply because most activities occur at this level. However, when considering the ratio of errors and opportunities, rule-based error are over two times more likely and knowledge-based errors are nearly three times more likely to occur as sensomotoric errors (Hobbs & Williamson, 2002b). The hardwired nature of skilled performance is simply more robust than rule- and knowledge-based performance. One way to reduce the likelihood of knowledge-based errors is therefore to encourage rule-based performance with more training and standard procedures, and stimulating cooperation to utilize available expertise (Hobbs & Williamson, 2002b). Sensomotoric errors, on the other hand, are best reduced with a task organization that limits confusion of situations and interruptions while mitigating the risks from erroneous behaviour.

Generally, omissions (the failure to carry out necessary parts of a task) are the most likely error type in maintenance-related activities and they often occur during installation where there are more possibilities for mistakes. For example, this may be the failure to replace some component, or the failure to remove foreign objects before leaving the job (Reason, 2000).

4.2 Ground crew tasks

Since some maintenance tasks on the Swedish NH90 are performed by the industry and some by the Swedish Armed Forces, an investigation was conducted of how the maintenance is organized and an identification of the personnel categories responsible for each task. The investigation consisted of reviewing planned maintenance activities and discussions with SMEs. The result of the investigation is shown in Figure 4-2

The focus of the ground crew task analysis was limited to the tasks performed by the Swedish Armed Forces. Specifically, the main focus of the analysis was daily inspections, safety inspection (SI), and fault isolation since these areas were identified as the most critical in discussions with SMEs for the current phase of the TNA. Only a brief analysis was performed of role change, service, minor modifications, preservation of complete helicopter, minor aircraft battle damage repair, and minor and moderate structural repairs. The 150 fh, 300 fh, and 600 fh inspection tasks were not included in the analysis since only partial information was available about these tasks.

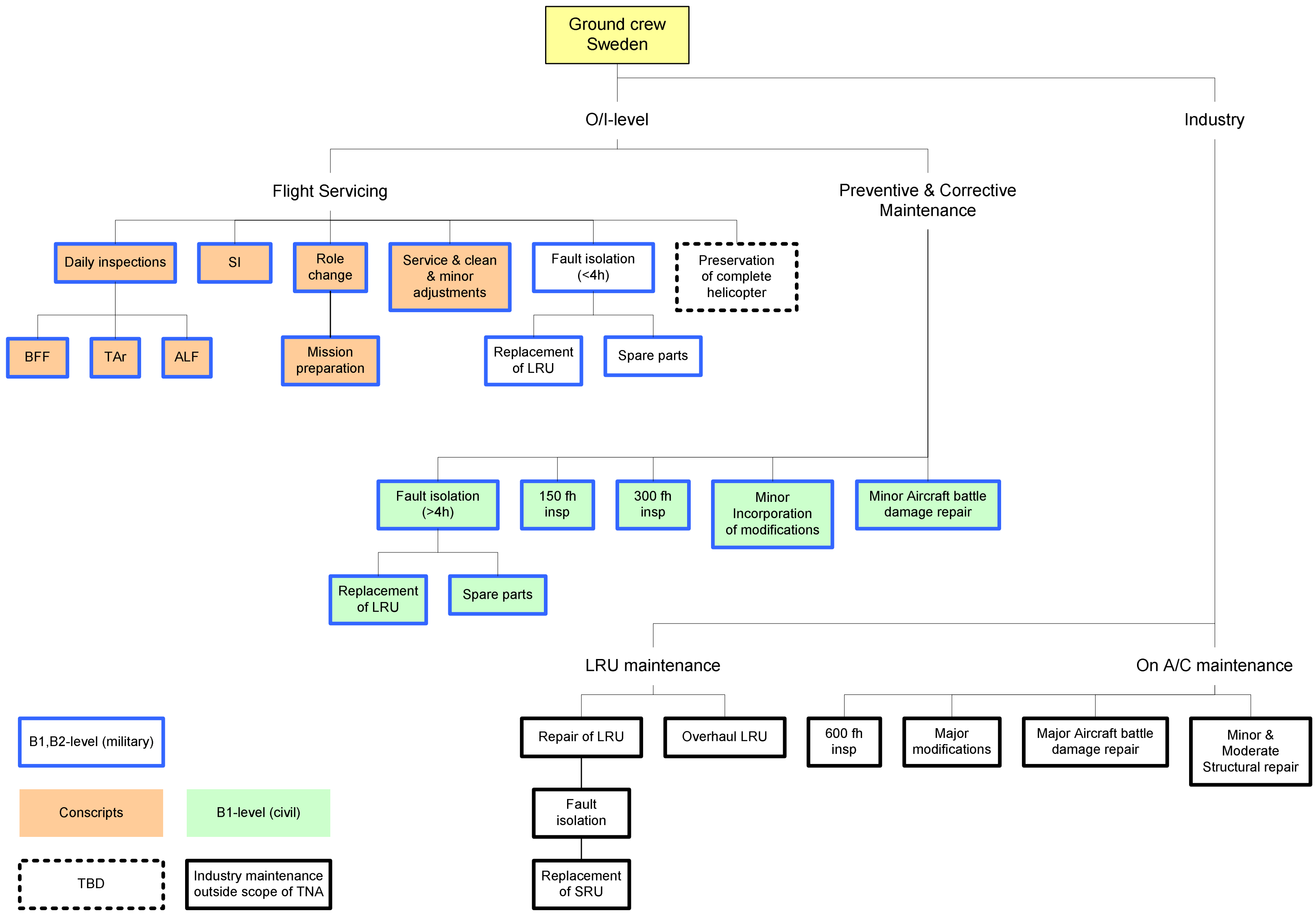

Figure 4-2 Maintenance tasks

4.2.1 Daily inspections and SI

For a basic understanding of task characteristics, the DIF method was applied to the before first flight (BFF), turn around (TAr), after last flight (ALF), and SI checklists for the Swedish NH90. SMEs rated the checklist items along the DIF dimensions. Since these checklists are performed more often then every two weeks, all items are performed frequent by definition. The frequency dimension was therefore not rated by the SMEs. Type specific checklists for TTH were used when possible depending on which type is purchased by the SMEs'. However, since the SI checklist was only available for the NFH, all SMEs used this checklist.

Only a simple analysis was performed by averaging the SMEs' ratings for each checklist item and DIF dimension. Additionally, the standard deviation was computed for estimated completion time. Inspection of the ratings shows that SMEs rate all items as important and either not difficult or moderately difficult. Since all items were rated as frequent and important, the decision tree in Figure 2-9 was reduced to initial training and train depending on if the item was rated as not difficult or moderately difficult. This was expected given the routine use of these checklists. Simple thresholds were then applied to the DIF means and standard deviation to identify critical items. The threshold was set to identify items that any SME associated with training, time pressure, or experienced risk for injury. Two levels were used for mental workload. Means larger or equal to 30, but less than 50, were considered as moderate mental workload, and means larger or equal to 50 were considered as high mental workload. Further, the mean estimated completion time was categorized by rounding up to the nearest 10 second interval. The threshold for the standard deviation in estimated completion time was set to 100 seconds. A detailed summary of the items that the SMEs consider to require special consideration can be found in Levin et al. (2004).

Table 4-1 summarizes the results of the ground crew DIF analysis in Levin et al. (2004) for training need, time pressure, and mental workload. The table shows what AECMA areas are associated with more than initial training need, higher than low time pressure, or moderate or high mental workload. The left columns show the combination of training need, time pressure, and mental workload. The right columns show the number of items for the AECMA areas that were over the thresholds for all checklists in. Areas with 30 or more items were considered to have many numbers of items. Areas with 10 or more but less than 30 items were considered to have some number of items. Finally, areas with one or more but less than 10 items were considered to have a few numbers of items. The levels of 30 and 10 number of items were selected based on inspection to describe the results. The areas that do not appear in the table are only associated with initial training, no time pressure, and no mental workload.

Table 4-1 shows that checklist items associate with moderate training need, time pressure, and mental workload, dominate the DIF results. For these areas, *Fuselag*e, and *Main rotor* have many items. *Engine, Folding blades/pylon, Hydraulic power, Landing gear, Main rotor drive, Tail rotor*, and *Tail rotor drive* have some items. *APU, Doors, Electrical power, Engine fuel and control, Equipment/Furnishings, Exhaust, Power plant*, and *Stabilizers* have a few items. For areas associated with moderate training need, mental workload, but no time pressure, there were some items for Oil, and a few items for *Environmental control, Fire protection, Fuel, GLIMS/MDS, Indicating and recording system, Parking and mooring, Rotors flight control*, and *Surveillanc*e. For areas associated with only an initial training need, time pressure, and mental workload there were a few items for *Tactical electronic warfare*, and *Unspecified*. For areas associated with only an initial training need there were a few items for *Missiles*, and *Navigatio*n. For areas associated with only time pressure there where a few items for *Mission tactical management system*, and *Windows*. Finally, for areas associated with only mental workload there were a few items for *Engine controls, Engine indicating*, and *Lights*. Examination of the subjective ratings shows that the discrimination of training need is mostly due to two SMEs. The other SME usually rate all tasks as not difficult.

Table 4-1 Summary of ground crew DIF analysis. The checklist items were classified according to AECMA 1000D.

DIF dimension			Number of items		
			Many (x≥30)	Some (30>x≥10)	Few (x<10)
Train	Time pressure	MWL	Fuselage Main rotor	Engine Folding blades/pylon Hydraulic power Landing gear Main rotor drive Tail rotor Tail rotor drive	APU Doors Electrical power Engine fuel and control Equipment/Furnishings Exhaust Power plant Stabilizers
Train		MWL		Oil	Environmental control Fire protection Fuel GLIMS/MDS Indicating and recording system Parking and mooring Rotors flight control Surveillance
	Time pressure	MWL			Tactical electronic warfare Unspecified
Train					Missiles Navigation
	Time pressure				Mission tactical management system Windows
		MWL			Engine controls Engine indicating Lights

The distribution of estimated completion time shows that for the daily inspections about 70-75% of all items are completed quickly in 10 or 20 seconds. Generally, when the estimated completion time increases there is greater need for training, the sense of time pressure increases, and there is higher mental workload. The distribution for SI is different and shows that about 65% of all items are completed in less than 1 minute, where the majority of the items take between 30 and 50 seconds. The variance in estimated completion time was mostly small and exceeds 100 seconds for only a few items. The differences in estimated completion time may be due to different understandings of what is included in the task, experiences, or helicopter configurations. Generally, since the variance was small, the results above are valid. Table 4-2 shows the average sum of the SMEs estimated completion time relative NHI's estimates for the daily inspections and SI. The table shows that the idealized circumstances for NHI's estimates may not be representative. Actual completion times probably lies somewhere between these estimates. Even so, the inspections are much faster than for the helicopters that are currently used.

Table 4-2 Estimated completion time for inspections

Inspection	No. of mechanics	SMEs (min)	NHI (min)
BFF	2	35	8
Tar	2	25	10
ALF	2	40	8
SI	3	115 (1h 55min)	20

Table 4-3 summarizes the ground crew DIF analysis for cooperation and experienced risk for injury. Cooperation may simplify the task for *Lights* which have some items. Only a few items were found where cooperation may simplify the task for *Electrical power, Equipment, Fuel, Fuselage, Landing gear, Main rotor drive, Parking and mooring, Power plant*, and *Tail rotor drive*. Basic communication and coordination is needed for cooperation in these tasks. A more sophisticated cooperation based on a common situation assessment is not necessary, however. Only a few items were found where there was an experienced risk for injury in *Fuselage, Main rotor, Main rotor drive, Parking and mooring, Power plant*, and *Tail rotor*. For all these areas there is a risk of crush injuries until the helicopter is secured.

Table 4-3 Areas where cooperation may simplify the task and where there is a risk for injury

DIF dimension	No. of items		
	Many (x≥30)	Some (30>x≥10)	Few (x<10)
Cooperation		Lights	Electrical power Equipment Fuel Fuselage Landing gear Main rotor drive Parking and mooring Power plant Tail rotor drive
Risk for injury			Fuselage Main rotor Main rotor drive Parking and mooring Power plant Tail rotor

4.2.2 150, 300, and 600 fh inspections

The 150 fh, 300 fh, and 600 fh inspection tasks are not analyzed further since only limited information was available from the manufacturer.

4.2.3 Fault isolation

The integrated avionics systems on modern platforms, such as JAS39 Gripen, F-22, and the Swedish NH90, offers a complexity that can not be easily categorized using traditional specialties, such as avionics, power plant, weapons, etc. While specific computers are responsible for controlling each subsystem, they all interact in providing system functions. Due to this interaction, fault isolation can no longer be specialized on individual subsystem. Instead, the fault isolation must be based on an understanding of the system behavior as a whole including the effects of mechanical and electrical systems while performing specific functions. With system understanding it is also easier for the maintenance engineer to relate to and comprehend fault reports by pilots, since they have a similar background. Since the source code for integrated avionics systems often consists of a couple million lines of code, built-in-test (BIT) functions are often provided as an aid in localizing the faulty unit. The BIT functions automate diagnostic test sequences and the unit identified as faulty can then simply be replaced and sent to specialized maintenance shops for repair. The problem is that while the BIT can identify some faults, they are currently far from a solution to the whole complexity of integrated avionics systems. Thus, the fault can not be repeated for many units that are sent in for repair and they are simply returned as "could not duplicate" (CND) or "no fault found" (NFF). Table 4-4 shows that the BIT false alarm rates for current platforms can be high. While calibration of acceptable signal levels can reduce some of the unit replacements, and the BITs are improving over time, the low BIT hit rates are a systematic characteristic of integrated avionics systems. Overall, there are four levels of faults isolation, (1) the BIT may accurately identify the faulty unit, (2) the BIT identifies a possible area but further diagnostics are needed, (3) fault isolation is achieved with BITs and extensive interpretation of the behavior of the avionics software, and (4) only manipulation of subsystems (see Integrated Avionics Maintenance Trainer, IAMT).

Table 4-4 BIT false alarm rates for current platforms

Platform	BIT false alarm rate	Mean flight hours between false alarm	Reference
A/F-18C	88%	<1h	Bain & Orvig (2000)
A/F-18D	NA	6.9	Westervelt (2002)
A/F-18E/F	8.2%	52.7	Bain & Orvig (2000)
F-15 EWS	65%	NA	DoT (2001)

In order to get a better understanding of the effects of transitioning from traditional to integrated avionics, on fault isolation procedures, skill levels, training methodology, and training media, a brief study was conducted of fault isolation on JAS39. Since both the Swedish NH90 and JAS39 use integrated avionics systems that operate over a bus-architecture, there may be valuable experiences from the introduction of JAS39 of what to expect for the Swedish NH90. The following sections describe the results from a few interviews with maintenance engineers, instructors, and training media designers in the Swedish Armed Forces.

Fault isolation on JAS39 Gripen

The most common type of fault isolation for JAS39 is when the BIT detects a malfunction either during start-up or in the air. The malfunctions are registered automatically by the system and consist of the start and end times, the subsystem where the erroneous symptom was observed, the likely component that is faulty, basic flight information when the malfunction was registered, and three possible solutions. Since faults often have a cascade effect due the interaction of subsystems, they are automatically prioritized as primary and secondary fault in three levels. The suggested solutions are based on statistics that are computed from repairs performed on all operational aircrafts. The solutions are ranked according the probability of component failure, probable cause of fault, and ease of replacement. Since the fault may disappear when the system is restarted, it is important to record and document as much as possible about the fault and its characteristics before flight data is transferred to the logistical system and the aircraft is shut down. That way it may also be possible to verify that the fault is corrected using the same procedure. The flight data consist of a few thousand parameters of valve settings, temperatures, electrical power, hydraulic pressure, altitude, speed, engine thrust, etc. that are continuously updated in the aircraft and recorded onboard. Early on, this recording was intended only for statistics about aircraft usage, but was soon adapted as an important tool for fault isolation when reviewed in a separate test system. The maintenance engineer gets a good understanding of the fault by combining symptoms, history of flight data, and knowledge about the system's architecture.

During the life time of a platform, many faults occur that can be validated as harmless and normal deviations. The first step in the fault isolation is therefore to review if the fault is a normal deviation. For example, the radar altitude meter may confuse clouds and ground which results in fluctuating altitude measurements that are registered as a fault. A review of flight data and known weather reports shows whether the fault can be attributed to this deficiency. While this is usually sufficient, some known faults have a tendency to occur more frequently over time and will eventually require further diagnosis. When further fault isolation is necessary there are currently only two possibilities that correspond to the first two levels of fault isolation where the BIT accurately identifies the faulty unit or only identifies a possible area. More difficult faults that require an understanding of the software or further manipulations are currently beyond the maintenance engineer's responsibility. Such difficult faults often require cooperation with manufacturers. The general fault isolation process for the two first levels consists of a series of references to fault trees when available, conditions for alarms, functional diagrams describing the overall relationships, and electrical schemes. The parameters recorded in the flight data are generally sufficient for providing the data for this process, but specialized test equipment is used occasionally. Once the fault is isolated, the most efficient solution is implemented based on the system's suggestions. In practice, the maintenance engineers have sufficient confidence in the recommended solutions to implement them without fully completed fault isolation.

Training in fault isolation starts with a theoretical course that covers all relevant documentation and test systems. Next, the students receive initial training in menu handling and reserve power operation using the Aircraft System Trainer (AST), a real-time simulation that runs on a VME-system and PC using the same software as the aircraft. Replicas of the actual throttle and flight stick are used to interact with the simulation. The system uses two screens, one for simulation control, cockpit displays, and data panels, and the other for visualization of system behavior. Separate modules for electronic presentation system, system computer, radar, APU, engine, electronics, fuel system, etc. provide the necessary interaction for real-time simulation of the complete system. Faults are simulated by manipulating the parameters on the system bus. While the initial purpose was to use simulation instead of the real aircraft for training, many CBT features were added during development, such as demonstrations, video recordings, photos, pictures, animated system schemes, and system documentation. These visualizations are very valuable for conveying the functional relationships of the integrated avionics. Especially, for older maintenance engineers that only have little experience of computers and often need extra practice before moving on to the real aircraft. An undocumented evaluation shows that the AST reduced the number of maintenance error compared to traditional training. Presently, the initial training only uses limited parts of the full system. The last training section consists of performing fault isolation on actual aircrafts with manually introduced faults. The faults are based on real cases and selected to illustrate the fault isolation process when there are no suggested solutions. The purpose is thus not to teach the students how to solve specific faults, but how to use and interpret available documentation and information. The faults that are implemented and documented based on an agreement with supervisors that are responsible for the aircraft. The faults are currently not approved by the manufacturer to be without side effects. A supervisor monitors the students fault isolation, but does not interfere unless there is a risk for injury or the student is obviously lost. Recently another device called the General Modular Simulation System (GMS) has been introduced as a replacement for AST to be used for future versions of JAS39 Gripen editions.

The reason for this training methodology is that the students need confidence to be able to proceed with the fault isolation on their own when they return to their base. Generally, students have no problems completing the course, although older maintenance engineers often need repetition of theoretical topics before the course and more time to understand the dynamics of integrated avionics. This does not mean that older maintenance engineers need more training overall, however, since they already have the mechanical skill that younger engineers have to acquire through OJT.

Apparently, the current training methodology for fault isolation is sufficient for the requirements on the maintenance engineer to repair most of the faults and leave the more difficult ones to other organizational levels. While experience may help refine judgments of whether it is a known fault, recognize diagnostic information, or useful shortcuts, there are currently no formalized procedures to make such expertise more widely available neither through training nor special meetings. Currently, the daily practice and documentation of all repairs are sufficient.

4.2.4 Other tasks

Role change: Since the number of missions for each mission type only changes slowly, many helicopters are often preconfigured for specific mission types. This limits the number of role changes where equipment is added/removed to adapt to changing demands. The equipment that may be added/removed in a role change are sensors (radar, FLIR, LLTV, sonar), avionics systems (command and control console), weapons (machine gun, torpedoes), countermeasures, and hardware (hoist, sling load, fast rope, repelling). The role change involves adding/removing equipment, calibrating sensors and countermeasures, and verifying function using BIT for avionics systems. Table 4-5 shows the estimated completion time for change of typical equipment. Role changes are often performed as a part of the 150h and 300h inspections due to the time requirements. Role changes are therefore performed with moderate frequency. SMEs view role change as important and not difficult, except when adding countermeasures since that requires careful calibration of sensors and is consequently moderately difficult. Most of the equipment is heavy and requires cooperation to change. The risk for injury is generally low when changing equipment, except when adding flares where special procedures are need due to the flammability. Time pressure or mental workload was experienced as low for any role change.

Table 4-5 Estimated completion time for role change of typical equipment

Equipment	Add (h)	Remove (h)
Radar	2	1
C2 console	1	1
Sonar	3	2
Countermeasures	Not available	Not available
FLIR	2	1
LLTV	2	1
Hoist	2	1
Sling load	1	1
Fast rope	1	1
Repelling	1	1

Service, clean, and minor adjustments: involves cleaning of the helicopter and replacing consumables and broken sprints. The cleaning includes windshields, rotor blades, cabin, and oil spill. Consumables that need to be replaced are wiper fluid, wiper blades, tire pressure, and breaks. Service, clean, and minor adjustments are important and performed frequently either before first flight or after last flight, but are not difficult. No cooperation is required and there is low risk for injury, time pressure, and mental workload. Estimated completion time is about 10 minutes.

Minor modifications: often involve implementing the manufacturer's service bulletins. For example, bolts may be tightened with the wrong force or the material in a component defective and needs to be replaced. Such minor modifications are usually performed during the flight servicing, although infrequently. SMEs consider incorporation of minor modifications as not difficult and unimportant. No cooperation is required and there is low risk for injury, time pressure, and mental workload. Estimated completion time is about 10 minutes.

Preservation of complete helicopter: involves both regular preventive maintenance and protection of the helicopter in temporary storage. The purpose in both cases is to protect the helicopter against corrosion. For example, this may be achieved by blowing an oil and air mixture into the engines. Since the Swedish NH90 has less mechanical systems than previous generations, there are presumably less demands on preservation.

Minor aircraft battle damage repair: involves primitive fixes to restore the basic operational status and is usually not performed in peace time. A helicopter subject to small arms fire or shrapnel may receive minor damages to gas tank, blades, hydraulic lines, electric cables, structure, drive shaft, tires etc. in a way that the damage can be temporarily repaired by simple means until a complete repair can be performed. The repair methods include fillings or plugs for leaking tanks, attaching metal plates over hole in structure using rivets, smoothing of hole edges to minimize cracks, and replacing damaged parts of pipes, tubes, and wired. More complex repairs of optical fibers etc. are not performed.

Minor and moderate structural repairs: Minor damages are typically not safety critical and do not affect the helicopter’s performance, such as damages on sponsons.

Table 4-6 DIF-ratings for other tasks

Task	Difficulty	Importance	Frequency	Training need	Co-operation	Risk for injury	Time pressure	Mental workload	Completion time
Role change	Not difficult Moderately difficult (counter-measures)	Important	Moderately frequently	Initial training Train (counter-measures)	Yes	Low Medium (countermeasures)	Low	Low	≥ 1h
Service, clean, and minor adjustments	Not difficult	Important	Very frequently	Initial training	No	Low	Low	Low	10 min
Minor modifications	Not difficult	Not important	Infrequent	Initial training	No	Low	Low	Low	10 min
Preservation of complete helicopter	Moderately difficult	Important	Infrequent	Overtrain	Yes	Low	Low	Medium	1h
Minor aircraft battle damage repair	Not difficult	Important	Infrequent	Train	No	Low	Medium	Low	Not available
Minor and moderate structural repairs	Moderately difficult	Important	Infrequent	Overtrain	Yes	Medium	Medium	High	Not available

4.2.5 Conclusions of ground crew OTTA

The OTTA shows that there are no fundamental differences between the Swedish NH90's airframe and current helicopters that affects the daily inspections and SI. However, some areas, such as Fuselage and Main rotor, need more training and are associated with more time pressure and higher mental workload than other areas. Since task complexity, time pressure, and mental workload makes the performance sensitive to distractions and stress, maintenance engineers need a practical understanding of when performance may compromised, how to avoid such situations, and how to detect and recover from possible errors. With appropriate conditions for error detection, operators normally detect about 90% of their errors by themselves (Amalberti, 1996, 1997). Although maintenance engineers obtain conceptual knowledge about human performance according to JAR-66, this is often not enough for improving the risk assessments during task execution. As discussed in chapter 4.1 maintenance engineers match situations with suitable measures more or less automatically in familiar situations. Proper risk assessment should therefore be integrated in the action sequences already when the connections are established during training. For example, the risk assessment should consider hand-over and time pressure problems, slips in routine tasks, lack of communication, procedure violation, misdiagnosis, lack of checks, and visual inspection. Some additional factors that should be included in the training can be found in chapter 4.1and Reason and Hobbs (2003). An appropriate mental model of the relevant factors for risk assessment and a decision process that assures that these factors will be considered are important both for learning of action sequences as well as for handling of unfamiliar situations during task execution. Currently, JAR-66 only partly covers the relevant factors and does not provide any training in the decision process. One method for improving the decision process is to train the maintenance engineers in critiquing their understanding of the situation. Cohen et al. (1995) found that such training increases the awareness of arguments by 30%, assumptions by 41%, conflicts by 58%, and the quality of the resulting decision by 30%. When students have acquired the knowledge and decision process, they can be exposed to wide range of situations that require judgment for learning the action sequences integrated with the technical training (see Advanced Integrated Training in Avionics Maintenance, AITRAM). Finally, although the discussion concerns risk assessment for human performance, the same principles apply to making risk assessments for what defects are acceptable and which are not in the current situation.

The main difference between the Swedish NH90 and previous helicopters is in the complexity offered by integrated avionics systems, where subsystems interact in providing system functionality. System understanding and subsequent fault isolation can therefore no longer be based on individual subsystems as provided by current JAR-66 training. Although managing and operating BIT is sufficient for many situations, it is usually far from covering the whole complexity as shown by the low hit rates for other platforms using integrated avionics systems. Until the actual performance of the Swedish NH90 BIT and diagnostic system is known and have reached a matured level it is therefore fair to assume that fault isolation will require significant expertise of the maintenance engineer. A training media that visualizes the full effect of interacting subsystems is required for appropriate knowledge of the fault isolation methodology. Further, diagnosis using documentation and test systems is facilitated by good working memory, logical reasoning skill, and computers experience. Generally, only the current generation of inexperienced maintenance engineers has the required computer experience to understand and interact with integrated avionics systems. Experienced maintenance engineers have not been exposed to computers to the same degree and consequently need considerably more training than the inexperienced engineers.
For other tasks, as shown in Table 4-6, change, *preservation, and structural repairs* require more time, training, and cooperation than the other tasks.

4.3 Ground crew TGA

The purpose of the Training Gap Analysis (TGA) is to determine how the introduction of the Swedish NH90 impacts training requirements for air and ground crews. Important goals of the TGA are to (1) identify any differences in the type of training required by experienced and inexperienced jobholders, (2) define the gap between the new operational performance required and the entry level, (3) define the type of skills to be trained, and (4) define a set of Training Objectives (TOs) for the Swedish NH90 air and ground crews. The following sections describe the methods and results for the TGA.

4.3.1 Ground crew training programs

Sweden conform to the Joint Aviation Regulations (JAR) nomenclature for maintenance engineers, where B1 and B2 are specialists on airframe/engine and avionics respectively, and A technicians only have a more basic maintenance training. Only B1 and B2 technicians are usually allowed to sign off that the work has been completed. Although the JAR nomenclature is used, technicians are often not certified according to the civilian JAR standard due to a lack of practice on required equipment. The next sections describe how these competencies are currently achieved, followed by a generic description of the competencies that each maintenance engineer category possesses.

In the current school system, technicians-to-be begin their military career by attending the Military Academy for two years. About one semester of this time is devoted to aeronautical subjects; the rest is spent studying general and other military subjects. After graduating from the Military Academy, they receive complementary education to become a B1 technician and type rating training for qualification as B1 technicians. After two years of work experience as a B1 technician, they can attend a course for an additional B2 qualification. Currently, there are no A technicians, instead conscripts receive maintenance training at their unit after basic conscript training to aid the B1 and B2 technicians. The conscripts usually have a background from vocational school.

The training is mainly done in a classic classroom manner using overhead projectors and a black board. Hands-on training using parts from scrapped and/or crashed aircrafts and helicopters are often used, if available. The Aerotechnical Services School (FMHS/FTS) is formally responsible for all training and therefore certifies all training, regardless of where it’s carried out.

Maintenance engineers in are employed by the Swedish Air Force throughout their career.

4.3.2 Ground crew training objectives

The review shows that training of maintenance engineers roughly consists of vocational school, military training, basic A/B1/B2 training, and A/B1/B2 type rating.

Since the basic A/B1/B2 training is based on JAR-66 (JAA, 1998), it is used as the entry level for inexperienced maintenance engineers. However, since JAR-66 is of fairly recent origin, the entry level for experienced maintenance engineers of the conceptual knowledge covered in JAR-66 is more varied. Experienced maintenance engineers therefore need repetition of basic knowledge according to JAR-66 before beginning the type rating. The experienced maintenance engineers especially need more basic knowledge of JAR-66 modules that traditionally have not been included in the B1/B2 training, such as human factors. Some other basic knowledge that needs repetition is materials and hardware, and digital techniques. While experienced maintenance engineer need more repetition before type rating, the situation is the opposite after the type rating during the on-job training. Since the experienced engineers already have significant mechanical skill from hands-on practice, they need less on-job training than the inexperienced maintenance engineers who lacks this practice.

The OTTA shows that some tasks are more complex than others even in the mostly routine daily inspections and SI. Since such complexity is know to make task performance sensitive to distractions and stress, both B1 and B2 engineers should continuously analyze and manage the practical implications of such human factors issues. For example, this means that maintenance engineers have to make appropriate judgments of when the proper task performance is jeopardized based on an understanding of possible errors and error detection, as discussed in chapter 4.1 and Reason and Hoobs (2003). Since JAR-66 only partly covers the relevant factors for this judgment and management, these human factors aspects should be considered for inclusion in the type rating course. A similar argument applies to the risk assessments for what defects are acceptable and which are not in the current situation, which should be included in the type rating course.

The OTTA shows that B2 engineers will have the main training gap for the Swedish NH90 where the integrated avionics system is based on interacting subsystem. Although managing and operating BIT is sufficient for many situations, it is usually far from covering the whole complexity. Considerable training is therefore required to develop the system understanding that is needed to judge BIT validity and interpret documentation and test systems during fault isolation. Especially, for the experienced B2 engineer who usually lack to the necessary computer experience to understand and interact with integrated avionics systems.

Levin et al. (2004) provide a detailed description of the training objectives that were derived for the ground crew tasks based on the results of the OTTA and TGA when applied to the maintenance tasks. Since the most detailed information was available for daily and safety inspections they compromise the majority of the training objectives. AECMA 1000D was used to classify the maintenance tasks for daily inspections and safety inspections. The training objectives consider that experienced maintenance engineers need some repetition of basic knowledge according to JAR-66 for inspections as well as for fault isolation. Further, the training objectives consider that maintenance engineers need spatial knowledge of where components are located, that they need to understand the function of the component and how it impacts helicopter performance and safety, and that they should be able to perform the correct maintenance actions and exercise appropriate judgment. For maintenance actions where either time pressure or mental workload may cause human error, there is an additional training objective for how to analyze and manage such factors. Finally, maintenance engineers need practical skill in applying documented checklists.

4.4 Ground Crew TRA

The aim of the TRA work is to state technical requirements of vital importance for the ability to meet the training objectives.

The OTTA and TGA show that the training media for current type rating is probably sufficient for the routine maintenance tasks, where the training media may consist of documentation, visualizations, cut-up parts, and practice on actual helicopters. However, several studies indicate that the time for training is reduced by about 40% with virtual reality techniques where cockpit interior and components are presented in sufficient detail for practice of maintenance procedures (Barnett et al., 2000, Stone, 2002). Further, some form of virtual reality techniques may be necessary for a wider exposure to operational scenarios that foster an awareness of factors which affect personal and team performance. Such training media may enhance the understanding of hand-over and time pressure problems, slips in routine tasks, lack of communication, procedure violation, misdiagnosis, lack of checks, and visual inspection (see Advanced Integrated Training in Avionics Maintenance, AITRAM, Vora et al., 2002, and Wenzel et al., 2002, for examples of virtual maintenance trainers). Alternatively, safety training may be performed as role games for improving the understanding of risky situations (Zimolong & Gresch, 1987).

The situation is different for fault isolation on integrated avionics systems since traditional training media simply do not provide the necessary complexity to illustrate the dynamics of interacting subsystems in a way that provides an understanding of the system behaviour as a whole. Most current development programs for new aircrafts have realized this and are developing integrated simulators that suit both air and ground crews. The system understanding provided by such simulators facilitates the recurrent training for new system editions, communication with aircrew for comprehension of fault reports, and hypothesis testing for fault isolation, in addition to functioning as a training media for type rating of fault isolation. For all these functions, there are several benefits of using a simulator environment with powerful visualization capabilities. The illustration of interacting subsystems enhances the system understanding required for a proper use of BIT results, flight data, documentation, and test systems, which are all physically separate from the helicopter. While fault isolation on the helicopter provide an understanding of the spatial relationships of where components are located and some operational experience, these areas are probably less important for the system understanding and can be obtained in a later phase of the training. Whether the simulator has to include the full system or whether a less complex system will suffice is a topic of much discussion, since even a simple pen and paper exercise will provide a basic training in fault isolation. Consequently, it is the types of faults that the students are exposed to during training and how the illustrations enhance the system understanding that matters and not the number of faults.

4.5 Ground Crew TOA

The purpose of the Training Option Analysis (TOA) is to:

- Determine how the CAI to be developed for the Swedish Armed Forces fulfil NH90 training needs
- Determine which NH90 training needs that cannot be covered by CAI
- Recommend specifications for a VMT that is considered for industrial development based on the training needs

The result of the TOA is a recommended training solution.

Appendix F shows the training media that are recommended for each ground crew training objective. First, the repetition of basic knowledge according to JAR-66 is best performed in a classroom. Second, spatial knowledge of where components are located can only be partially obtained with CAI since only the rough location of some but not all components is visualized in 2D. A VMT will therefore significantly enhance the spatial knowledge of how components are located relative each other, as well as the components' accessibility. The understanding of component function and how it impacts helicopter performance and safety, on the other hand, can be solely obtained in a VMT using explanations and examples. Concerning the actual performance of maintenance actions a VMT or real helicopter are the only alternatives. Since the purpose of a VMT is to save training time or provide an added training value, the recommended use of a VMT was limited to tasks that were rated as requiring training and not just initial training. The VMT function is also limited to tasks which have previously been developed for virtual environments, such as fault isolation, visual inspection, accessibility, component installation, and execution of procedures. Items that possibly may include these tasks were also included. Similar considerations were applied to identification of faulty and operational condition. The intention was to provide indications of where a VMT may provide added value. The VMT should also provide exposure to a wide range of situations for all tasks that require judgement. Since the time for training of procedures is expected to be considerably less when using a VMT compared to the real helicopter, this could potentially reduce the total time for training as well as the time for OJT. Unfortunately, JAR-66 has fairly strict requirements for the amount of OJT and is not adapted to the use of virtual reality techniques before OJT. Until JAR-66 is adapted to virtual reality techniques, the content of the OJT should be changed to extend the procedural knowledge that the maintenance engineers already have obtained in a VMT.

The OTTA clearly indicates that the performance of some maintenance actions may be more sensitive than others to time pressure and mental workload even during mostly routine daily and safety inspections. Although it is important to analyze and manage factors that may cause human error, such an analysis is currently beyond JAR-66 requirements. No training media are therefore recommended for these training objectives. Instead only alternative training media are provided. Whether the JAR-66 requirements are sufficient for coping with human error, or whether maintenance engineers need more training to exercise appropriate judgements can only be determined by the Swedish Armed Forces. If more training is desired regarding human error, classroom training can provide an understanding of the mechanisms for human error and how to cope with them to reduce the likelihood of occurrence. However, although classroom training can provide a theoretical understanding of human error mechanisms and management this knowledge is not automatically integrated into action sequences. OJT is partially insufficient too since there is no guarantee that ground crews will be exposed to the desired range of situations. The recommended training option is therefore to use a VMT for exposure to situations the require judgment about human performance. Such a capability is, however, commonly not included in a VMT. Maintenance actions that have more than an Initial training need also require some human factors training in a VMT, either due to task complexity or infrequent task performance.

A VMT is typically based on rehosted software and a simulated system bus, which is the same architecture as in the AST (see chapter 4.2.3). A VMT's simulation of faults and visualisation of system functions should support both initial training of the fault isolation methodology as well as the development of an extensive system understanding. Otherwise, there is no alternative than to use the real helicopter for training of fault isolation to develop more of the extensive system understanding. However, using the real helicopter for training of fault isolation also has several limitations, such as the restricted availability of helicopters for training, limitations on which faults that can be inserted, etc. Even with OJT it may take years to develop the extensive system understanding due to the irregular nature of fault occurrences. Further, a VMT should also provide sufficient visualisations of cockpit and cabin functions for ground crews to see and understand the system behaviour from the aircrews' perspective. Typically, however, more stylised displays are used showing only the most important panels in the cockpit. If the VMT displays are be insufficient for portraying the aircrews' perspective, the ground crews' communication with aircrews for comprehension of fault reports can also be facilitated by utilizing the same training media that the aircrews use to develop their system understanding of integrated avionics systems. Finally, using a VMT as an enhanced tool for hypothesis testing is more of an option for further development when the training media for fault isolation has reached a sufficient level of complexity. At that point, the hypothesis testing tool can be integrated in the training media for fault isolation along with test systems and electronic documentation.

Table 4-7 shows that the available TM in the form of classroom training, CAI, and real helicopter covers most GC training objectives. All training objectives are also at least partially covered. However, a VMT may enhance the fulfilment of training needs in several ways. In particular:

- *Spatial understanding*: The spatial understanding of how components are located relative each other, as well as the components' accessibility.

- *Performance of actions*: The understanding of how to perform maintenance actions and verify component function

- *Identification of faulty and operational condition*: The ability to identify faulty and operational condition based on an exposure to a wide range of situations that require judgement. Since it is unclear whether CAI has this capability the assumption may be that the current practice of repeated exposure to more or less normal situations during

OJT is sufficient for detection of defects. However, there is no guarantee that OJT will provide exposure to the complete range of situations.

- *Application of checklists and test methodology*: A VMT has considerably higher availability and more flexibility in introducing faults than a real helicopter.

- *Communication with pilots for comprehension of fault reports*: Comprehension of fault reports requires an understanding of how faults affect the system's behaviour from the aircrews' perspective. A VMT that does not adequately portray how faults appear from the aircrews' perspective may therefore hamper the ground crews understanding of the fault reports. OJT is partially insufficient too since it is not an efficient learning environment for ground crews need to learn the necessary vocabulary to communicate with aircrews about the behaviour of integrated avionics systems.

- *Demonstrate extensive system understanding*: OJT is insufficient since it takes years to develop the extensive system understanding due to the irregular nature of fault occurrences.

The optional training need that may also be covered by a VMT is:

- *Analysis and management of factors that affect task performance*: Although classroom training can provide a theoretical understanding of human error mechanisms and management this knowledge is not automatically integrated into action sequences. OJT is partially insufficient too since there is no guarantee that ground crews will be exposed to the desired range of situations. One approach to expose ground crews to the desired range of situations is virtual training environments. Such a capability is, however, commonly not included in a VMT.

Table 4-7 Summary of GC TOA

GC Training Objectives	Classroom	CAI	VMT	Real Hcp
Repetition of basic knowledge	Covered			
Spatial knowledge		Partially	Recom mended	
Understanding of function		Covered		
Perform actions			Partially	Covered
Identification of faulty and operational condition			Recom mended	Partially
Analyze and manage factors that affect task performance	Partially		Optional	Partially
Application of checklists			Recom mended	Covered
Apply documentation, methodology, test system, BIT & repair procedure for fault isolation			Recom mended	Covered
Communication with pilots for comprehension of fault reports			Recom mended	Partially
Demonstrate extensive system understanding			Recom mended	Partially

4.5.1 Recommended GC training solution

The type rating course will presumably consist of blocks of training objectives, where each block is divided into a theoretical part that utilizes CAI and a practical part that utilized the

VMT and the real helicopter. Assuming that each training media is used for about 10 weeks with 12 students in each class, a total of 48 students can be trained each year on one VMT. One VMT at the national training centre should therefore be sufficient for training of all maintenance and flight engineers. Finally, to cover a situation where the maximum of 12 students are trained simultaneously, there should be 12 CAI licences at the national training centre to cover the annual training need.

4.5.2 Training needs not covered by the use of anticipated TM

The ground crew TOA shows that the following areas may not be sufficiently considered in the CAI and VMT TM:
- Exposure to situations that require judgment about faulty and operational condition
- Exposure to situations that require judgment about human performance
- Exposure to faults and visualization of system behaviour that develop an extensive system understanding
- Visualization of system status in the simulated cockpit and cabin in a way that facilitates communication with aircrews for comprehension of fault reports

If maintenance engineers obtain more experience in judgment of system condition and human performance during type rating it will certainly improve safety. However, since these improvements are currently not formally required by the aviation authorities, the utility of these functions can only be determined by the Swedish Armed Forces. Normally, judgment of system condition and human performance are to some extent included within OJT and the regular safety management. The situation is different for fault isolation since the lack of extensive system understanding from using the VMT means that there has to be experts locally available with such an extensive system understanding. Experiences from when JAS39 was introduced shows that obtaining such expertise takes considerable time, and there is therefore initially a risk that delays in fault isolation may reduce helicopter availability. Finally, the implications is less severe of an impaired visualization of system status in the simulated cockpit since the aircrews' TM for developing system understanding can also be used for training of ground crews.

4.5.3 Recommended changes to TM

The ground crew exit levels when using the available TM are sufficient for JAR-66 requirements. However, a VMT is recommended that provide exposure to situations that require judgment about system condition. While such a VMT will certainly improve safety, only the Swedish Armed Forces can determine whether these safety improvements are important enough to warrant modifications of the TM.

A VMT that support the development of extensive system understanding should provide information about what registered system parameters say about component function and subsystem interactions, and portray a wide range of anomalous behaviour. Such a TM would provide ground crews with more of the extensive system understanding required to cope with the full complexity of integrated avionics systems. However, only the Swedish Armed Forces can determine whether these improvements are warranted or if they expect experts with extensive system understanding to be locally available.

Further prioritizations of VMT functionality may be obtained from Table 4-1 by considering areas with many items, time pressure, mental workload, or risk for injuries. Since there is currently a strong interest and development of VMTs for many applications, the Swedish Armed Forces are recommended to thoroughly review possible training concepts before finalizing design requirements. The development of visualization and immersion technologies may well provide new functionality that can be explored for a VMT.

4.5.4 Limited training risk analysis

The training needs that are not covered or not sufficiently covered by classroom training, CAI, or OJT are spatial understanding, identification of faulty and operational condition, application of checklists and test methodology, communication with pilots for comprehension of fault reports, demonstration of extensive system understanding, and optionally analysis and management of factors that affect task performance. While more training in judgment of system condition and human performance will certainly improve safety, the improvement is more incremental than fundamental since these areas are to some extent already included within OJT and the regular safety management. Only the Swedish Armed Forces can determine whether these safety improvements are important enough to warrant more training. Similarly, there is a limited risk of an impaired visualization of system status in the simulated cockpit in a way that does not sufficiently facilitate communication with aircrews for comprehension of fault reports. If the restrictions of the simulated cockpit hampers the ground crews' system understanding, they can always use the aircrews' TM to develop a system understanding that facilitates communication with aircrews.

The analysis of the currently available TM relative the training needs shows that there is only one major risk, the lack of extensive system understanding for fault isolation. This lack of extensive system understanding means that until there are experts locally available with such knowledge there is a risk for delays in fault isolation that may reduce helicopter availability. Only a VMT with recommended capabilities can reduce this risk.

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JAR-FCL 2 Flight Crew licensing helicopters

JAR–FCL 2.240 (b)(1) Type ratings – Requirements

JAR–FCL 2.261 (a), (b)(2) Type ratings – Knowledge and flight instruction

JAR–FCL 2.262 (b) Type ratings – Skill

JAR-FCL 4 Flight Crew licensing Flight Engineers

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Appendix A Acronyms and abbreviations

Table A

ARCC	Air Rescue Coordination Centre
AST	Aircraft System Trainer
ATPL	Air Transport Pilot License
CAI	Computer Aided Instructions
COTS	Commercial Off-The-Shelf
CPL	Commercial Pilot License
CPLH	Commercial Pilot License Helicopter
CPT	Cockpit Procedure Trainer
CRM	Crew Resource Management
CTA	Cognitive Task Analysis
DIF	Difficulty, Importance, Frequency analysis
DOF	Degrees-Of-Freedom
FFS	Full Flight Simulator
FMTF	Full Mission Training Facility
FMV	Defence Materiel Administration
FOI	Defence Research Agency
FOV	Field-Of-View
FS	Flight Simulator
GFE	Government Furnished Equipment
GMS	General Modular Simulation System
HFTS	Helicopter Flight Training Services GmbH
HMI	Human Machine Interface
HTA	Hierarchical Task Analysis
IMO	International Maritime Organization
IOS	Instructor Operator Station
IR	Instrument Rating
JAR	Joint Aviation Regulations
LP	Left Pilot
ML	Missions List
MCC	Multi Crew Co-operation
MRCC	Maritime Rescue Coordination Centre
MRS	Mission Rehearsal Simulator
MWL	Mental workload
NAHEMA	NATO Helicopter Management Agency
NHI	NATO Helicopter Industries
OJT	On-the-Job Training
OTTA	Operational and Technical Task Analysis
OTTS	Operational and Technical Task Statement
PF	Pilot Flying
PFI	Private Financed Initiative
PIW	Person In Water
PNF	Pilot non flying
PPL	Private Pilots License
PTT	Part Task Trainer
RCT	Rear Cabin Trainer
SME	Subject Matter Expert
SOW	Statement Of Work
TGA	Training Gap Analysis
TM	Training Media
TNA	Training Needs Analysis

TO	Training Objective
TOA	Training Option Analysis
TOD	Time Of Day
TRA	Technical Requirement Analysis
VMT	Virtual Maintenance Trainer

Appendix B Definitions

Table B

Collaboration	Co-operation refers to how crewmembers **work jointly together** in parallel with the same task element in order to achieve a common goal. For example, during a hoist operation when several individuals work closely together with the same task element.
Conceptual knowledge	Conceptual knowledge is the understanding of how semantic concepts are related to each other within the area of interest, i.e. “knowing that”, knowledge of facts and information about something. For example, the speed of the helicopter must not be higher than x km/h, if so - vital consequences will arise. This component must be checked every two months; if not - flight security is reduced. Thus a number of if - then relations, i.e. rules that guide the individual (know what).
Cognition	Cognition relates to the conscious “thinking”. It is the mental activity by which an individual is aware of and knows about the environment, including such processes as perceiving, remembering, reasoning, judging, and problem solving.
Contextual factors	Contextual factors refer to particular circumstances that impact task performance. For example, weather, rules of engagement, etc.
Co-operation	Co-operation refers to how crewmembers **work together** in parallel but with different task elements in order to achieve a common goal. For example, during navigation when the co-pilot is selecting maps and pilot flying is looking for obstacles.
Co-ordination	Co-ordination refers to how crewmembers **work separately** with different task elements and regulate their activities in order to achieve a common goal. For example, during sonar search when the pilot must hover until the sonar buoy is secured.
Cue	A cue is a stimulus that has acquired meaning.
Cutaneous	The word cutaneous means relates to or affects the skin.
Haptics	The definition of haptic vary, stated here is one of the more common definitions. Haptics deals with: • **Taction**, the sense of touch and • **Kinesthesia**, the sense of position and motion.
Haptic perception	Haptic perception involves both tactile perception through the skin and kinesthetic perception of position and movement of the joints and muscles. For example, if we hold an apple, we perceive it through the skin of our fingers and the position of our fingers.
Incidental learning	Incidental learning of a specific skill is the learning of a specific skill that occurs without the intended purpose to specifically practice the skill. Incidental learning can be said to be a “spill-over” effect when something else is practiced or performed. What is learned incidentally is not always available to conscious awareness.

	A problem may be that a person who has incidentally learned how a device works, often have no proper mental model of the functionality of the device, and thereby only have poor conceptual understanding of it (see Proctor & Dutta, 1995) An example of incidental learning is, if a student pilot is flying with a senior pilot over sea, with the purpose of learning to detect indications of submarines, the student pilot may at the same time learn something about the instruments of the cockpit or to communicate with rear-cabin.
Initial training	Refers to type rating / ab-initio training and not to the training conducted at the developer's facility as a part of the initial H/C contract.
Knowledge	Knowledge is the state or fact of knowing, the familiarity, awareness, or understanding that has been gained through experience or study. Knowledge is the sum or range of what has been perceived, discovered, or learned. To have knowledge about something is to have specific information about that thing.
Motor skill	Motor skill is the ability to correctly control a body part when performing a task. When a motor skill is well learned it is performed automatically without conscious awareness (Proctor & Dutta, 1994). For example, performing the correct and subtle movements of the tongue, lips etc. when speaking, performing the correct hand and arm movements when steering a helicopter, or when a LRU is dismounted.
Perception	Perception is a conscious mental awareness and interpretation of a sensory stimulus. Perception relates to pick-up of information from the environment.
Perceptual skill	Perceptual skill is the ability to interpret sensory information (vision, hearing, taste, smell and touch) (Ashcraft, 1994). There are different levels of perceptual skill 1) *detection* – if there is a stimulus or not, 2) *discrimination* – of whether two or more stimulus are the same or different, 3) *identification* – of a specific stimulus, alone or among others (Proctor & Dutta, 1994). Simple perceptual tasks can be performed preattentively, while more complex tasks generally require attentional control. With practice, tasks initially performed slowly with attentional control generally become automated and performed fast (Proctor & Dutta, 1994). For example, recognizing defective circuit boards; understanding the state of a machine or process by looking at displays, meters, indicators, lights etc.; recognizing engine problems by hearing divergence from normal motor sound; recognizing a rotor problem by sensing divergence from normal vibrations.
Procedural skill	Procedural skill is "knowing how" to do a task. This includes various mental procedures of thought, but also motor skills (Ashcraft, 1994). For example, how to perform the checklist, or how to carry out a safety inspection, i.e. often the knowledge of how to do "things" in consecutive order.
Proprioception	Proprioception relates to pick-up of information from within the body. It is a conscious or non-conscious reception by the brain, of information from the vestibular- and somatosensory system (i.e. muscles, tendons, and joints).

Sensation	Sensation refers to the immediate, relatively unprocessed result of stimulation of sensory receptors in the eyes, ears, nose, tongue, or skin (result of stimulus energy such as frequency and intensity). Perception, on the other hand, is the process by which organisms interpret and organize sensations to produce a meaningful experience of the world (typically involves further processing of sensory input).
Skill	Skill is the proficiency, facility, or dexterity that is acquired or developed through training or experience. Skill is the quality of being able to accomplish something that has been learned.
Somatosensory	The somatic sensory system can be thought of as a group of at least four senses: the sense of touch, temperature, body positions and pain. In other words it can be viewed as a collective category for all sensations that are not seeing, hearing, tasting, smelling or the vestibular sense of equilibrium.
Tactile system	The tactile system is comprised of sensory receptors, located under the surface of the skin, that send information to the central nervous system. This information includes light touch, pain, temperature, and pressure.
Team skill/ Teamwork	Team skill refers to a team's ability to work together during task performance as well as the team members' individual competences. The teamwork may require co-ordination, co-operation, or collaboration, as defined below, depending on how the task is distributed among team members. The team's performance depends on how team members manage task distribution, communication, leadership, and planning.

Appendix C DIF Scales

The following tables show the definition of the DIF scales given to SMEs (adapted from US Army, 1997).

Table C1 DIF criteria difficulty

If these indicators --	then this difficulty
1. ability to perform gets better with practice but task does not get easier 2. task has unique activities 3. task has a lot of concurrent activities 4. task requires considerable concentration effort 5. task requires considerable decision making 6. task requires outside assistance or expertise	VERY DIFFICULT
7. task requires constant practice or performance to maintain proficiency 8. task requires some practice to maintain proficiency 9. gets easier with practice 10. requires some concentrated effort 11. task requires some decision making	MODERATELY DIFFICULT
OTHER THAN ABOVE (easy to perform, little concentration required, etc.)	NOT DIFFICULT

Note: The indicators for category *Difficulty* are not necessarily listed in order of difficulty. Only one indicator is sufficient to determine the rating.

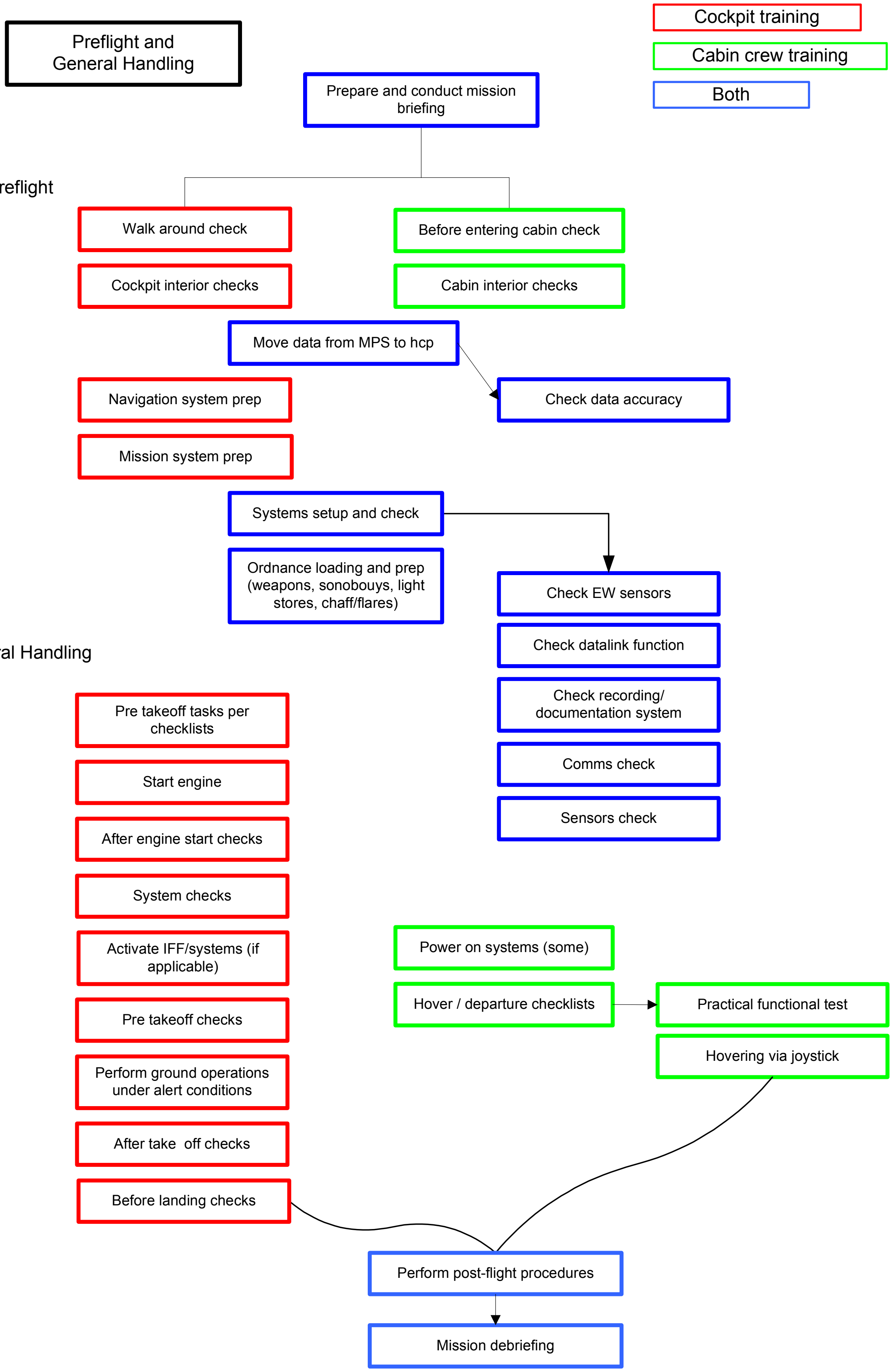
Table C2 DIF criteria importance

If these indicators --	then this importance
1. task performance failure may lead to severe injury or unacceptable high damage to equipment (flight safety) 2. task failure may lead to failure of unit mission 3. poor performance will cause injury or high damage to equipment (money, manpower, down time, etc.) (system safety) 4. task failure will hamper a unit's success in a function or mission 5. poor performance will cause damage and losses, but will not cripple the unit.	IMPORTANT
OTHER THAN ABOVE (no real harm done, missions not affected, unit functions still performed, etc.)	NOT IMPORTANT

Table C3 DIF criteria frequency

If these indicators --	then this frequency
done at least once every 2 weeks	VERY FREQUENT
done at least once every 8 weeks	MODERATELY FREQUENT
done less frequently than once in 8 weeks	NOT FREQUENT

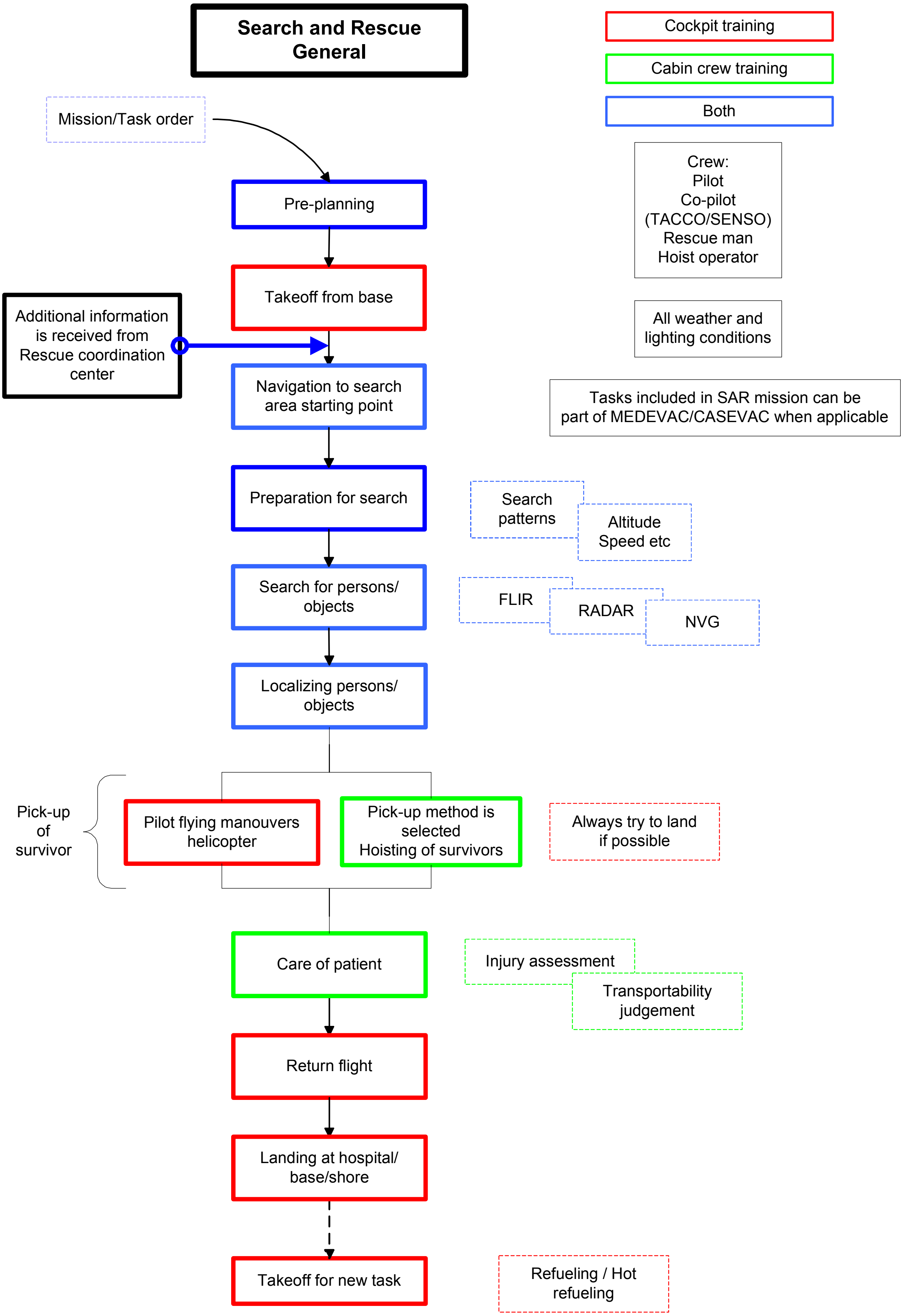
Appendix D Flowcharts

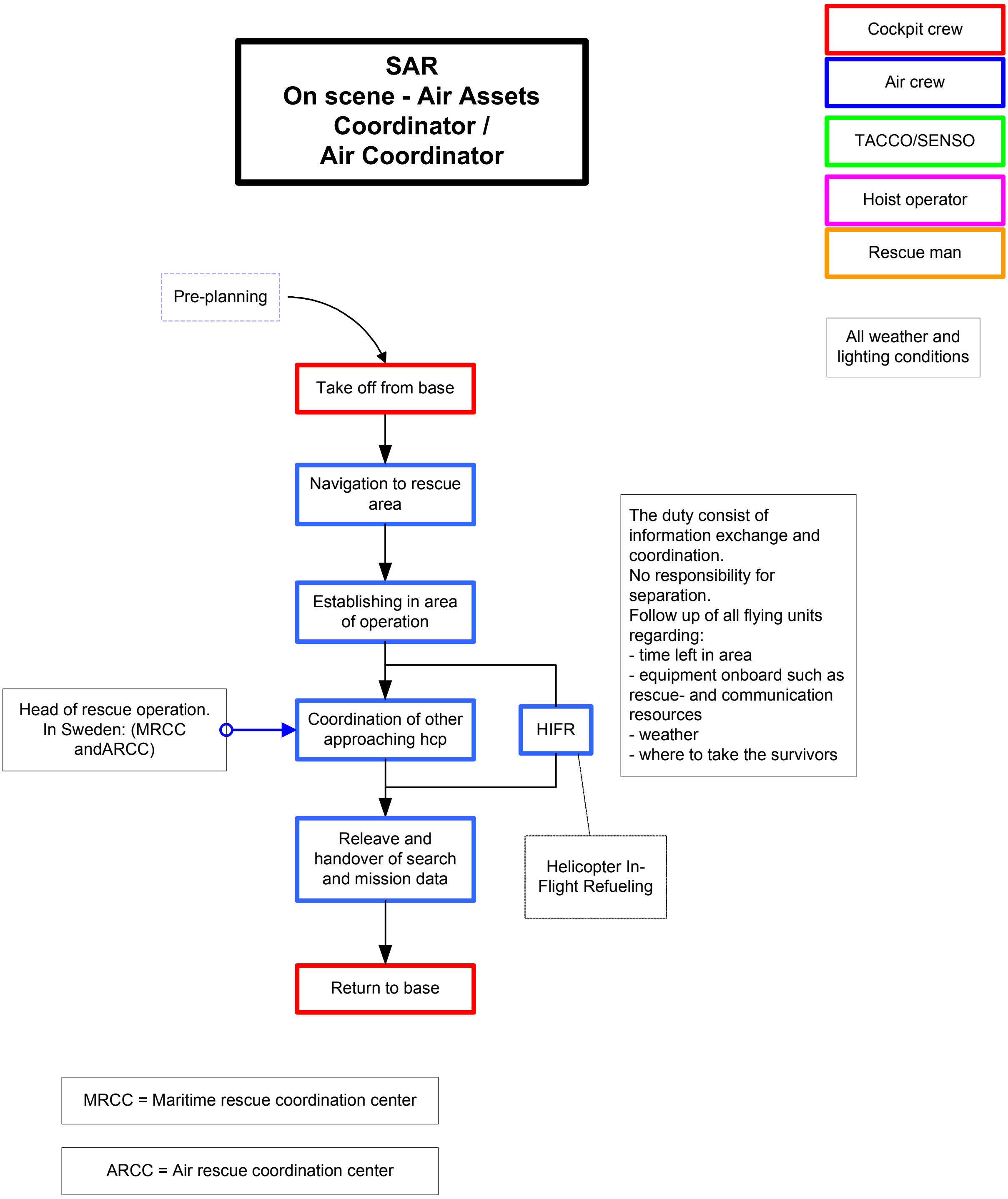


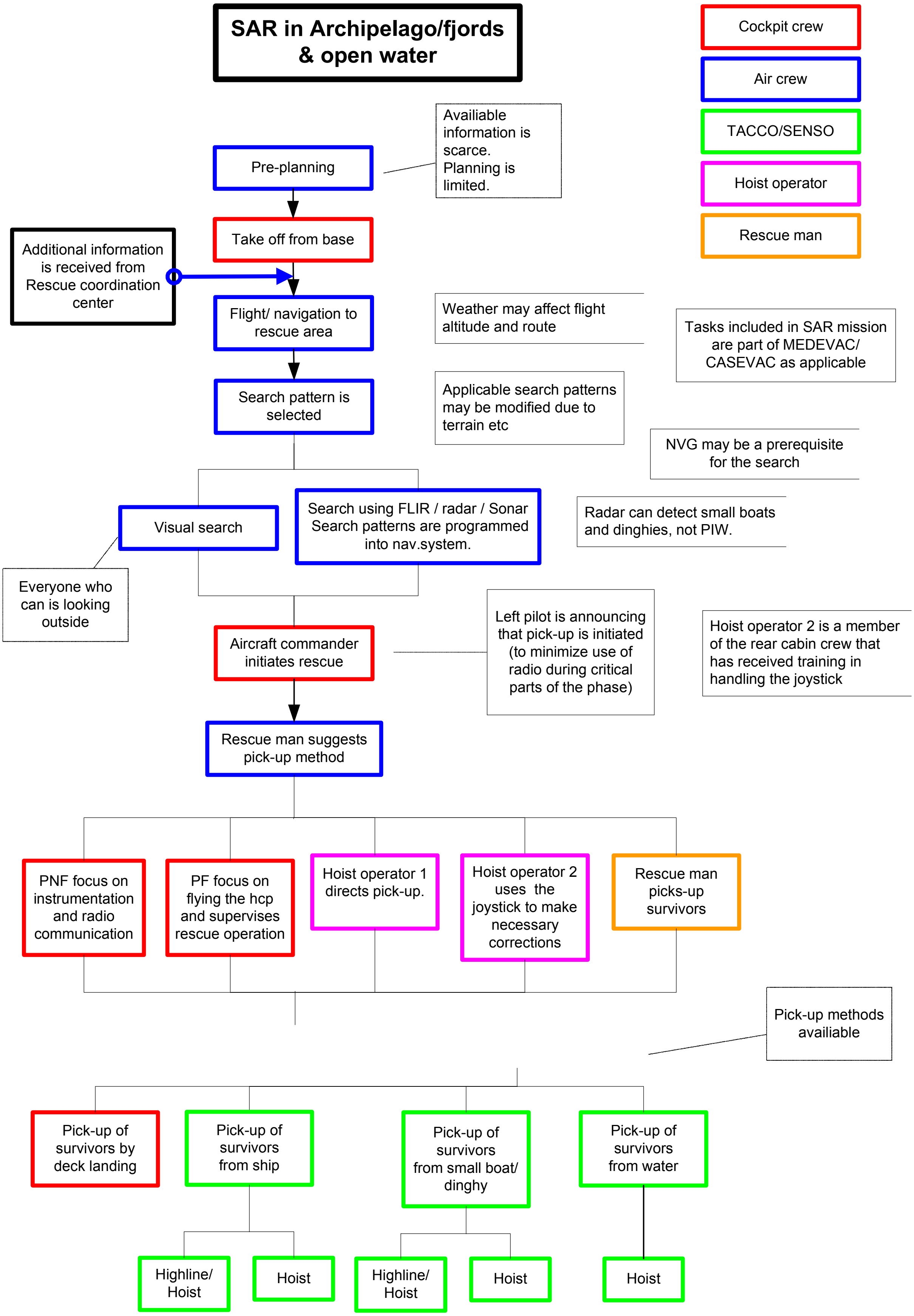
In flight non-mission specific

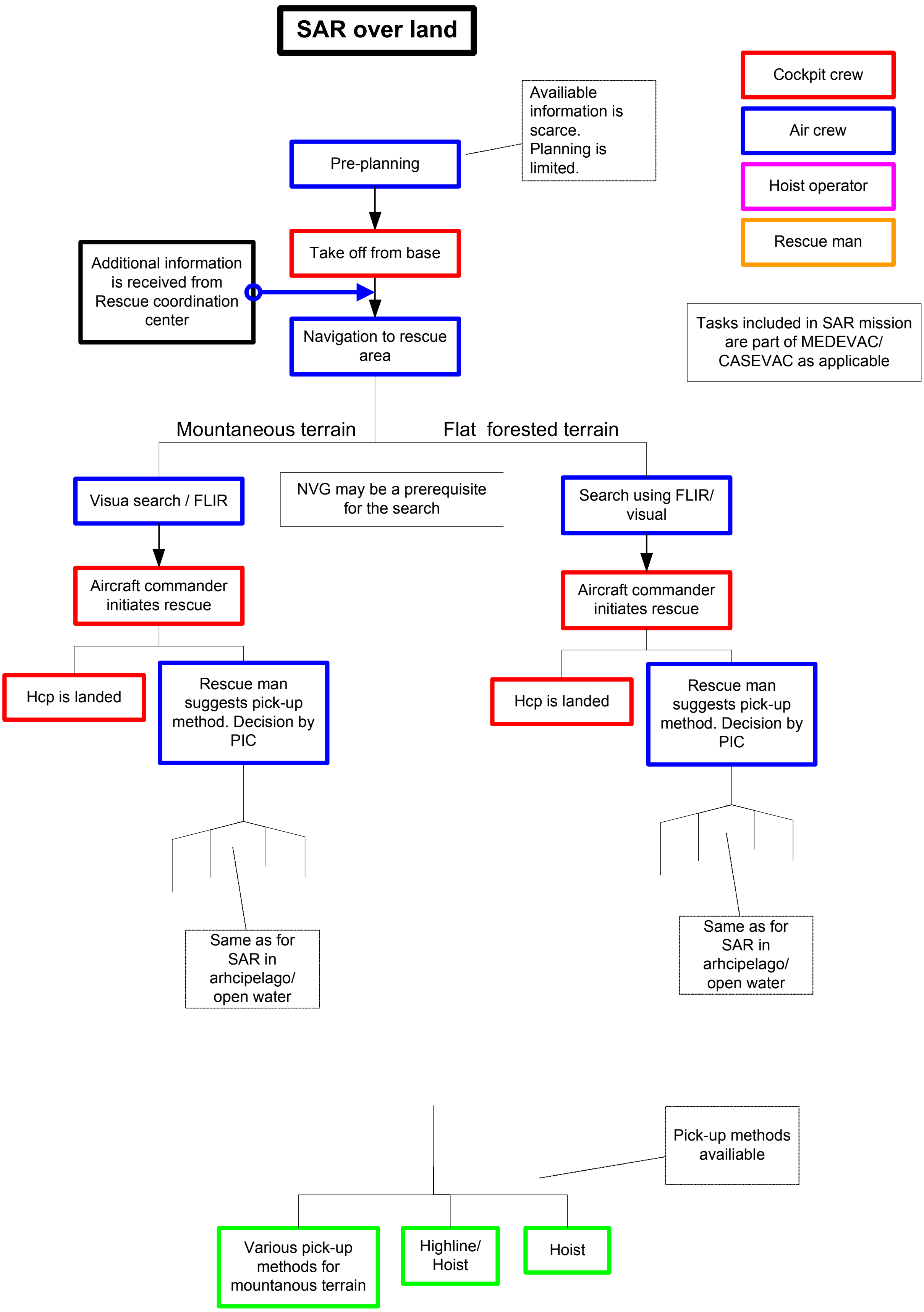
Cockpit training
Cabin crew training
Both

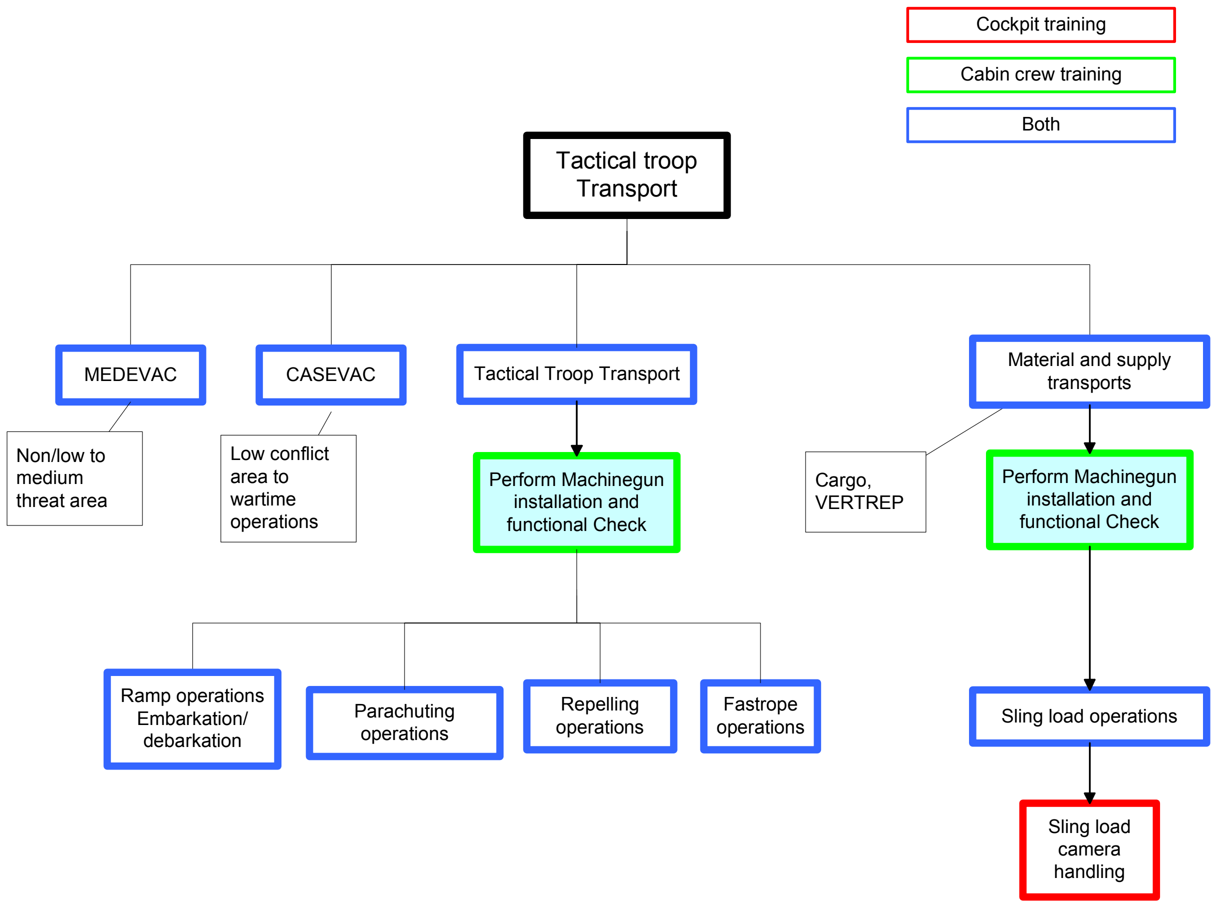
Taxi	Air taxi Hover taxi Skis taxi
Take off	Normal take off Cat A take off Crosswind take off Instrument take off Maximum performance take off and climb Heavy weight take off as applicable Take off with asymetric stores Formation take off Hover/departure checklist
Hover	Hover maneuvers close to objects of various sizes Hover IGE Hover OGE Autotransition to hover position Auto hovering (sonar cable hold) Auto hovering Manual hovering (sonar cable reference)
Pattern/Airfield operations	
Conversion	VFR to IFR IFR to VFR IFR to NVD NVD to IFR VFR to NVD NVD to VFR
VFRand NVD operations	Visual navigation Formation flight Full envelope flight Slope operations Low altitude flying techniques (NOE)
IFR operation	Basic instrument flight Enroute navigation with own systems Formation flight Mission profiles IFR, single and multi ship operation Instrument approach Own systems approach High level operations/procedures Low level operations
Landing	Normal landing Steep landing Shallow landing Vertical landing Cat A landing Deck landing Running landing Landing at designated locations, hospital, rig, base, shore, pinnacle, confined area Moving ship landing Moving deck landing
Various tasks and conditions	Brown out and white out conditions Snow operations Rapid deceleration Pinnacle operations Firefighting operations Sling load operations including sling load camera
Emergency prodecures and ditching	Various malfunctions Emergency situation recovery SD and unusual attitude recoveries

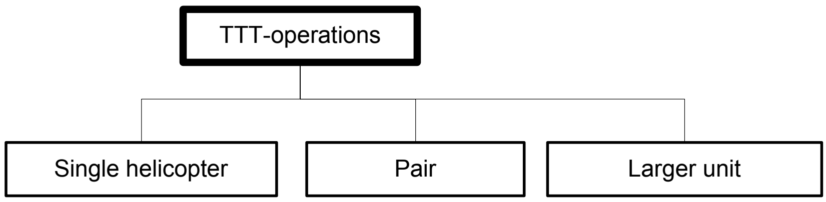

Search and Rescue
General
Cockpit training
Cabin crew training
Both
Mission/Task order
Pre-planning
Crew:
Pilot
Co-pilot
(TACCO/SENSO)
Rescue man
Hoist operator
Takeoff from base
Additional information
is received from
Rescue coordination
center
All weather and
lighting conditions
Navigation to search
area starting point
Tasks included in SAR mission can be
part of MEDEVAC/CASEVAC when applicable
Preparation for search
Search
patterns
Altitude
Speed etc
Search for persons/
objects
FLIR
RADAR
NVG
Localizing persons/
objects
Pick-up
of
survivor
Pilot flying manouvers
helicopter
Pick-up method is
selected
Hoisting of survivors
Always try to land
if possible
Care of patient
Injury assessment
Transportability
judgement
Return flight
Landing at hospital/
base/shore
Takeoff for new task
Refueling / Hot
refueling

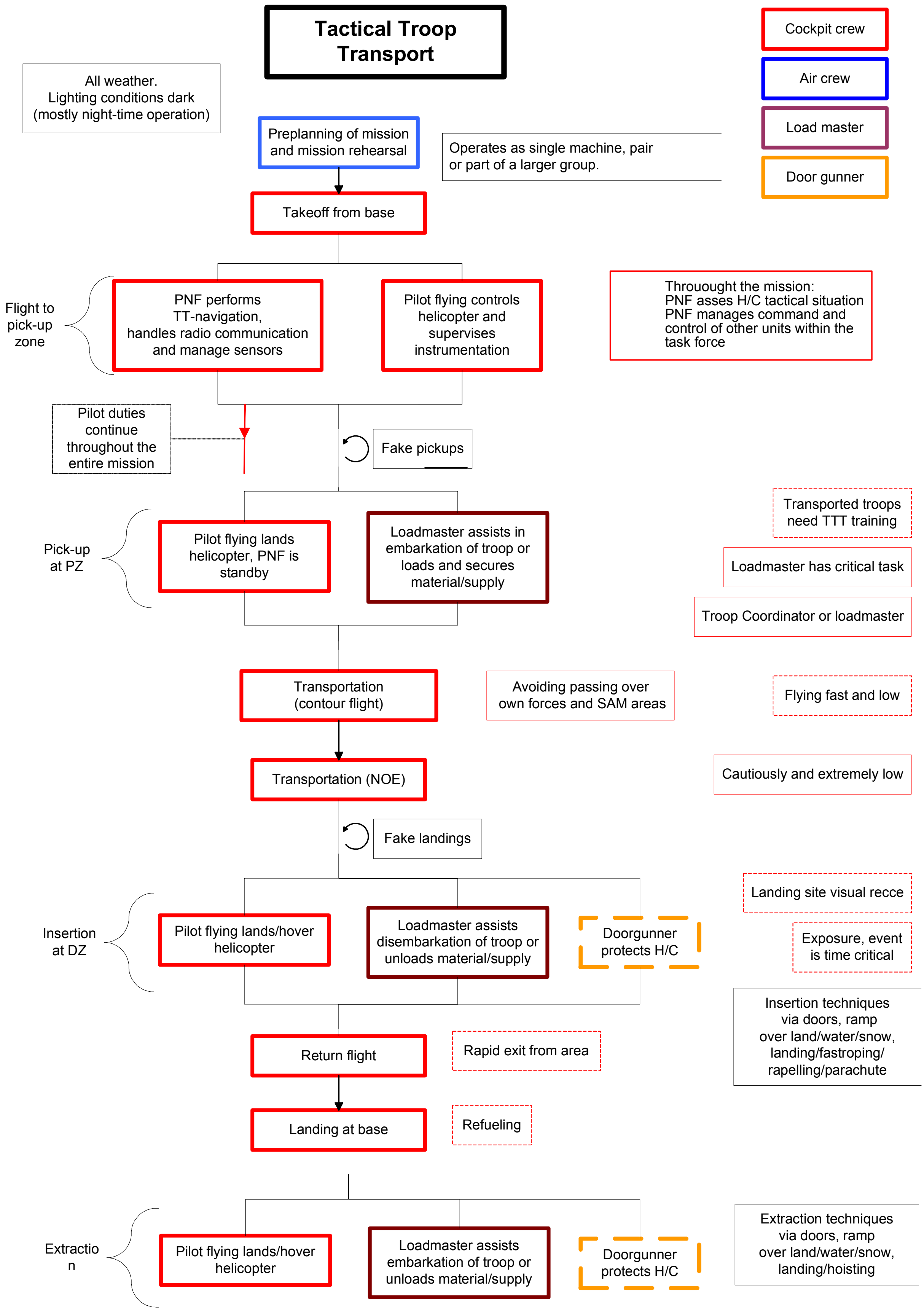

SAR
On scene - Air Assets Coordinator / Air Coordinator
Cockpit crew
Air crew
TACCO/SENSO
Hoist operator
Rescue man
All weather and lighting conditions
Pre-planning
Take off from base
Navigation to rescue area
Establishing in area of operation
The duty consist of information exchange and coordination.
No responsibility for separation.
Follow up of all flying units regarding:
- time left in area
- equipment onboard such as rescue- and communication resources
- weather
- where to take the survivors
Head of rescue operation. In Sweden: (MRCC andARCC)
Coordination of other approaching hcp
HIFR
Releave and handover of search and mission data
Helicopter In-Flight Refueling
Return to base
MRCC = Maritime rescue coordination center
ARCC = Air rescue coordination center

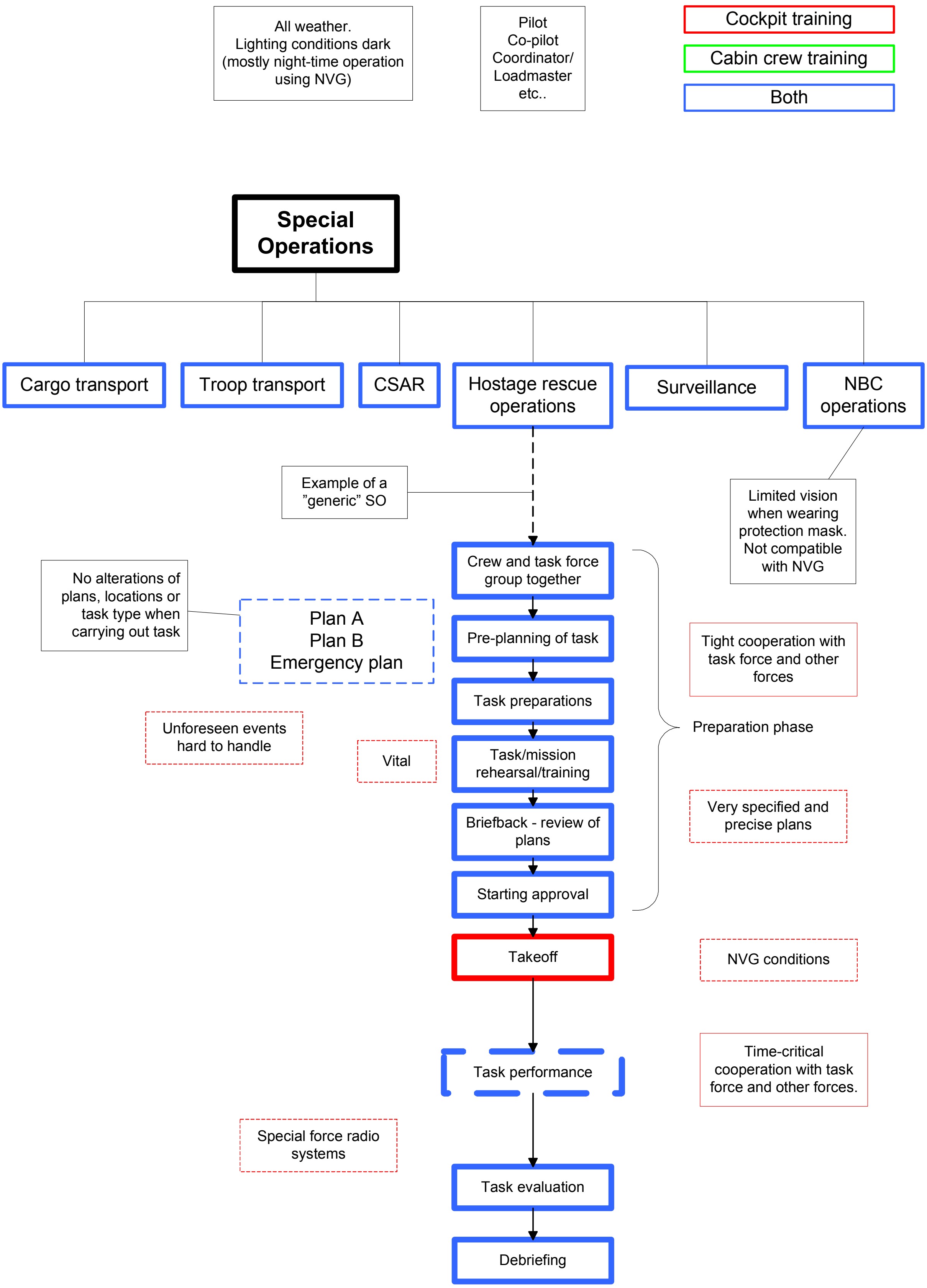

SAR in Archipelago/fjords & open water
Cockpit crew
Air crew
TACCO/SENSO
Hoist operator
Rescue man
Pre-planning
Availiable information is scarce. Planning is limited.
Take off from base
Additional information is received from Rescue coordination center
Flight/ navigation to rescue area
Weather may affect flight altitude and route
Tasks included in SAR mission are part of MEDEVAC/ CASEVAC as applicable
Search pattern is selected
Applicable search patterns may be modified due to terrain etc
NVG may be a prerequisite for the search
Visual search
Search using FLIR / radar / Sonar Search patterns are programmed into nav.system.
Radar can detect small boats and dinghies, not PIW.
Everyone who can is looking outside
Aircraft commander initiates rescue
Left pilot is announcing that pick-up is initiated (to minimize use of radio during critical parts of the phase)
Hoist operator 2 is a member of the rear cabin crew that has received training in handling the joystick
Rescue man suggests pick-up method
PNF focus on instrumentation and radio communication
PF focus on flying the hcp and supervises rescue operation
Hoist operator 1 directs pick-up.
Hoist operator 2 uses the joystick to make necessary corrections
Rescue man picks-up survivors
Pick-up methods availiable
Pick-up of survivors by deck landing
Pick-up of survivors from ship
Pick-up of survivors from small boat/ dinghy
Pick-up of survivors from water
Highline/ Hoist
Hoist
Highline/ Hoist
Hoist
Hoist

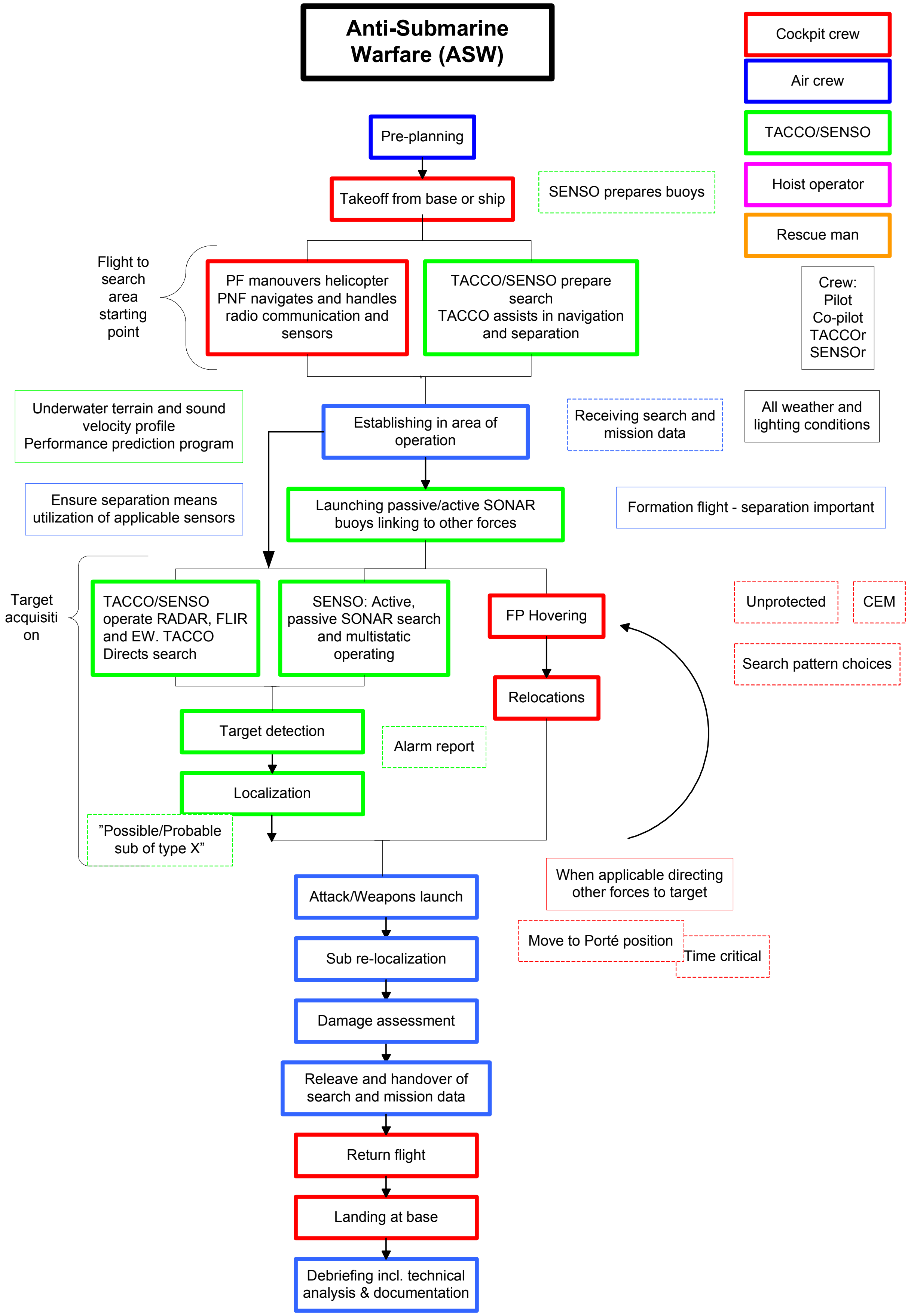

SAR over land
Cockpit crew
Air crew
Hoist operator
Rescue man
Availiable information is scarce. Planning is limited.
Pre-planning
Take off from base
Additional information is received from Rescue coordination center
Navigation to rescue area
Tasks included in SAR mission are part of MEDEVAC/ CASEVAC as applicable
Mountaneous terrain
Flat forested terrain
Visua search / FLIR
NVG may be a prerequisite for the search
Search using FLIR/ visual
Aircraft commander initiates rescue
Aircraft commander initiates rescue
Hcp is landed
Rescue man suggests pick-up method. Decision by PIC
Hcp is landed
Rescue man suggests pick-up method. Decision by PIC
Same as for SAR in arhcipelago/ open water
Same as for SAR in arhcipelago/ open water
Pick-up methods availiable
Various pick-up methods for mountanous terrain
Highline/ Hoist
Hoist

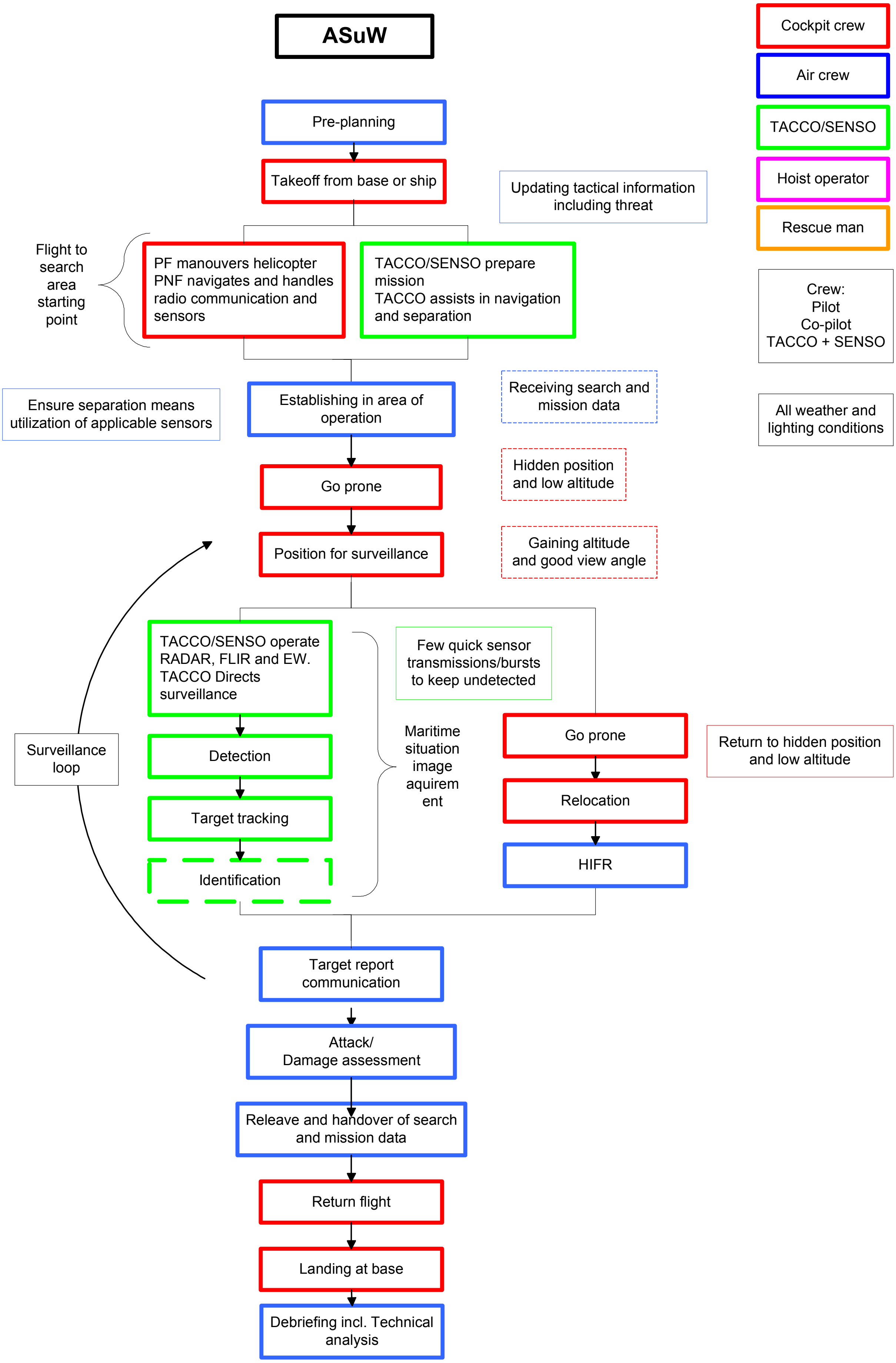

Cockpit training
Cabin crew training
Both
Tactical troop Transport
MEDEVAC
CASEVAC
Tactical Troop Transport
Material and supply transports
Non/low to medium threat area
Low conflict area to wartime operations
Perform Machinegun installation and functional Check
Cargo, VERTREP
Perform Machinegun installation and functional Check
Ramp operations Embarkation/ debarkation
Parachuting operations
Repelling operations
Fastrope operations
Sling load operations
Sling load camera handling

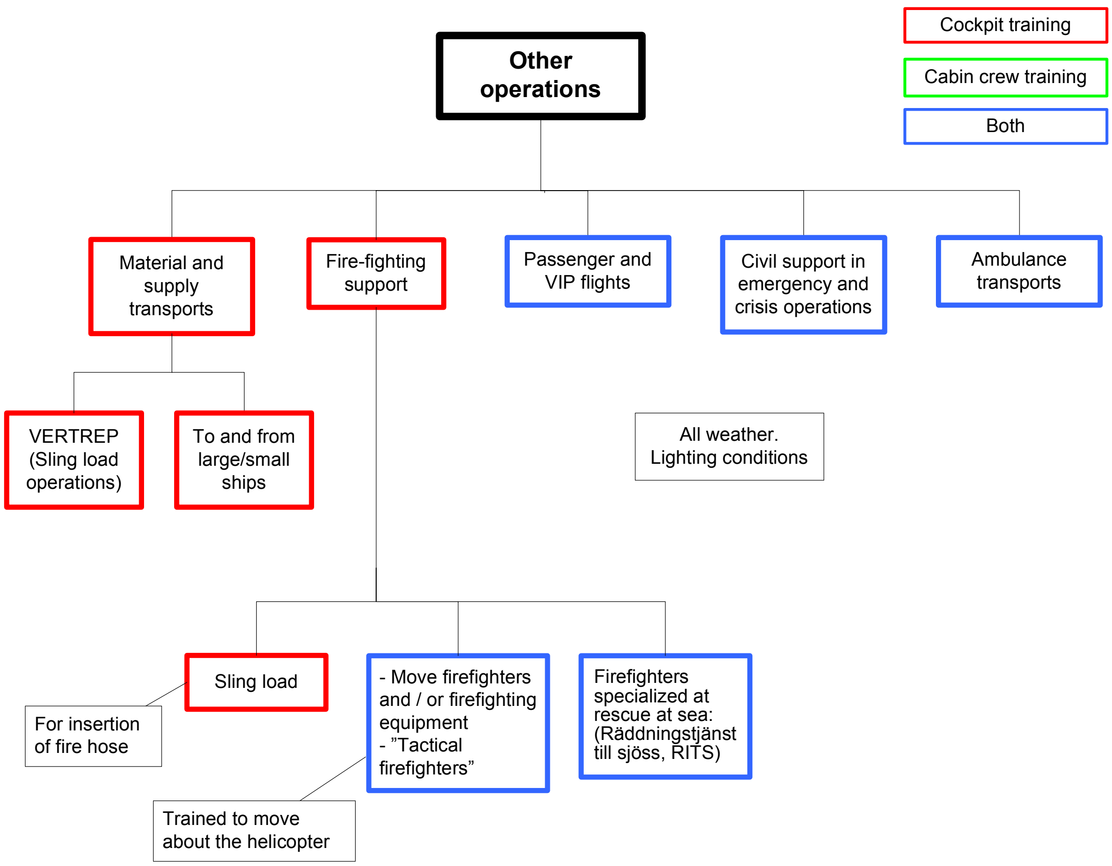

TTT-operations
Single helicopter
Pair
Larger unit


Tactical Troop Transport
Cockpit crew
Air crew
Load master
Door gunner
All weather. Lighting conditions dark (mostly night-time operation)
Preplanning of mission and mission rehearsal
Operates as single machine, pair or part of a larger group.
Takeoff from base
Flight to pick-up zone
PNF performs TT-navigation, handles radio communication and manage sensors
Pilot flying controls helicopter and supervises instrumentation
Throuought the mission: PNF asses H/C tactical situation PNF manages command and control of other units within the task force
Pilot duties continue throughout the entire mission
Fake pickups
Pick-up at PZ
Pilot flying lands helicopter, PNF is standby
Loadmaster assists in embarkation of troop or loads and secures material/supply
Transported troops need TTT training
Loadmaster has critical task
Troop Coordinator or loadmaster
Transportation (contour flight)
Avoiding passing over own forces and SAM areas
Flying fast and low
Transportation (NOE)
Cautiously and extremely low
Fake landings
Insertion at DZ
Pilot flying lands/hover helicopter
Loadmaster assists disembarkation of troop or unloads material/supply
Doorgunner protects H/C
Landing site visual recce
Exposure, event is time critical
Insertion techniques via doors, ramp over land/water/snow, landing/fastroping/ rapelling/parachute
Return flight
Rapid exit from area
Landing at base
Refueling
Extractio n
Pilot flying lands/hover helicopter
Loadmaster assists embarkation of troop or unloads material/supply
Doorgunner protects H/C
Extraction techniques via doors, ramp over land/water/snow, landing/hoisting


All weather.
Lighting conditions dark (mostly night-time operation using NVG)
Pilot
Co-pilot
Coordinator/
Loadmaster
etc..
Cockpit training
Cabin crew training
Both
Special Operations
Cargo transport
Troop transport
CSAR
Hostage rescue operations
Surveillance
NBC operations
Example of a ”generic” SO
Limited vision when wearing protection mask. Not compatible with NVG
No alterations of plans, locations or task type when carrying out task
Plan A
Plan B
Emergency plan
Crew and task force group together
Pre-planning of task
Task preparations
Task/mission rehearsal/training
Briefback - review of plans
Starting approval
Tight cooperation with task force and other forces
Preparation phase
Very specified and precise plans
Unforeseen events hard to handle
Vital
Takeoff
NVG conditions
Task performance
Time-critical cooperation with task force and other forces.
Special force radio systems
Task evaluation
Debriefing


Anti-Submarine Warfare (ASW)
Cockpit crew
Air crew
TACCO/SENSO
Hoist operator
Rescue man
Crew:
Pilot
Co-pilot
TACCOr
SENSOr
Pre-planning
Takeoff from base or ship
SENSO prepares buoys
Flight to search area starting point
PF manouvers helicopter PNF navigates and handles radio communication and sensors
TACCO/SENSO prepare search TACCO assists in navigation and separation
Underwater terrain and sound velocity profile Performance prediction program
Establishing in area of operation
Receiving search and mission data
All weather and lighting conditions
Ensure separation means utilization of applicable sensors
Launching passive/active SONAR buoys linking to other forces
Formation flight - separation important
Target acquisiti on
TACCO/SENSO operate RADAR, FLIR and EW. TACCO Directs search
SENSO: Active, passive SONAR search and multistatic operating
FP Hovering
Relocations
Unprotected
CEM
Search pattern choices
Target detection
Alarm report
Localization
"Possible/Probable sub of type X"
Attack/Weapons launch
When applicable directing other forces to target
Move to Porté position
Time critical
Sub re-localization
Damage assessment
Releave and handover of search and mission data
Return flight
Landing at base
Debriefing incl. technical analysis & documentation


ASuW
Cockpit crew
Air crew
TACCO/SENSO
Hoist operator
Rescue man
Crew:
Pilot
Co-pilot
TACCO + SENSO
All weather and lighting conditions
Pre-planning
Takeoff from base or ship
Updating tactical information including threat
Flight to search area starting point
PF manouvers helicopter
PNF navigates and handles radio communication and sensors
TACCO/SENSO prepare mission
TACCO assists in navigation and separation
Ensure separation means utilization of applicable sensors
Establishing in area of operation
Receiving search and mission data
Go prone
Hidden position and low altitude
Position for surveillance
Gaining altitude and good view angle
Surveillance loop
TACCO/SENSO operate RADAR, FLIR and EW.
TACCO Directs surveillance
Detection
Target tracking
Identification
Few quick sensor transmissions/bursts to keep undetected
Maritime situation image aquirem ent
Go prone
Relocation
HIFR
Return to hidden position and low altitude
Target report communication
Attack/
Damage assessment
Releave and handover of search and mission data
Return flight
Landing at base
Debriefing incl. Technical analysis


Cockpit training
Cabin crew training
Both
Other operations
Material and supply transports
Fire-fighting support
Passenger and VIP flights
Civil support in emergency and crisis operations
Ambulance transports
VERTREP (Sling load operations)
To and from large/small ships
All weather. Lighting conditions
Sling load
- Move firefighters and / or firefighting equipment
- ”Tactical firefighters”
Firefighters specialized at rescue at sea: (Räddningstjänst till sjöss, RITS)
For insertion of fire hose
Trained to move about the helicopter

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
2	**Mission training aircrew and type rating / recurrent training rear cabin crew**																	
3	**SAR in archipelago/fjords**																	
4	Mission pre-planning		A	C/I	I	OT	L3. Provision to use the same mission planning eq. as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate work space. Case studies.	X	X	NP	X	NP	X	X	N/A	N/A	N/A	N
5	Flight and navigation to rescue area	PF controls helicopter	C	O/I	I	T / OT	L2 Complete sim of H/C and avionics subsystems. Db supporting archipelago/fjords. Features are important for speed and height perception High Db res in areas of interest.	X	X	X-	R	O	N/A	X	X	P	M fov H res	B
6		PF supervises instrumentation	C	O/I	--	IT / T	L2 Complete sim of H/C and avionics subsystems	X	X	X	R	X-	N/A	X	X	X	NSR	N
7		PNF performs navigation	C	O/I	--	T / OT	L2 Complete sim of H/C and avionics subsystems. Db supporting archipelago/fjords. Careful representation of features is important for recognition	X	X	X-	R	X-	N/A	X	X	P	S fov H res	N
8		PNF handles radio communication	C	O/C /I	I	OT	L2 Complete sim of H/C and avionics subsystems. Provisions for sim of external communication with e.g. ATC, hospital, rescue coordination center, ships as simulated by the instructor	X	X	X	R	X-	N/A	X	N/A	N/A	N/A	N
9		TACCO supports PNF in navigation	R/A	O/I	I	T / OT	L2 Complete sim of H/C and avionics subsystems. Complete sim of rear cabin consoles and associated functionality. Db supporting archipelago/fjords.	R	N/A	N/A	N/A	O	R	X	N/A	N/A	N/A	N
10	Selection of search pattern		C or R	C/I	I	T	L2 Complete sim of H/C and avionics subsystems. L3 Complete sim of rear cabin consoles and associated functionality. Db supporting archipelago/fjords.	R	X	X-	R	X-	R	X	N/A	N/A	N/A	N
11	Search	Visual search	C/A	O/I	--	OT	L3. High res vis display system and db, applicable vis objects. Detailed and dynamic objects needed. Small objects will be difficult to detect with the dome solution	X	X	X	R	NP	X	X	X	P	S fov H res	N
12		Search using FLIR	R/A	O/I	--	OT	L3. Sensor Db: High res and coding of applicable objects incl small objects, PIW	R	X	X	R	X-	R	X	N/A	N/A	N/A	N
13		Search using Radar	R/A	O/I	--	OT	L3. Sensor Db: High res and coding of applicable objects incl small objects, PIW	R	X	X	R	NP	R	X	N/A	N/A	N/A	N
14		Cockpit crew operates EW	C	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	X	NP	R	NP	N/A	X	N/A	N/A	N/A	N
15	Autotransition to hover position		C/A	O/L/ I	--	OT	L2 Complete sim of H/C and avionics subsystems. L3 Complete sim of rear cabin consoles and associated functionality. Db supporting archipelago/fjords. Sea states, rotor down-wash, ship wake etc.	R	P	R	X	X-	R	X	X	X	M fov M res	B

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
16	Selection of pick-up method. Involves aircrew decision (Rescue man/PIC)		R/A	O/I	I	OT	L3. High res vis display system and db, sea states, ship wake, rotor down-wash, applicable detailed and dynamic objects, weather effects, seasonal varieties, TOD-sim. Case studies.	R	X	X	R	O	X	X	P	X	L fov H res	N
17	Pick-up of survivors	PNF focus on instrumentation and radio communication	C	O/C /I	I	IT	L2 Complete sim of H/C and avionics subsystems	X	X	X	R	X-	N/A	X	X	X	NSR	N
18		PF focus on flying the hcp and supervises the rescue operation	C/A	L/I	--	T / OT	L3. High res vis display system and db, sea states, ship wake, rotor down-wash, applicable detailed and dynamic objects, weather effects, seasonal varieties, TOD-sim.	R	X	X-	X	O	N/A	X	P	X	L fov H res	B
19		Hoist operator 1 directs pick-up	R/A	L/I	--	OT	L3. High res vis display system and db, sea states, ship wake, rotor wash, applicable detailed and dynamic objects, weather effects, seasonal varieties, TOD-sim, vis system for hoist operators	R	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
20		Hoist operator 2 uses the joystick to make necessary corrections	R	L/I	--	T / OT	L3. High res vis display system and db, sea states, ship wake, rotor wash, applicable detailed and dynamic objects, weather effects, seasonal varieties, TOD-sim, vis system for hoist operators	R	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
21	Pick-up methods	Pick-up of survivors by deck landing	A	L/I	I/C	OT	L2 Complete sim of H/C and avionics subsystems L3. High res vis display system and db, sea states, ship wake, rotor down-wash, applicable detailed and dynamic objects, weather effects, seasonal varieties, TOD-sim.	X	P	R	X	NP	X	X	E	X	L fov H res	B
22		Pick-up of survivors from ship	R/A	L/I	I/C	OT	L3. High res vis display system and db, sea states, ship wake, rotor down-wash, applicable detailed and dynamic objects, weather effects, seasonal varieties, TOD-sim. Rear cabin mock-up with hoist, vis system for hoist operators	R	N/A	N/A	N/A	N/A	X	X	P	X	L fov H res	N
23		Pick-up of survivors from small boat/ dinghy/ water	R/A	L/I	--	OT	L3. High res vis display system and db, sea states, ship wake, rotor down-wash, applicable detailed and dynamic objects, weather effects, seasonal varieties, TOD-sim. Rear cabin mock-up with hoist, vis system for hoist operators	R	N/A	N/A	N/A	N/A	X	X	P	X	L fov H res	N
24	Return flight	Same as flight and nav to rescue area	C	O/I	I	IT / T	L2 Complete sim of H/C and avionics subsystems. Features are important for speed and height perception. High Db res in areas of interest.	X	X	X-	R	O	X	X	X	P	M fov H res	B
25		Care of patient	R	L/I	I	OT	Simulated patient: "Living doll", Medical equipment for NH90	NP	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
26	Landing at hospital/base/shore		C	O/I	I	T	L3. High res vis display system with applicable features and objects such as runways, landing decks etc, applicable and detailed dynamic objects, weather effects, seasonal varieties, TOD-sim. Sea states, rotor down-wash, ship wake	X	X	X	R	NP	N/A	X	E	X	L fov H res	B
27	Debriefing		A	I/L	--	T	Debriefing station. Adequate work space for debriefing.	R	X	X	X	NP	X	X	N/A	N/A	N/A	N
28	**SAR in open water**																	
29	Mission pre-planning		A	C/I	I	OT	L3. Provision to use the same mission planning eq. as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate working space. Case studies.	X	X	NP	X	NP	X	X	N/A	N/A	N/A	N
30	Flight and navigation to rescue area		C/(A)	O/I	I	T / OT	L2 Complete sim of H/C and avionics subsystems. Db supporting open water. Features are important for speed and height perception. High Db res in areas of interest. Careful representation of features is important for recognition	R	X	X-	R	O	R	X	X	P	M fov H res	B
31	**SAR over land mountainous terrain**																	
32	Mission pre-planning		A	C/(L)/I	I	OT	L3. Provision to use the same mission planning eq. as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate working space. Case studies.	X	X	NP	X	NP	X	X	N/A	N/A	N/A	N
33	Flight and navigation to rescue area		C/A	O/I	I	OT	L2 Complete sim of H/C and avionics subsystems. L3. High res db supporting various types of land use and mountaneous terrain.	R	X	X-	R	O	R	X	X	P	M fov H res	B
34							Features are important for speed and height perception. High db res in areas of interest. Careful representation of features is important for recognition											
35	Visual search		C/A	O/I		OT	L3. High res vis display system and db. L3. Db supporting various types of land use and mountaneous terrain.	X	X	X	R	NP	X	X	X	P	S fov H res	N
36							Applic. detailed and dynamic vis objects, vis system for rear cabin, weather effects, seasonal varieties, TOD-sim. Small objects will be difficult to detect in a dome solution											
37	Search using FLIR		R/A ()	O/I	--	OT	L3. Sensor Db: High res and coding of applicable objects incl small objects	R	X	X	R	X-	R	X	N/A	N/A	N/A	N

	A / B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**	**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
38	Pick-up of survivors (Highline/Hoist)	A	L/I	I	OT	L3. High res vis displ syst and db. L3. Db with various types of land use and mountaneous terrain. Applic. detailed and dynamic vis objects. Rear cabin mock-up with hoist. Vis syst for hoist operators. Weather effects, seasons, TOD-sim. Rotor down-wash	R	N/A	N/A	N/A	N/A	X	X	P	X	L fov H res	N
39	**SAR over land flat terrain (forested)**																
40	Mission pre-planning	A	C/I	I	OT	L3. Provision to use the same mission planning eq. as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate working space. Case studies.	X	X	NP	X	NP	X	X	N/A	N/A	N/A	N
41	Flight and navigation to rescue area	C/A	O/I	I	T / OT	L2 Complete sim of H/C and avionics subsysts. Db supporting various types of land use and rough terrain.	R	X	X-	R	O	R	X	X	P	M fov H res	B
42						Features are important for speed and height perception. High Db res in areas of interest. Careful representation of features is important for recognition											
43	Visual search	C/A	O/I		OT	L3. High res vis display syst and db. L3. Db supporting various types of land use and flat forrested terrain.	X	X	X	R	NP	X	X	X	P	S fov H res	N
44						Applicable and detailed vis objects, vis syst for rear cabin, weather effects, seasonal varieties, TOD-sim. Small objects will be difficult to detect in a dome solution											
45	Search using FLIR	R/A	O/I	--	OT	L3. Sensor Db: High res and coding of applicable objects incl small objects	R	X	X	R	X-	R	X	N/A	N/A	N/A	N
46	SAR ACO																
47	Coordination of other approaching hcp (Involves entire aircrew.)	A	O/I	I/C	OT	L1. Similar functionality as in the H/C. Provision for interaction with several air units, ships and rescue coordination center. Case study	O	O	O	O	O	O	O	N/A	N/A	N/A	N
48	TTT																
49	Mission pre-planning	A (+ troop)	O or L /I	I/C	T	L3. Provision to use the same mission planning eq. as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate working space. Case studies.	X	X	NP	X	NP	X	X	N/A	N/A	N/A	N

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
50	Mission rehearsal. Involves aricrew. Use of TM depends on mission type and area of opeation.		A (+ troop)	O or L /I	I/C	T	L2 Complete sim of H/C and avionics subsysts. L3. High res vis displ syst and db. L3. Db supporting various types of terrain/urban areas. Appl. vis objects. Vis syst for rear cabin. Weather effects, seasonal varieties, TOD-sim.	R	O	O	R	O	R	O	X	X	M fov H res	N
51							Detailed and dynamic objects needed. Careful representation of features are important for recognition.											
52	Flight to Pick-up zone	PNF performs TT-navigation	C	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. High res vis displ syst and db. L3. Db supporting various types of terrain/urban areas.	X	X	X	R	NP	N/A	X	X	P	M fov H res	N
53							Appl. vis objects. Weather effects, seasonal varieties, TOD-sim. Careful representation of features are important for recognition											
54		PNF handles radio communication	C	O/C /I	I/C	T	L2 Complete sim of H/C and avionics subsysts. Provisions for sim of external communication with e.g. other air units, ground units, troop etc	X	X	X	R	X-	N/A	X	N/A	N/A	N/A	N
55		PF flies the hcp and supervises instrumentation	C	O/I	I	T	L2 Complete sim of H/C and avionics subsysts. L3. Db supporting various types of terrain/urban areas. Features are important for speed and height perception. High Db res in areas of interest.	X	X	X-	R	O	N/A	X	X	X	M fov H res	B
56		Cockpit crew operates FLIR	C	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	X	X	R	X-	N/A	X	N/A	N/A	N/A	N
57		Cockpit crew operates EW	C	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	X	NP	R	NP	N/A	X	N/A	N/A	N/A	N
58	Pick-up at PZ	PF lands the helicopter	C	O/I	(I)	T	L2 Complete sim of H/C and avionics subsysts. L3. High res vis displ syst and db. L3. Detailed terrain model of var types of terrain/urban areas & features, detailed dynamic objects. Weather effects, seasonal varieties, TOD-sim.	X	X	X	R	NP	N/A	X	P	X	L fov H res	B
59		Loadmaster assists/prepares for landing	R / A	L/I	--	T	L3. Rear cabin mock-up. L2. vis syst for load master.	R	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
60		Load master loads and secures troop or material/supply	R	O/I	I	T	L3. Rear cabin mock-up. L2. vis syst for load master.	R	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
61	Sling load operation.		A	O/L/I	I	OT	L2 Complete sim of H/C and avionics subsysts. L3. Rear cabin mock-up. L2. vis syst for load master.	R	X	NP	R	NP	R	R	X	X	L fov M res	N

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
62	Transportation; Contour flight	PNF performs TT-navigation	C	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. High res vis displ syst and db.	X	X	X	R	NP	N/A	X	X	P	M fov H res	N
63							Db supporting various types of terrain/urban areas, appl terrain features, appl and dynamic objects. Weather effects, seasonal varieties, TOD-sim. Careful representation of features are important for recognition											
64	Transportation; NOE flight	PNF performs TT-navigation	C	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. High res vis displ syst and db. L3.	X	X	X	R	NP	N/A	X	X	P	M fov H res	N
65							Db supporting various types of terrain/urban areas, appl terrain features, appl and dynamic objects. Weather effects, seasonal varieties, TOD-sim. Careful representation of features are important for recognition											
66	Disembarkation at DZ:	PF lands the helicopter at drop zone	C	O/I	(I)	T	L2 Complete sim of H/C and avionics subsysts. L3. High res vis displ syst and db. L3. Detailed db with various types of terrain/urban areas, appl terrain features, appl and dynamic objects. Weather effects, seasonal varieties, TOD-sim.	X	X	X	R	NP	N/A	X	P	X	L fov H res	B
67		Loadmaster assists/prepares for landing	R / A	L/I	--	T	L3. Rear cabin mock-up. L2. vis syst for load master.	R	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
68		Load master unloads troop or material/supply during disembarkation	R	O/I	I/C	T	L3. Rear cabin mock-up. L2. vis syst for load master. + troop and associated mtrl	R	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
69	Insertion: Fastrope	PF hovers the helicopter at drop zone	C / A	O/I	(I)	OT	L2 Complete sim of H/C and avionics subsysts . L3. High res vis displ syst and db. L3. Detailed terrain model of var types of terrain/urban areas & features, detailed dynamic objects. Weather effects, seasonal varieties, TOD-sim.	X	X	X	R	NP	N/A	X	P	X	L fov H res	B
70		Load master assists troop during disembarkation	R	O/I	I/C	OT	L3. Rear cabin mock-up. L2. vis syst for load master. + troop and associated mtrl	R	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
71	Insertion: Rappelling	PF hovers the helicopter at drop zone	C / A	O/I	(I)	OT	L2 Complete sim of H/C and avionics subsysts . L3. High res vis displ syst and db. L3. Detailed db with various types of terrain/urban areas, appl terrain features, appl and dynamic objects. Weather effects, seasonal varieties, TOD-sim.	X	X	X	R	NP	N/A	X	P	X	L fov H res	B

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
72		Load master assists troop during disembarkation	R	O/I	I/C	OT	L3. Rear cabin mock-up. L2. vis syst for load master. + troop and associated mtrl	R	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
73	Insertion: Parachuting	PF flies the helicopter at drop zone	C / A	O/I	(I)	T	L2 Complete sim of H/C and avionics subsysts . L3. High res vis displ syst and db. L3. Detailed db with various types of terrain/urban areas, appl terrain features, appl and dynamic objects. Weather effects, seasonal varieties, TOD-sim.	X	X	X-	R	O	N/A	X	X	X	L fov H res	B
74		Load master assists troop during disembarkation	R	O/I	I/C	T	L3. Rear cabin mock-up. L2. vis syst for load master. + troop and associated mtrl	R	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
75	Extraction: Landing	PF lands the helicopter at embarkation zone	C	O/I	(I)	OT	L2 Complete sim of H/C and avionics subsysts . L3. High res vis displ syst and db. L3. Detailed terrain model of var types of terrain/urban areas & features, detailed dynamic objects. Weather effects, seasonal varieties, TOD-sim.	X	X	X	R	NP	N/A	X	P	X	L fov H res	B
76		Load master assists troop during embarkation	R	O/I	I/C	T	L3. Rear cabin mock-up. L2. vis syst for load master. + troop and associated mtrl	R	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
77	Extraction: Hoisting	PF hovers the helicopter at embarkation zone	C / A	O/L/I	(I)	OT	L2 Complete sim of H/C and avionics subsysts . L3. High res vis displ syst and db. L3. Detailed terrain model of var types of terrain/urban areas & features, detailed dynamic objects. Weather effects, seasonal varieties, TOD-sim.	X	X	X	R	NP	N/A	X	P	X	L fov H res	B
78		Load master assists troop during embarkation	R	O/L/I	I/C	OT	L3. Rear cabin mock-up. L2. vis syst for load master. + troop and associated mtrl	R	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
79	Doorgunner protects H/C		R	C/L/I	--	OT	L3. Rear cabin mock-up. L2. vis syst for doorgunner. Detailed terrain modeling. Detailed and dynamic objects needed. Thrests on landing site.	R	N/A	N/A	N/A	N/A	R	X	X	X	M fov H res	N
80	Debriefing		A	I/L	--	T	Debriefing equipment. Video and audio of cockpit crew and rear cabin crew. Replay of selected displays.	R	X	X	X	NP	X	X	N/A	N/A	N/A	N
81	ASW																	
82	Mission pre-planning		A	O/(L)/I	I/C	T	L3. Provision to use the same mission planning eq. as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate work space. Case studies.	X	X	NP	X	NP	X	X	N/A	N/A	N/A	N
83	Flight and navigation to search area	PF controls helicopter	C	O/I	I	T / OT	L2 Complete sim of H/C and avionics subsysts . Db supporting archipelago/fjords/open water. Features are important for speed and height perception High Db res in areas of interest.	X	X	X-	R	O	N/A	X	X	P	M fov H res	B

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
84		PF supervises instrumentation	C	O/I	--	T / OT	L2 Complete sim of H/C and avionics subsysts	X	X	X	R	X-	N/A	X	X	X	NSR	N
85		PNF performs navigation	C	O/I	--	T / OT	L2 Complete sim of H/C and avionics subsysts . Db supporting archipelago/fjords/open water. Careful representation of features is important for recognition	X	X	X-	R	X-	N/A	X	X	P	S fov H res	N
86		PNF handles radio communication	C	C/I	I	OT	L2 Complete sim of H/C and avionics subsysts . Provisions for sim of external communication with e.g. within 2-ship, within task group, other units	X	X	X	R	X-	N/A	X	N/A	N/A	N/A	N
87		TACCO supports PNF in navigation etc.	R/A	O/I	--	T / OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	N/A	N/A	N/A	O	R	X	N/A	N/A	N/A	N
88		TACCO/SENSO prepare for search	R	C/(O)/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water. .	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
89		TACCO ensures separation	R/A	O/I	I/C	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
90	Establishing in area of operation		R	C/I	I	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
91	Launch of active/passive sonar boys		R	C/I	--	IT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	E	N/A	N/A	N/A	N
92	Target acquisition	Autotransition to hover position	C/A	O/L/I	--	T / OT	L2 Complete sim of H/C and avionics subsysts. L3 Complete sim of rear cabin consoles and associated functionality. Db supporting archipelago/fjords.	R	P	R	X	X-	R	X	X	X	M fov M res	B
93		PF is hovering	C	I	--	T	L2 Complete sim of H/C and avionics subsysts. L2. Vis displ syst and sensor db supporting archipelago/fjords/open water.	X	X	X	R	NP	N/A	X	X	X	M fov H res	B
94		PNF focus on instrumentation and radio communication	C	C/I	I	T	L2 Complete sim of H/C and avionics subsysts. Provisions for sim of external communication with e.g. within 2-ship, within task group, other units	X	X	X	R	X-	N/A	X	X	X	NSR	N
95		TACCO directs search	R	O/I	I/C	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
96		TACCO operates radar	R	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
97		TACCO operates FLIR	R	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
98		TACCO operates EW	R	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
99		Cockpit crew operates FLIR	C	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	X	X	R	X-	N/A	X	N/A	N/A	N/A	N
100		Cockpit crew operates EW	C	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	X	NP	R	NP	N/A	X	N/A	N/A	N/A	N
101		SENSO operates sonar syst in passive search	R	C/I	--	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
102		SENSO operates sonar syst in active search	R	O/I	--	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
103		SENSO operates in multi-static mode	R	C/I	--	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
104		Target detection	R/A	O/I	I	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	X	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
105		Target localization	R/A	O/I	I	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	X	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
106	Attack/Weapon launch		R/A	O/L/I	(C/I)	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim weapon systs. of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	NP	NP	X	NP	X	X	X	X	S fov H res	N

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
107	Sub re-localization		A	O/L/I	--	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
108	Damage assessment		A	O/I	I	OT	L2 Complete sim of H/C and avionics subsysts. L2. vis syst for cockpit crew. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	X	NP	R	NP	R	O	X	X	S fov H res	N
109	Relieve and handover of search and mission data		R	C/I	I	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
110	Debriefing	Target analysis	R	C	--	T	L3. ASW-mission specific post flight analysis equipment	N/A	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
111		Mission debriefing	A	I/L	--	T	Debriefing equipment. Video and audio of cockpit crew and rear cabin crew. Replay of selected displays.	R	X	NP	X	NP	X	X	N/A	N/A	N/A	N
112	ASuW																	
113	Mission pre-planning		A	O/I (L)	I/C	T	L3. Provision to use the same mission planning eq. as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate work space. Case studies.	X	X	NP	X	NP	X	X	N/A	N/A	N/A	N
114	Flight and navigation to surveillance area	PF controls helicopter	C	O/I	I	T / OT	L2 Complete sim of H/C and avionics subsysts. Db supporting archipelago/fjords/open water/coastal terrain. Features are important for speed and height perception. High Db res in areas of interest.	X	X	X-	R	O	N/A	X	X	P	M fov H res	B
115		PF supervises instrumentation	C	O/I	--	T / OT	L2 Complete sim of H/C and avionics subsysts	X	X	X	R	X-	N/A	X	X	X	NSR	N
116		PNF performs navigation	C	O/I	--	T / OT	L2 Complete sim of H/C and avionics subsysts . Db supporting archipelago/fjords/open water. Careful representation of features is important for recognition	X	X	X-	R	X-	N/A	X	X	P	S fov H res	N
117		PNF handles radio communication	C	C/I	I	OT	L2 Complete sim of H/C and avionics subsysts . Provisions for sim of external communication with e.g. within 2-ship, within task group, other units	X	X	X	R	X-	N/A	X	N/A	N/A	N/A	N
118		TACCO supports PNF in navigation etc.	R/A	O/I		T / OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terrain.	R	N/A	N/A	N/A	O	R	X	N/A	N/A	N/A	N
119		TACCO/SENSO prepare for search	R	C/(O)/I	--	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terrain.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
120		TACCO ensures separation	R/A	C/I	I/C	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terrain.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
121	Establishing in area of operation		R	C/I	I	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terrain.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
122	Surveillance loop	PF goes prone	C	O/I	--	OT	L2 Complete sim of H/C and avionics subsysts. Db supporting archipelago/fjords/open water	R	X	X	R	NP	N/A	X	X	X	M fov H res	B
123		PF takes up to surveillance position	C	I		OT	L2 Complete sim of H/C and avionics subsysts. Db supporting archipelago/fjords/open water	R	X	X	R	NP	N/A	X	X	X	M fov H res	B
124		TACCO directs search	R	I/O/C	--	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terain.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
125		TACCO acquires maritime situation image	R	C	--	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terain.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
126		Target detection	R	O/L/I	--	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terain.	X	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
127		Target localization	R	O/L/I	--	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terain.	X	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
128		When applicable Target identification (visual)	R/A	O/I	--	OT	L2 Complete sim of H/C and avionics subsysts. L3. vis syst (not for rear cabin crew) supporting archipelago/fjords/open water/coastal terrain and associated features and objects	R	X	NP	R	NP	R	X	X	X	S fov H res	N
129		TACCO operates FLIR	R	C		OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terrain.	R	N/A	N/A	N/A	O	R	X	N/A	N/A	N/A	N
130		TACCO operates EW	R	O/I		OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terrain.	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
131		Cockpit crew operates FLIR	C	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	X	X	R	X-	N/A	X	N/A	N/A	N/A	N

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
132		Cockpit crew operates EW	C	O/I	--	T	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water.	R	X	NP	R	NP	N/A	X	N/A	N/A	N/A	N
133		PF relocates	C	C/I	--	OT	L2 Complete sim of H/C and avionics subsysts. Db supporting archipelago/fjords/coastal terrain	R	X	X	X	X-	N/A	X	X	X	M fov H res	N
134	Target report communication		R	C	I	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terain.	R	X	N/A	R	NP	R	X	N/A	N/A	N/A	N
135	Attack		A	L/I	I	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terain.	R	NP	NP	X	NP	X	X	X	X	S fov H res	N
136	Damage assessment		A	O/I	I	OT	L2 Complete sim of H/C and avionics subsysts. L2. vis syst for cockpit crew. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terrain.	R	X	N/A	R	NP	R	O	X	X	S fov H res	N
137	Relieve and handover of search and mission data		R	C	I	OT	L2 Complete sim of H/C and avionics subsysts. L3. Complete sim of rear cabin consoles and associated functionality. L3. Sensor Db supporting archipelago/fjords/open water/coastal terain. .	R	N/A	N/A	N/A	NP	R	X	N/A	N/A	N/A	N
138	Debriefing	Target analysis	R	C	--	OT	L3. Mission specific post flight analysis equipment	N/A	N/A	N/A	N/A	N/A	X	X	N/A	N/A	N/A	N
139		Mission debriefing	A	I/L	--	OT	Debriefing equipment. Video and audio of cockpit crew and rear cabin crew. Replay of selected displays.	R	X	NP	X	NP	X	X	N/A	N/A	N/A	N
140	Special operations																	
141	SO					TBD	L3. Large variations in Db contents, detailed sim of terrain features and objects. Rapid db creation. Large gaming area. Dynamic objects needed.	R	X	O	R	NP	R	O	P	x	L fov H res	N
142	International operations																	
143						TBD	L3. Large variations in Db contents, detailed sim of terrain features and objects. Rapid db creation. Dynamic objects needed. L1. Use in comination with other simulator facilities when many different units need to interact. Case studies.	R	X	O	R	NP	R	O	P	x	L fov H res	N
144	**Type rating / Recurrent training**																	
145	**Pre-mission**																	
146	Perform pre-mission	Obtain orders	A	--	I			R	X	NP	R	NP	R	X	N/A	N/A	N/A	N
147		Collect mission data	A	I/C	I/C			R	X	NP	R	NP	R	X	N/A	N/A	N/A	N

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
148	preparations	Perform mission planning	A	O/I (L)	I/C		L3. Provision to use the same mission planning eq. as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate work space.	R	X	NP	R	NP	R	X	N/A	N/A	N/A	N
149		Perform combat mission planning	C	O/I (L)	I/C		L3. Provision to use the same mission planning eq. as for the real H/C. This means that the simulator facility must be equipped with a set of mission planning stations and adequate work space.	R	X	NP	R	NP	R	X	N/A	N/A	N/A	N
150		Prepare sonoboys	R	--	I/C			N/A	N/A	NP	N/A	NP	N/A	E	N/A	N/A	N/A	N
151	Prepare Mission Briefing		A	O/I (L)	I/C			R	X	NP	R	NP	R	X	N/A	N/A	N/A	N
152	Conduct Mission Briefing		A	O/I (L)	I/C			R	X	NP	R	NP	R	X	N/A	N/A	N/A	N
153	Preflight	Walk around check	C	I/C	I			N/A	N/A	N/A	N/A	N/A	N/A	E	N/A	N/A	N/A	N
154		Cockpit interior checks	C	I/C				X	X	X	R	NP	N/A	X	N/A	N/A	N/A	N
155		Before entering cabin checks	R	I/C	I			NP	N/A	N/A	N/A	N/A	NP	E	N/A	N/A	N/A	N
156		Move data from MPS to H/C	A	I/C			L3 Complete sim of H/C and avionics subsystems	R	X	NP	R	NP	R	X	N/A	N/A	N/A	N
157		Navigation system prep	C	I/O			L3 Complete sim of H/C and avionics subsystems	R	X	NP	R	NP	R	X	N/A	N/A	N/A	N
158		Mission system prep	A	I/O			L3 Complete sim of H/C and avionics subsystems	R	X	NP	R	NP	R	X	N/A	N/A	N/A	N
159		Other systems setup and check	A	I/O			L3 Complete sim of H/C and avionics subsystems	R	X	NP	R	NP	R	X	N/A	N/A	N/A	N
160		Ordnance loading and prep (Weapons, sonobouys, light stores, chaff/flares)	A	I/O				N/A	N/A	N/A	N/A	N/A	N/A	E	N/A	N/A	N/A	N
161	General Handling																	
162	Ground handling	Perform Pretakeoff Tasks per check lists	C	I/O			L3 Complete sim of H/C and avionics subsystems	R	X	X	R	NP	R	X	N/A	N/A	N/A	N
163		Start Engine	C	I/O			L3 Complete sim of H/C and avionics subsystems	X	X	X	R	NP	N/A	X	N/A	N/A	N/A	N
164		Perform After Engine Start Checks	C	I/O			L3 Complete sim of H/C and avionics subsystems	X	X	X	R	NP	X	X	N/A	N/A	N/A	N

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
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165		Perform Systems checks	C	I/O			L3 Complete sim of H/C and avionics subsystems	X	X	X	R	NP	X	X	N/A	N/A	N/A	N
166		Pre take off checks	C	I/O			L3 Complete sim of H/C and avionics subsystems	X	X	X	R	NP	X	X	N/A	N/A	N/A	N
167		Perform Ground Operations Under Alert Conditions	C	I/O				N/A	N/A	N/A	N/A	N/A	N/A	E	N/A	N/A	N/A	N
168	Taxi	Taxi (on wheels)	C	--	I		L3 Complete sim of H/C and avionics subsystems. L2 visual displ system	X	P	X	X	NP	N/A	X	X	X	M fov H res	B
169		Air taxi	C	--	I		L3 Complete sim of H/C and avionics subsystems. L2 visual displ system	X	P	X	X	NP	N/A	X	X	X	M fov H res	B
170		Hover taxi	C	--	I		L3 Complete sim of H/C and avionics subsystems. L2 visual displ system	X	P	X	X	NP	N/A	X	X	X	M fov H res	B
171		Skis taxi	C	I	I		L3 Complete sim of H/C and avionics subsystems. L2 visual displ system	O	E	NP	O	NP	N/A	O	X	X	M fov H res	Y
172	Take off	Normal take off	C	--	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X	X	NP	N/A	X	P	X	L fov H res	B
173		Cat A take off	C	--	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X	X	NP	N/A	X	P	X	L fov H res	B
174		Crosswind take off	C	--	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X	X	NP	N/A	X	P	X	L fov H res	B
175		Instrument take off	C	--	I		L3 Complete sim of H/C and avionics subsysts L2. Visual displ system	X	X	X	R	NP	N/A	X	X	X	S fov L res	N
176		Maximum performance take off and climb	C	--	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X-	X	NP	N/A	X	P	X	L fov H res	B
177		Heavy weight take off	C	--	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X-	X	NP	N/A	X	P	X	L fov H res	B
178		Take off with asymetric stores	C	--	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	NP	X	NP	N/A	X	P	X	L fov H res	B
179		Formation take off	C	I	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	X	X	R	NP	N/A	X	P	X	L fov H res	B
180		Take off from ship	C	O/I	I		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db, sea states, ship wake, rotor wash, applicable and dynamic objects, weather effects, seasonal varieties, TOD-sim.	X	E	A	X	NP	N/A	X	E		L fov H res	Y

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
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181		Hover/departure checklists	A	I	--		L3 Complete sim of H/C and avionics subsysts	X	X	X-	R	NP	X	X	N/A	N/A	N/A	N
182	Hover	Hover maneuvers	C	--	--		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X-	X	NP	N/A	X	P	X	L fov H res	B
183		Hover IGE	C	--	--		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X-	X	NP	N/A	X	P	X	L fov H res	B
184		Hover OGE	C	--	--		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X-	X	NP	N/A	X	P	X	L fov H res	B
185	Pattern / Airfield operations		C	C/I	I		L3 Complete sim of H/C and avionics subsystems. L2 visual displ system	X	X	X	R	NP	N/A	X	X	X	S fov M res	N
186	Conversion	VFR to IFR	C	C/I	--		L3 Complete sim of H/C and avionics subsystems. L2 visual displ system	X	X	X	R	NP	N/A	X	X	X	S fov M res	N
187		IFR to VFR	C	C/I	--		L3 Complete sim of H/C and avionics subsystems. L2 visual displ system	X	X	X	R	NP	N/A	X	X	X	S fov M res	N
188		IFR to NVD	C	C/I	--		L3 Complete sim of H/C and avionics subsystems. L2 visual displ system	X	X	X	R	NP	N/A	X	X	X	S fov M res	N
189		NVD to IFR	C	C/I	--		L3 Complete sim of H/C and avionics subsystems. L2 visual displ system	X	X	X	R	NP	N/A	X	X	X	S fov M res	N
190		VFR to NVD	C	C/I	--		L3 Complete sim of H/C and avionics subsystems. L2 visual displ system	X	X	X	R	NP	X	X	X	X	S fov M res	N
191		NVD to IFR	C	C/I	--		L3 Complete sim of H/C and avionics subsystems. L2 visual displ system	X	X	X	R	NP	X	X	X	X	S fov M res	N
192	VFR and NVD operations	Visual navigation	C/A	O/I	--		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	X	X	R	NP	N/A	X	X	P	S fov H res	N
193		Formation Flight	C/A	O/I	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X	R	NP	N/A	X	X	X	M fov H res	B
194		Full envelope flight	C	--	--		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	O	E	A-	O	NP	NP	O	X	X	M fov H res	Y
195		Slope operations	C	O/I	--		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	O	E	A	O	NP	N/A	X	P	X	L fov H res	Y
196		Low altitude flying techniques	C	--	--		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X	X	NP	N/A	X	P	X	L fov H res	B
197		Return to ship	A	O/I	I		L3 Complete sim of H/C and avionics subsysts. Db supporting archipelago/fjords/open water. Dynamic objects needed. Features are important for speed and height perception. High Db res in areas of interest.	X	X	X	R	O	N/A	X	X	P	M fov H res	N

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
198	IFR operation	Basic instrument flight	C	--	--		L3 Complete sim of H/C and avionics subsystems	X	X	X	R	NP	X	X	N/A	N/A	N/A	N
199		Enroute Navigation	C/A	O/I	--		L3 Complete sim of H/C and avionics subsystems	X	X	X-	R	NP	X	X	N/A	N/A	N/A	N
200		Formation flight	C/A	O/I	I		L3 Complete sim of H/C and avionics subsystems	X	X	X	R	NP	N/A	X	N/A	N/A	N/A	N
201		Mission profiles IFR, single and multiship operation	C/A	O/I	I		L3 Complete sim of H/C and avionics subsystems	X	X	X	R	NP	N/A	X	N/A	N/A	N/A	N
202		Instrument approach	C	C/I	I		L3 Complete sim of H/C and avionics subsystems	X	X	X	R	NP	N/A	X	N/A	N/A	N/A	N
203		Own systems approach	C	C/I	I		L3 Complete sim of H/C and avionics subsystems	X	X	X-	R	NP	N/A	X	N/A	N/A	N/A	N
204		High level operations/procedures	C	--	--		L3 Complete sim of H/C and avionics subsystems	X	X	X	R	NP	N/A	X	N/A	N/A	N/A	N
205		Low level operations	C	--	--		L3 Complete sim of H/C and avionics subsystems	X	X	X	R	NP	N/A	X	N/A	N/A	N/A	N
206	Landing	Perform before landing checks	C/A	O/I	--		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	X	X	R	X	X	X	N/A	N/A	N/A	N
207		Normal landing	C	--	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X	X	NP	N/A	X	P	X	L fov H res	B
208		Steep landing	C	--	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X	X	NP	N/A	X	P	X	L fov H res	B
209		Shallow landing	C	--	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X	X	NP	N/A	X	P	X	L fov H res	B
210		Vertical landing	C	--	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X	X	NP	N/A	X	P	X	L fov H res	B
211		Cat A landing	C	--	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X	X	NP	N/A	X	P	X	L fov H res	B
212		Deck landing	C/A	O/L/I	I		L2 Complete sim of H/C and avionics subsystems L3. High res vis display system and db, sea states, ship wake, rotor wash, applicable and dynamic objects, weather effects, seasonal varieties, TOD-sim.	O	E	A	O	NP	N/A	X	P	X	L fov H res	Y
213		Running landing	C	--	I		L3 Complete sim of H/C and avionics subsysts L3. Visual displ system	X	P	X	X	NP	N/A	X	P	X	L fov H res	B
214		Perform after landing check	C/A	O/I	--		L3 Complete sim of H/C and avionics subsystems	R	X	X	R	X	R	X	N/A	N/A	N/A	N
215	Refueling	In-flight refueling	C	O/I	I		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db. Dynamic objects	O	R	NP	O	NP	X	X	P	X	L fov H res	Y

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
216		Hot refueling	C	--	I			NP	NP	NP	NP	NP	N/A	E	N/A	N/A	N/A	N
217	Post-flight procedures		A	O/I	--			N/A	N/A	N/A	N/A	N/A	N/A	E	N/A	N/A	N/A	N
218	Other tasks																	
219	Confined area		A	--	--		L2 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db	R	X	X	R	NP	R	O	P	X	L fov H res	N
220	Rapid deceleration		C	--	--		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db	X	P	X	X	NP	N/A	X	P	X	L fov H res	B
221	Pinnacle operations		C/A	O/I	--		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db	O	P	NP	O	NP	N/A	X	P	X	L fov H res	Y
222	Snow operations		C/A	O/I	--		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db. Detailed and dynamic objects needed. Blowing snow	O	P	A	O	NP	N/A	X	P	X	L fov H res	Y
223	Firefighting operations		A	O/L/I	I		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db. Detailed and dynamic objects needed	R	X	X	R	NP	R	R	X	X	L fov M res	N
224	Sling load operations		A	O/L/I	I		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db. Detailed and dynamic objects needed	R	X	X	R	NP	R	R	X	X	L fov M res	N
225		Rig operations	C/A	--	I		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db. Detailed and dynamic objects needed	O	P	A	O	NP	N/A	X	P	X	L fov H res	Y
226	Emergency procedures: System																	
227	Respond to ground operation emergencies	Engine emergency shutdown	C	C/I	--		L3 Complete sim of H/C and avionics subsysts	X	X	X	R	NP	N/A	O	N/A	N/A	N/A	N
228	Respond to In-Flight emergencies	Respond to engine failures	C	C/I	--		L3 Complete sim of H/C and avionics subsysts	X	P	A	X	NP	N/A	O	X	X	S fov L res	Y
229		Fire in airframe, cockpit and cabin	C	C/I	--		L3 Complete sim of H/C and avionics subsysts	X	X	X	R	NP	X	O	N/A	N/A	N/A	N
230		PowerT	C	C/I	--		L3 Complete sim of H/C and avionics subsysts	X	P	A	X	NP	N/A	O	X	X	S fov L res	Y
231		Flight control and Rotorsystem	C	C/I	--		L3 Complete sim of H/C and avionics subsysts	X	P	A-	X	NP	N/A	O	X	X	S fov L res	Y
232		Electrical system	C	C/I	--		L3 Complete sim of H/C and avionics subsysts. Motion needed should the malfunction affect the helicopter dynamic behaviour	X	X	X	R	NP	N/A	O	N/A	N/A	N/A	N
233		Fuelsystem	C	C/I	--		L3 Complete sim of H/C and avionics subsysts. Motion needed should the malfunction affect the helicopter dynamic behaviour	X	X	X	R	NP	N/A	O	N/A	N/A	N/A	N

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	**Training objective**		**Category**	**Within crew**	**Outside crew**	**Training need**	**X=task can be trained P=preferred R=recommended O=not feasible E=can exclusively be trained A=dedicated to this TM NP=not provided N/A=not applicable TRA fidelity levels: L3, L2, L1**	**FMTF**	**FFS**	**FFS T1**	**CPT**	**PTT**	**RCT**	**OJT**	**Direct Projection**	**Collimated Display**	**FOV / res**	**Need for motion**
234		Hydraulic system	C	C/I	--		L3 Complete sim of H/C and avionics subsysts. Motion needed should the malfunction affect the helicopter dynamic behaviour	X	X	X	R	NP	N/A	O	X	X	S fov L res	N
235		Control and Display System	A	C/I	--		L3 Complete sim of H/C and avionics subsysts	R	X	X	R	NP	R	O	N/A	N/A	N/A	N
236		Navigation System	A	C/I	--		L3 Complete sim of H/C and avionics subsysts	R	X	X	R	NP	R	O	X	X	S fov L res	N
237		Plant Management System	C	C/I	--		L3 Complete sim of H/C and avionics subsysts	R	X	X	R	NP	R	O	N/A	N/A	N/A	N
238		Communication and Identification System	A	C/I	--		L3 Complete sim of H/C and avionics subsysts	R	X	X	R	NP	R	O	N/A	N/A	N/A	N
239		H/C Mission System	A	C/I	--		L3 Complete sim of H/C and avionics subsysts	R	X	X	R	NP	R	O	N/A	N/A	N/A	N
240		Sensors	A	C/I	--		L3 Complete sim of H/C and avionics subsysts	R	X	X	R	NP	R	O	N/A	N/A	N/A	N
241		Weapon system	A	C/I	--		L3 Complete sim of H/C and avionics subsysts	R	X	X	R	NP	R	O	N/A	N/A	N/A	N
242	Emergency procedures: Handling																	
243	Autorotation		C	C/I	--		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db	O	P	A	O	NP	N/A	O	E		L fov H res	Y
244	Ditching	Single engine water takeoff	C	C/I	--		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db	O	P	A	O	NP	N/A	O	E		L fov H res	Y
245		Water taxi	C	--	--		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db	O	P	NP	O	NP	N/A	O	E		L fov H res	Y
246	Emergency ship landings		C	C/I	I/C		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db. Detailed and dynamic objects needed.	O	P	A	O	NP	N/A	O	E		L fov H res	Y
247	Dip emergencies		C	C/I	--		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db. In combination with evacuation training rig	O	P	A	O	NP	R	O	E		L fov H res	Y
248	SD and unusual attitudes		C	--	--		L3 Complete sim of H/C and avionics subsysts L3. High res vis display syst and db. Motion is needed for some of the training	X	P	A	X	NP	N/A	O	X	X	L fov M res	Y
249	**CRM/MCC**		A	C/I				R	X	X	R	X	R	R	NSR	NSR	NSR	NSR

Maintenance task	Sub-task	AECMA 1000D (XX)	AECMA 1000D (XX-XX)	Training Objectives B1	Training need	Classroom	CAI	VMT	Real helicopter	Comments
Daily inspections BFF, Tar, ALF				Repetition of basic knowledge according to JAR-66	I	R				Only for experienced B1/B2 engineers
				Apply documented BFF checklist	T			R	R	1
				Apply documented Tar checklist	T			R	R	1
				Apply documented ALF checklist	T			R	R	1
	Airframe	Door		Know location of Cockpit doors, Cabin doors, Cabin door windows	I		R	R		2
				Understand function of doors	I		R			3
				Identify faulty and operational condition for Cockpit door, Cabin door, Cabin door windows	I				R	4
				Check movement and lock for cockpit doors, Cabin doors	I				R	
				Check lock in end position for Cabin doors	I				R	
		Fuselage	Access openings	Know location of Cowlings on upper deck, Cowling fasteners, EFP access door	I		R	R		2, Non-standard category for AECMA 1000D (XX-XX)
				Understand function of Cowlings on upper deck, Cowling fasteners, EFP access door	I		R			3
				Identify faulty and operational condition for EFP access door	I				R	4
				Identify faulty and operational condition for Cowlings on upper deck	T			R	R	4
				Analyze and manage factors which affect identification of faulty and operational condition for Cowlings on upper deck		X		X	X	5
				Check attachment, close and lock of Cowling fasteners	T			R	R	
				Analyze and manage factors which affect verification of attachment, close and lock of Cowling fasteners		X		X	X	5
			Drainage	Know location of Engine drain port, Upper deck drain port, Hydraulic drain port	I		R	R		2, Non-standard category for AECMA 1000D (XX-XX)
				Understand function of Engine drain port, Upper deck drain port, Hydraulic drain port	I		R			3
				Check for no foreign objects in Engine drain port, Upper deck drain port, Hydraulic drain port	T				R	
				Analyze and manage factors which affect detection of foreign objects in Engine drain port, Upper deck drain port, Hydraulic drain port		X		X	X	5
				Check for no leakage in Engine drain port, Upper deck drain port, Hydraulic drain port	T				R	
				Analyze and manage factors which affect detection of leakage in Engine drain port, Upper deck drain port, Hydraulic drain port		X		X	X	5
			Ramp	Know location of Rear ramp, hatch, hinge, window	I		R	R		2, Non-standard category for AECMA 1000D (XX-XX)
				Understand function of Rear ramp	I		R			3
				Identify faulty and operational condition for Rear ramp, hatch, hinge, window	I				R	4
			Structure	Know location of relevant Sections, Sponsons, Cabin access step, Mooring point, Cabin roof, Side-walls, Cable cutter, Tail folding hinge	I		R	R		2, Non-standard category for AECMA 1000D (XX-XX)
				Understand function of Sponsons, Cabin access steps, Mooring points, Cable cutter, Tail folding hinge	I		R			3
				Identify faulty and operational condition for relevant Sections, Sponsons, Cabin access step, Mooring point, Cabin roof, Side-walls, Cable cutter	T			R	R	4
				Analyze and manage factors which affect identification of faulty and operational condition for relevant Sections, Lower fuselage, Cabin roof, Side-walls		X		X	X	5
				Check for leakage on relevant Sections, Lower fuselage, Cabin roof, Side-walls	T				R	
				Analyze and manage factors which affect detection of leakage on relevant Sections, Lower fuselage, Cabin roof, Side-walls		X		X	X	5
				Check for cracks in Tail folding hinge	I				R	
			Air inlet	Know location of Front upper air intake	I		R	R		2, Non-standard category for AECMA 1000D (XX-XX)
				Understand function of Front upper air intake	I		R			3
				Identify faulty and operational condition for Front upper air intake	T			R	R	4
				Analyze and manage factors which affect identification of faulty and operational condition for Front upper air intake		X		X	X	5
				Check for no foreign objects in Front upper air intake	T				R	
				Analyze and manage factors which affect detection of foreign objects in Front upper air intake		X		X	X	5
			Electrostatic discharging	Know location for connection of Electrostatic discharging connector cable	I		R	R		2, Non-standard category for AECMA 1000D (XX-XX)
				Understand function of Electrostatic discharging connector cable	I		R			3
				Plugg/unplugg of Electrostatic discharging connector cable	I				R	
		Stabilizers		Know location of Horizontal stailizer, Vertical stabilizer, Static discharger	I		R	R		

Maintenance task	Sub-task	AECMA 1000D (XX)	AECMA 1000D (XX-XX)	Training Objectives B1	Training need	Classroom	CAI	VMT	Real helicopter	Comments
				Understand function of Horizontal stailizer, Vertical stabilizer, Static discharger	I		R			
				Identify faulty and operational condition for Horizontal stailizer, Vertical stabilizer, Static discharger	I				R	4
				Analyze and manage factors which affect identification of faulty and operational condition for Horizontal stailizer, Vertical stabilizer		X			X	5
				Check attachment of Horizontal stabilizer, Static discharger	I				R	
				Check for leakage on Vertical stabilizer	T				R	
				Analyze and manage factors which affect detection of leakage in Vertical stabilizer		X		X	X	5
		Windows		Know location for Cockpit windows, Windshield, Cabin windows	I		R	R		2
				Identify faulty and operational condition for Cockpit windows, Windshield, Cabin windows	I				R	4
				Check cleanliness of Cockpit windows, Windshield, Cabin windows	I				R	
				Check for no foreign objects in Lower cockpit area behind window	I				R	
	Avionic systems	Communications		Know location of VHF-FM antenna, HF antenna, V/UHF antenna	I		R	R		2
				Understand function of VHF-FM antenna, HF antenna, V/UHF antenna	I		R			3
				Identify faulty and operational condition for VHF-FM antenna, HF antenna, V/UHF antenna	I				R	4
				Check attachment of HF antenna	I				R	
		Crew escape		Know location of Jettison handle, Snap wire, Jettisonable window tape, First aid kit, Axe	I		R	R		2
				Understand function of Jettison handle, Snap wire, Jettisonable window tape	I		R			3
				Identify faulty and operational condition for Jettisonable window tape, First aid kit, Axe	I				R	4
				Check position Jettison handle, Snap wire	I				R	
				Check attachment of First aid kit, Axe	I				R	
		Electrical power		Know location of Battery compartment, Battery, Master cut-off, Electrical cabinet, Circuit breakers	I		R	R		2
				Understand function of Battery, Master cut-off, Circuit breakers	I		R			3
				Identify faulty and operational condition for Battery compartment, Master cut-off cover	I				R	4
				Check engaged, tripped, and clipped of Circuit breakers	T				R	
				Analyze and manage factors which affect verification of engaged, tripped, and clipped for Circuit breakers		X		X	X	5
				Connect/Disconnect batteries	I				R	
				Check connection of Batteries	I				R	
		Environmental control		Know location of Temperature sensor	I		R	R		2
				Understand function of Temperature sensor	I		R			3
				Identify faulty and operational condition for Temperature sensor	I				R	4
				Check for no foreign objects in Temperature sensor	I				R	
		Ice and rain protection		Know location of Windshield wipers, Wash fluid level	I		R	R		2
				Understand function of Wash fluid	I		R			3
				Identify faulty and operational condition for Windshield wipers, Wash fluid reservoir	I				R	4
				Check Wash fluid level (add if necessary)	I				R	
		Indicating and recording system		Know location of Pitots, Static pitot drain outlet	I		R	R		2
				Understand function of Pitots, Static pitot drain outlet	I		R			3
				Identify faulty and operational condition for Pitots, Static pitot drain outlet	T			R	R	4
				Analyze and manage factors which affect identification of faulty and operational condition for Pitot		X		X	X	5
				Check for no foreign objects in Static pitot drain outlet	T				R	
				Install cover for Pitot	T			R	R	
				Analyze and manage factors which affect installation of cover for Pitot		X		X	X	5
		Lights		Know location of External lights, Landing light, Weapon light, Formation light, Position light, Search light, Hover light, Anti-collision light, Anti-coll. light fasteners	I		R	R		2
				Understand function of External lights, Landing light, Weapon light, Formation light, Position light, Search light, Hover light, Anti-collision light, Anti-coll. light fasteners	I		R			3
				Identify faulty and operational condition for External lights, Landing light, Weapon light, Formation light, Position light, Search light, Hover light, Anti-collision light, Anti-coll. light fasteners	I				R	4
				Check function of External lights	I				R	

Maintenance task	Sub-task	AECMA 1000D (XX)	AECMA 1000D (XX-XX)	Training Objectives B1	Training need	Classroom	CAI	VMT	Real helicopter	Comments
				Check position of Anti-coll. Light fasteners	I				R	
				Check locking of Anti-coll. Light fasteners	I				R	
		Navigation		Know location of DF antenna, DME antenna, GPS antenna, VOR/LOC antenna	I		R	R		2
				Understand function of DF antenna, DME antenna, GPS antenna, VOR/LOC antenna	I		R			3
				Identify faulty and operational condition for DF antenna, DME antenna, GPS antenna, VOR/LOC antenna	I				R	4
	Engines	APU		Know location of APU exhaust, oil level	I		R	R		2
				Understand function of APU	I	R	R			3
				Identify faulty and operational condition for APU exhaust	T			R	R	4
				Analyze and manage factors which affect identification of faulty and operational condition for APU exhaust		X		X	X	5
				Check for no foreign objects in APU exhaust	T				R	
				Analyze and manage factors which affect detection of foreign objects in APU exhaust		X		X	X	5
				Install cover for APU exhaust	T			R	R	
				Analyze and manage factors which affect installation of cover for APU exhaust		X		X	X	5
				Check APU oil level (add if necessary)	T				R	
				Analyze and manage factors which affect verification of APU oil level		X		X	X	
		Engine fuel and control		Know location of Fuel system vent line outlets, Flame arrestors	I		R	R		2
				Understand function of Engine fuel and control	I		R			3
				Check for no foreign objects in Outlets, Flame arrestors	T				R	
		Exhaust		Know location of Engine exhausts and IR suppr.	I		R	R		2
				Understand function of Engine exhausts and IR suppr.	I		R			3
				Check for no foreign objects in Engine exhausts	T				R	
				Analyze and manage factors which affect detection of foreign objects in Engine exhausts		X		X	X	5
				Install cover for Engine exhausts	T			R	R	
				Analyze and manage factors which affect installation of cover for Engine exhausts		X		X	X	5
		Oil		Know location of Engine oil levels	I		R	R		2
				Understand function of Engine oil system	I		R			3
				Check Engine oil level (add if necessary)	T			R	R	
				Analyze and manage factors which affect verification of Engine oil level		X		X	X	
		Power plant		Know location of Engine air intake	I		R	R		2
				Understand function of Engine air intake	I		R			3
				Check for no foreign objects in Engine air intake	T				R	
				Analyze and manage factors which affect detection of foreign objects in Engine air intake		X		X	X	5
	General systems	Parking and mooring		Know location of Wheel chocks	I		R	R		2
				Understand function of Wheel chocks	I		R			3
				Put in position/remove Wheel chocks	I				R	
	Miscellaneous	GLIMS/MDS		Know location of Laptop	I		R	R		2
				Understand function of GLIMS	I		R			3
				Prepare, add discrepancies in GLIMS and initiate uscheduled maintenance ALF if necessary	T			R	R	
				Analyze and manage factors which affect preparation of GLIMS and initiation of uscheduled maintenance ALF		X		X	X	5
				Read and check MDS if crew remark	T			R	R	
				Analyze and manage factors which affect investigation of MDS		X		X	X	5
	Transmissions	Main rotor		Know location of MRH, Dampers, Rods, Blades, Attachment	I		R	R		2
				Understand function of MRH, Dampers, Rods, Blades, Attachment	I		R			3
				Identify faulty and operational condition for MRH, Dampers, Rods, Blades, Attachment	T			R	R	4
				Analyze and manage factors which affect identification of faulty and operational condition for MRH, Dampers, Rods, Blades, Attachment		X		X	X	5
				Check for no impacts on Main rotor blades lower side, leading edge, and tips	T			R	R	
				Analyze and manage factors which affect detection of impact on Main rotor blades lower side, leading edge, and tips		X		X	X	5
		Folding blades/pylons		Know location of Tail folding section, Swivel manifold	I		R	R		2
				Understand function of Tail folding section	I		R			3
				Identify faulty and operational condition for Tail folding section	T			R	R	4

Maintenance task	Sub-task	AECMA 1000D (XX)	AECMA 1000D (XX-XX)	Training Objectives B1	Training need	Classroom	CAI	VMT	Real helicopter	Comments
				Analyze and manage factors which affect identification of faulty and operational condition for Tail folding section		X		X	X	5
				Check leakage for Swivel manifold	I				R	
				Analyze and manage factors which affect detection of leakage on Swivel manifold		X			X	5
		Main rotor drive		Know location of Rotor brake, RAGB oil level, MGB oil cooler exhaust	I		R	R		2
				Understand function of Rotor brake, RAGB oil system, MGB oil cooler exhaust	I		R			3
				Check function of Rotor brake	I				R	
				Check locking of Rotor brake (if necessary)	I				R	
				Check RAGB oil level (add if necessary)	T			R	R	
				Analyze and manage factors which affect verification of RAGB oil level		X		X	X	5
				Check for no foreign objects in MGB oil cooler exhaust	T				R	
				Analyze and manage factors which affect detection of foreign objects in MGB oil cooler exhaust		X		X	X	5
		Tail rotor		Know location of TRH, Blades	I		R	R		2
				Understand function of TRH, Blades	I		R			3
				Identify faulty and operational condition for TRH, Blades	T			R	R	4
				Analyze and manage factors which affect identification of faulty and operational condition for TRH, Blades		X		X	X	5
		Tail rotor drive		Know location of TGB, IGB	I		R	R		2
				Understand function of TGB, IGB	I		R			3
				Check TGB, IGB oil level (add if necessary)	T			R	R	
				Analyze and manage factors which affect verification of TGB, IGB oil level		X		X	X	5
				Check TGB, IGB fairing fittings	T			R	R	
				Analyze and manage factors which affect verification of TGB, IGB fairing fittings		X		X	X	5
	Vehicle systems	Equipment/Furnishings		Know location of Cabin equipment, Rescue Hoist, Cockpit equipment, Avionic bay sand filter, Avionic Bay, Cabin Avionic Bay	I		R	R		2
				Understand function of Cabin equipment, Rescue Hoist, Cockpit equipment, Avionic bay sand filter, Avionic Bay, Cabin Avionic Bay	I		R			3
				Identify faulty and operational condition for Cabin equipment, Rescue Hoist, Cockpit equipment, Avionic bay sand filter, Avionic Bay, Cabin Avionic Bay	I				R	4
				Analyze and manage factors which affect identification of faulty and operational condition for Cabin equipment, Rescue Hoist, Cockpit equipment		X			X	5
				Identify faulty and operational condition for Rescue Hoist	T			R	R	4
				Analyze and manage factors which affect identification of faulty and operational condition for Rescue Hoist		X		X	X	5
				Check for no foreign objects in Avionic bay sand filters	I			R		
				Check lock of Seat safety belts	I			R		
				Check attachment of Cabin equipment	I			R		
				Check cleanliness of Cabin equipment	I			R		
		Fuel		Know location of EFT connectors, Cap gravity refueling, Cap pressure refueling, EFP	I		R	R		2
				Understand function of Fuel system	I		R			3
				Check leakage for EFT connectors	T				R	
				Check leakage for Cap gravity refueling, Cap pressure refueling	I				R	
				Check close and lock of Cap gravity refueling, Cap pressure refueling	I				R	
				Switch on EFP	I				R	
				Check EFP free water detection (drain if necessary)	I				R	
				Perform refueling	I				R	
		Fire protection		Know location of Cabin fire extinguisher, Hand fire extinguishers	I		R	R		2
				Understand function of Fire extinguishers	I		R			3
				Inspect data-plates on Cabin fire extinguisher, Hand fire extinguishers	I				R	
				Check attachment of Cabin fire extinguisher, Hand fire extinguishers	I				R	
				Check safety-pin on Cabin fire extinguisher, Hand fire extinguishers	I				R	
		Hydraulic power		Know location of Hydraulic lines, PCM	I		R	R		2

Maintenance task	Sub-task	AECMA 1000D (XX)	AECMA 1000D (XX-XX)	Training Objectives B1	Training need	Classroom	CAI	VMT	Real helicopter	Comments
				Understand function of Hydraulic system	I		R			3
				Check leakage for Hydraulic lines	I				R	
				Analyze and manage factors which affect detection of leakage on Hydraulic lines		X			X	5
				Check PCM oil level (add if necessary)	T			R	R	
				Analyze and manage factors which affect verification of PCM oil level		X		X	X	5
		Landing gear		Know location of Parking break, Wheel break oil level, Break system accumulator, Nose landing gear, Main landing gear, Safety-pins	I		R	R		2
				Understand function of Parking break system, Nose landing gear, Main landing gear, Safety-	I		R			3
				Check function of parking break	I				R	
				Check Wheel break oil level (add if necessary)	I				R	
				Check pressure indication for Brake system accumulator	T				R	
				Analyze and manage factors which affect check of pressure indication for Brake system accumulator		X		X	X	5
				Identify faulty and operational condition for Nose landing gear, Main landing gear, Tires	T			R	R	4
				Analyze and manage factors which affect identification of faulty and operational condition for Nose landing gear, Main landing gear		X		X	X	5
				Check oil leakage for Nose landing gear, Main landing gear	T				R	
				Analyze and manage factors which affect detection of leakage on Nose landing gear, Main landing gear		X		X	X	5
				Check inflation of Tires (inflate if necessary)	I				R	
				Insert/remove Safety-pins	I				R	
	Weapon systems	Missiles		Know location of Heavy Store Carrier installation points, Connectors	I		R	R		2
				Understand function of Heavy Store Carrier installation points, Connectors	I		R			3
				Identify faulty and operational condition for Heavy Store Carrier installation points, Connectors	T			R	R	4
		Surveillance		Know location of FLIR, IFF antenna	I		R	R		2
				Understand function of FLIR, IFF antenna	I		R			3
				Identify faulty and operational condition for FLIR, IFF antenna	I				R	4
				Check screen cleanliness for FLIR	I				R	
		Tactical electronic warfare		Know location of MLDSU, RSU, LSU, Dispenser, Magazines/Dummy	I		R	R		2
				Understand function of MLDSU, RSU, LSU, Dispenser, Magazines/Dummy	I		R			3
				Identify faulty and operational condition for MLDSU, RSU, LSU, Dispenser	I				R	4
				Analyze and manage factors which affect identification of faulty and operational condition for MLDSU on CFD structure, RSU on sponson, LSU		X			X	5
				Check cleanliness of MLDSU, RSU	I				R	
				Check attachment of Magazines/Dummy	I				R	
				Analyze and manage factors which affect verification of attachment for Magazines/ Dummy		X			X	5
				Check Dispenser safety-pin	I				R	
	Unspecified			Know location of Cockpit, Internal safety-pins	I		R	R		2
				Understand function of Cockpit, Internal safety-pins	I		R			3
				Identify faulty and operational condition for Cockpit	I				R	4
				Analyze and manage factors which affect identification of faulty and operational condition for Cockpit		X			X	5
				Check for no foreign objects in Cockpit	I				R	
				Check cleanliness of Cockpit	I				R	
				Insert/remove Internal safety-pins	I				R	
Safety inspection (see note 9)				Repetition of basic knowledge according to JAR-66	I	R				Only for experienced B1/B2 engineers
				Apply documented SI checklist	T			R	R	1
	Airframe	Fuselage		Know location of Oil cooler air intake, Air inlet	I		R	R		2, 9
				Check cleanliness of Oil cooler air intake	T				R	9
				Analyze and manage factors which affect check of cleanliness for Oil cooler air intake		X		X	X	5, 9
				Check for no foreign objects in Oil cooler air intake, Air inlet	T				R	9
				Analyze and manage factors which affect detection of foreign objects in Oil cooler air intake, Air inlet		X		X	X	5, 9

Maintenance task	Sub-task	AECMA 1000D (XX)	AECMA 1000D (XX-XX)	Training Objectives B1	Training need	Classroom	CAI	VMT	Real helicopter	Comments
				Identify faulty and operational condition for Air inlet	T			R	R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for Air inlet		X		X	X	5, 9
	Avionic systems	Electrical power		Know location of Electrical ground power unit, Electrical power system switches, relevant	I		R	R		2, 9
				Understand function of Electrical system	I		R			3, 9
				Connect/Disconnect Electrical ground power unit	I				R	9
				Switch on/off Electrical power system, Batteries	I				R	9
				Verify PBIT launch and completion	I				R	9
				Identify faulty and operational condition for relevant Electrical connectors and sensors, Alternator	T			R	R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for relevant Electrical connectors and sensors, Alternator		X		X	X	5, 9
				Check attachment of relevant Electrical connectors and sensors	I				R	9
				Analyze and manage factors which affect check of attachment for relevant Electrical connectors and sensors		X			X	5, 9
				Check cleanliness of Alternator	I				R	9
				Analyze and manage factors which affect check of cleanliness for Alternator		X			X	5, 9
		Environmental control		Know location of Heating modulation valve, ECS pack, ECS fan, Compressor, Servo control, Pipes and wiring	I		R	R		2, 9
				Understand function of Environmental control system	I		R			3, 9
				Identify faulty and operational condition for Compressor	I				R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for Compressor		X			X	5, 9
				Identify faulty and operational condition for Heating modulation valve, ECS pack, Servo control, Pipes and wiring	T			R	R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for		X		X	X	5, 9
				Check attachment of ECS fan	I				R	9
				Check leakage for ECS pack, Pipes and wiring	T				R	4, 9
				Analyze and manage factors which affect detection of leakage in ECS pack, , Pipes and		X		X	X	5, 9
		Indicating and recording system		Know location of Lamp test	I		R	R		2, 9
				Understand function of Lamp test	I		R			3, 9
				Perform lamp test of warning lamps	I			R		4, 9
				Analyze and manage factors which affect performing a lamp test of warning lamps		X			X	5, 9
		Lights		Know location of Cabin door lights, Cabin internal lights, Cockpit illumination, Hand lamps	I		R	R		2, 9
				Understand function of Cabin door lights, Cabin internal lights, Cockpit illumination, Hand	I		R			3, 9
				Check function of Anti-coll. Light, Cabin door lights, Cabin internal lights, Cockpit illumination, Day mode, Dimming function, Hand lamps, Formation lights, Hover light, Landing and search lights, Night mode, NVG mode, Position lights	I			R		9
	Engines	APU		Know location of APU, Pipes and wiring	I		R	R		2, 9
				Check cleanliness of APU	I				R	9
				Analyze and manage factors which affect of check cleanliness for APU		X			X	5, 9
				Check leakage of APU	I				R	9
				Analyze and manage factors which affect detection of leakage in APU		X			X	5, 9
				Check attachment of APU	I				R	9
				Analyze and manage factors which affect check of attachment for APU		X			X	5, 9
				Identify faulty and operational condition for Pipes and wiring	T			R	R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for Pipes and wiring		X		X	X	5, 9
				Check attachment of Pipes and wiring	T				R	9
				Analyze and manage factors which affect check of attachment for Pipes and wiring		X		X	X	5, 9
		Engine		Know location of Engines, Turbine blades, Compressor blades, Engine compartment, Engine line replaceable units, Pipes, Hoses, Wiring, Connectors, P3 valve	I		R	R		2, 9
				Understand function of Engine	I		R			3, 9
				Identify faulty and operational condition for Engines, Pipes, Hoses, Wiring	T			R	R	4, 9

Maintenance task	Sub-task	AECMA 1000D (XX)	AECMA 1000D (XX-XX)	Training Objectives B1	Training need	Classroom	CAI	VMT	Real helicopter	Comments
				Analyze and manage factors which affect identification of faulty and operational condition for Engines, Pipes, Hoses, Wiring		X		X	X	5, 9
				Check for damage on Turbine blades, Compressor blades	T			R	R	9
				Analyze and manage factors which affect detection of damage on Turbine blades, Compressor blades		X		X	X	5, 9
				Check cleanliness of Engine compartment and transmission deck	I				R	9
				Analyze and manage factors which affect check of cleanliness for Engine compartment and transmission deck		X			X	5, 9
				Inspect leakage, wears, scoring for Pipes, Hoses, Connectors	T			R	R	9
				Analyze and manage factors which affect detection of leakage, wears, scoring for Pipes, Hoses, Connectors		X		X	X	5, 9
				Identify faulty and operational condition for P3 valve	I				R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for P3 valve		X			X	5, 9
		Engine controls		Know location of FADEC, Electrical connectors	I		R	R		2, 9
				Understand function of FADEC	I		R			3, 9
				Check FADEC electrical connectors	I				R	9
				Analyze and manage factors which affect check of FADEC electrical connectors		X			X	5, 9
		Engine indicating		Know location of Thermo cables	I		R	R		2, 9
				Understand function of Thermo cables	I		R			3, 9
				Identify faulty and operational condition for Thermo cables	T			R	R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for Thermo cables		X		X	X	5, 9
		Exhaust		Identify faulty and operational condition for Exhaust nozzle	I				R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for Exhaust nozzle		X			X	5, 9
				Check fitting of Exhaust nozzle	I				R	9
		Oil		Know location of Clogging indication	I		R	R		2, 9
				Understand function of Clogging indication	I		R			3, 9
				Check no Clogging indication	I				R	4, 9
				Analyze and manage factors which affect check of Clogging indication		X			X	5, 9
		Power plant		Know location of Engine cowlings, Engine air intakes, Equipped rods and mounts	I		R	R		2, 9
				Check for damage on Engine air intakes	I				R	9
				Analyze and manage factors which affect detection of damage on Engine air intakes		X			X	5, 9
				Close/open Engine cowlings	I				R	9
				Identify faulty and operational condition for Equipped rods and mounts	I				R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for Equipped rods and mounts		X			X	5, 9
				Check attachment of relevant Equipped rods and mounts	I				R	9
				Analyze and manage factors which affect check of attachment for Equipped rods and mounts		X			X	5, 9
	General systems	Parking and mooring		Check operation of Locking systems	I				R	9
				Towing into hangar	T				R	9
				Analyze and manage factors which affect Towing into hangar		X		X	X	5, 9
	Transmissions	Main rotor	General	Know location of Dome fairing	I		R	R		2, 9
				Identify faulty and operational condition for Dome fairing	T			R	R	9
				Analyze and manage factors which affect detection of faulty and operational condition for Dome fairing		X		X	X	5, 9
				Check attachment of Dome fairing	T				R	9
				Analyze and manage factors which affect check of attachment for Dome fairing		X		X	X	5, 9
			Rotor heads	Know location of Main Rotor Hub, Spherical bearing external area, Upper flapping stop, Conical bearing elastomer, Drop retainer ring, Elastomers, Fittings, Laminated support bearing elastomer, Lead-lag damper	I		R	R		2, 9
				Identify faulty and operational condition for Conical bearing elastomer, Fittings, Laminated support bearing elastomer, Lead-lag damper, Main Rotor Hub, Spherical bearing external area, Upper flapping stop	T			R	R	4, 9

Maintenance task	Sub-task	AECMA 1000D (XX)	AECMA 1000D (XX-XX)	Training Objectives B1	Training need	Classroom	CAI	VMT	Real helicopter	Comments
				Analyze and manage factors which affect detection of faulty and operational condition for Conical bearing elastomer, Fittings, Laminated support bearing elastomer, Lead-lag damper, Main Rotor Hub, Spherical bearing external area, Upper flapping stop		X		X	X	5, 9
				Check attachment of Fittings, Main Rotor Hub	T				R	9
				Analyze and manage factors which affect check of attachment for Fittings, Main Rotor Hub		X		X	X	5, 9
				Check leakage for Main Rotor Hub	T				R	9
				Analyze and manage factors which affect detection of leakage for Main Rotor Hub		X		X	X	5, 9
				Check for grease on Drop retainer ring	T			R	R	9
				Analyze and manage factors which affect check for grease on Drop retainer ring		X		X	X	5, 9
				Check for cracks, rips on Elastomers	T			R	R	9
				Analyze and manage factors which affect detection of cracks, rips on Elastomers		X		X	X	5, 9
			Rotating controls	Know location of Swash-plate	I		R	R		2, 9
				Identify faulty and operational condition for Swash-plate	T			R	R	4, 9
				Analyze and manage factors which affect detection of faulty and operational condition for Swash-plate		X		X	X	5, 9
				Check attachment of Swash-plate	T			R	R	9
				Analyze and manage factors which affect check of attachment for Swash-plate		X		X	X	5, 9
				Check leakage for Swash-plate	T			R	R	9
				Analyze and manage factors which affect detection of leakage for Swash-plate		X		X	X	5, 9
		Main rotor drive	General	Know location of MGB, MGB compartment, MGB cowlings	I		R	R		2, 9
				Understand function of Main rotor drive system	I		R			3, 9
				Identify faulty and operational condition for MGB	T			R	R	9
				Analyze and manage factors which affect identification of faulty and operational condition for MGB		X		X	X	5, 9
				Check cleanliness of MGB compartment	I				R	9
				Analyze and manage factors which affect check of cleanliness for MGB compartment		X			X	5, 9
				Close/open MGB cowlings	I				R	9
			Engine gearbox couplings	Know location of Engine-to-MGB coupling, RAGB, RAGB LRUs, RAGB to MGB coupling	I		R	R		2, 9
				Identify faulty and operational condition for Engine-to-MGB coupling, RAGB LRUs, RAGB to MGB coupling	T			R	R	9
				Analyze and manage factors which affect identification of faulty and operational condition for Engine-to-MGB coupling, RAGB LRUs, RAGB to MGB coupling		X		X	X	5, 9
				Check attachment of Engine-to-MGB coupling, RAGB, RAGB LRUs	T				R	9
				Analyze and manage factors which affect check of attachment for Engine-to-MGB coupling, RAGB, RAGB LRUs		X		X	X	5, 9
				Check cleanliness of RAGB	I				R	9
				Analyze and manage factors which affect check of cleanliness for RAGB		X			X	5, 9
			Gearboxes	Know location of MGB oil cooling system, Oil cooler exhaust	I		R	R		2, 9
				Identify faulty and operational condition for MGB oil cooling system, Oil cooler exhaust	I				R	9
				Analyze and manage factors which affect identification of faulty and operational condition for MGB oil cooling system, Oil cooler exhaust		X			X	5, 9
				Check attachment of MGB oil cooling system	I				R	9
				Analyze and manage factors which affect check of attachment for MGB oil cooling system		X			X	5, 9
				Check leakage for MGB oil cooling system	I				R	9
				Analyze and manage factors which affect detection of leakage for MGB oil cooling system		X			X	5, 9
				Check MGB oil level (add if necessary)	T			R	R	9
				Analyze and manage factors which affect check of MGB oil level		X		X	X	5, 9
			Mounts and attachments	Know location of MGB attachment and suspension/SARIB Suspension System	I		R	R		2, 9
				Identify faulty and operational condition for MGB attachment and suspension/SARIB Suspension System	T			R	R	9
				Analyze and manage factors which affect identification of faulty and operational condition for MGB attachment and suspension/SARIB Suspension System		X		X	X	5, 9
				Check attachment of MGB attachment and suspension	I				R	9
				Analyze and manage factors which affect check of attachment for MGB attachment and suspension		X			X	5, 9

Maintenance task	Sub-task	AECMA 1000D (XX)	AECMA 1000D (XX-XX)	Training Objectives B1	Training need	Classroom	CAI	VMT	Real helicopter	Comments
			Indicating	Know location of MGB wear indicators	I		R	R		2, 9
				Identify faulty and operational condition for MGB wear indicators	I				R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for MGB wear indicators		X			X	5, 9
		Rotors flight control		Know location of Servo controls	I		R	R		2, 9
				Understand function of Servo controls	I		R			3, 9
				Identify faulty and operational condition for Servo controls	T			R	R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for Servo controls		X		X	X	5, 9
				Check attachment of Servo controls	T				R	9
				Analyze and manage factors which affect check of attachment for Servo controls		X		X	X	5, 9
				Check leakage for Servo controls	T				R	9
				Analyze and manage factors which affect detection of leakage for Servo controls		X		X	X	5, 9
		Tail rotor		Know location of Elastomers, Lead lag damper, Spherical bearing, Pitch rods	I		R	R		2, 9
				Understand function of Elastomers, Lead lag damper, Spherical bearing, Pitch rods	I		R			3, 9
				Identify faulty and operational condition for Elastomers, Lead lag damper, Pitch rods	T			R	R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for Elastomers, Lead lag damper, Pitch rods		X		X	X	5, 9
				Check for cracks in Spherical bearing	T			R	R	9
				Analyze and manage factors which affect detection of cracks in Spherical bearing		X		X	X	5, 9
		Tail rotor drive		Know location of Fairing tail rotor drive shaft area, IGB area, TGB fairing fitting, Tail rotor drive shaft area, TGB area, Pipes and wiring	I		R	R		2, 9
				Understand function of Tail rotor drive shaft	I		R			3, 9
				Identify faulty and operational condition for IGB area, Tail rotor drive shaft area including bearings, TGB area, Pipes and wiring	T			R	R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for IGB area, Tail rotor drive shaft area including bearings, TGB area, Pipes and wiring		X		X	X	5, 9
				Open/close Fairing tail rotor drive shaft area	I				R	9
				Check for no foreign objects in Tail rotor drive shaft area	T				R	9
				Analyze and manage factors which affect detection of foreign objects in Tail rotor drive shaft area		X		X	X	5, 9
	Vehicle systems	Equipment/Furnishings		Know location of Avionic Bay, Cabin Avionic Bay	I		R	R		2, 9
				Identify faulty and operational condition for Avionic Bay, Cabin Avionic Bay, Cockpit seats, Seat safety belts	I				R	4, 9
				Check lock of Seat safety belts	I				R	9
				Check attachment of Cabin equipment	I				R	9
				Check cleanliness of Cabin equipment	I				R	9
		Fire protection		Know location of Fire extinguishers, MGB compartments fire detectors	I		R	R		2, 9
				Understand function of fire protection system	I		R			3, 9
				Identify faulty and operational condition for Fire extinguishers, MGB compartments fire detectors	T			R	R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for Fire extinguishers, MGB compartments fire detectors		X		X	X	5, 9
				Check pressure for Fire extinguishers	T				R	9
				Analyze and manage factors which affect check of pressure for Fire extinguishers		X		X	X	5, 9
				Check attachment of Fire extinguishers	T				R	9
				Analyze and manage factors which affect check of attachment for Fire extinguishers		X		X	X	5, 9
		Fuel		Know location of Clogging indication	I		R	R		2, 9
				Understand function of Clogging indication	I		R			3, 9
				Check no Clogging indication	I				R	4, 9
				Analyze and manage factors which affect check of Clogging indication		X			X	5, 9
		Hydraulic power		Know location of Electrical hydraulic pump, Hydraulic pumps, Hoses, Hydraulic ground connection, Purge valve	I		R	R		2, 9
				Identify faulty and operational condition for Electrical hydraulic pump, Hydraulic pumps, Hoses, Hydraulic ground connection	T			R	R	4, 9

Maintenance task	Sub-task	AECMA 1000D (XX)	AECMA 1000D (XX-XX)	Training Objectives B1	Training need	Classroom	CAI	VMT	Real helicopter	Comments
				Analyze and manage factors which affect identification of faulty and operational condition for Electrical hydraulic pump, Hydraulic pumps, Hoses, Hydraulic ground connection		X		X	X	5, 9
				Check attachment of Electrical hydraulic pump, Hydraulic pumps, Hoses, Hydraulic ground connection point	T				R	9
				Analyze and manage factors which affect check of attachment for Electrical hydraulic pump, Hydraulic pumps, Hoses, Hydraulic ground connection point		X		X	X	5, 9
				Check leakage of Electrical hydraulic pump, Hydraulic pumps	T				R	9
				Analyze and manage factors which affect detection of leakage for Electrical hydraulic pump, Hydraulic pumps		X		X	X	5, 9
				Check locking of Purge valve	T				R	9
				Analyze and manage factors which affect detection of defective lock of Purge valve		X		X	X	5, 9
		Landing gear		Know location of Front wheel locking indication	I		R	R		2, 9
				Check function of Nose landing gear lock, Wheel brake	I				R	9
	Weapon systems	Surveillance		Identify faulty and operational condition for Dipping Funnel	I				R	4, 9
	Unspecified			Know location of Cockpit, Pipes, hoses, wiring	I		R	R		2, 9
				Understand function of Cockpit, Pipes, hoses, wiring	I		R			3, 9
				Identify faulty and operational condition for Cockpit, Pipes, hoses, wiring	I				R	4, 9
				Analyze and manage factors which affect identification of faulty and operational condition for Cockpit, Pipes, hoses, wiring		X			X	5, 9
				Check cleanliness of Cockpit	I				R	9
				Analyze and manage factors which affect check of cleanliness for Cockpit		X			X	5, 9
				Check for no foreign objects in Cockpit	I				R	9
				Analyze and manage factors which affect detection of foreign object in Cockpit		X			X	5, 9
				Check attachment of Pipes, hoses, wiring	I				R	9
				Analyze and manage factors which affect check of attachment for Pipes, hoses, wiring		X			X	5, 9
Role change	Add/remove equipment Calibrate and verify function			Know location of Radar, C2 console, Sonar, Counter Measures, FLIR, LLTV, Rescue hoist, Sling load, Fast rope, Repelling	I		R	R		2
				Understand function of Radar, C2 console, Sonar, Counter Measures, FLIR, LLTV, Rescue hoist, Sling load, Fast rope, Repelling	I		R			3
				Apply documented procedure for installation/removal of Radar, C2 console, Sonar, FLIR, LLTV, Rescue hoist, Sling load, Fast rope, Repelling	I				R	
				Apply documented procedure for installation/removal of Counter measures	T			R	R	
Mission preparation				Know location of Sonar, Counter Measures, Gun, Missiles, Torpedoes, ESUS, Smokes	I		R	R		2
				Understand function of Sonar, Counter Measures, Gun, Missiles, Torpedoes, ESUS, Smokes	I		R			3
				Apply documented procedure for installation of Sonar, Counter Measures, Gun, Missiles, Torpedoes, ESUS, Smokes	I				R	
				Apply documented procedure for installation/removal of Counter measures	T			R	R	
Service, clean,	Clean			Understand task relevance	I		R			Replenishment implemented in BFF, Tar, ALF
and minor	Perform adjustment			Apply documented procedure	I				R	
Minor incorporation of	Incorporate modification			Understand task relevance						Not applicable for TNA. Future modifications of NH90
				Apply documented procedure						
Fault isolation B1				Repetition of basic knowledge according to JAR-66	I	R				Only for experienced B1 engineers
				Demonstrate extensive system understanding of mechanical and electrical subsystems and their interactions	T				R	6
				Apply documentation for fault isolation	T			R	R	7
				Apply fault isolation methodology for mechanical and electrical systems based on system understanding	T			R	R	8
				Apply BIT procedure	T		R	R	R	7, Experienced B1 engineers lack necessary computer
				Apply repair procedures for mechanical and electrical faults	T			R	R	1
Fault isolation B2				Repetition of basic knowledge according to JAR-66	I	R				Only for experienced B2 engineers
				Demonstrate extensive system understanding of integrated avionics system	T				R	6, Experienced B2 engineers lack necessary computer
				Apply documentation for fault isolation	T			R	R	7, Experienced B2 engineers lack necessary computer
				Apply fault isolation methodology for integrated avionics system based on system understanding	T			R	R	8, Experienced B2 engineers lack necessary computer experience.

Maintenance task	Sub-task	AECMA 1000D (XX)	AECMA 1000D (XX-XX)	Training Objectives B1	Training need	Classroom	CAI	VMT	Real helicopter	Comments
				Apply test systems such as BIT, GLIMS/MDS, bus test, etc.	T		R	R	R	7, Experienced B2 engineers lack necessary computer
				Apply repair procedures for mechanical and electrical faults	T			R	R	1
Replacement of LRU Spare parts				Know location of LRUs, spare parts	I		R	R		2
				Understand function of LRUs, spare parts	I		R			3
				Apply replacement procedures for LRUs, spare parts	T			R	R	
Preservation of complete helicopter	Preserve/depreserve engine and other systems			Know appropriate coating	I		R			2
				Know environmental protection	I		R			2
				Understand function of Preservation	I		R			3
				Apply documented procedure	O			R	R	1
150 fh inspection, 300 fh inspection, 600 fh inspection										Not available
Minor & moderate structural repairs	Perform repair			Know Structural design, Design loads and load paths, Material and processes, Classification of areas and major components, System recovery and associated practices	I		R			2
				Apply repair procedures and techniques	O			R	R	1
				Perform repair certification	T			R	R	
Minor aircraft battle damage repair	Perform repair			Know Structural design, Design loads and load paths, Material and processes, Classification of areas and major components, System recovery and associated practices	I		R			2
				Apply assessment procedures	I				R	1
				Apply repair procedures and techniques	I				R	1
				Perform materials and equipment repair, Temporary repairs, Field/Shop repairs	T			R	R	1
				Perform repair certification	T			R	R	

Notes

1) Should have required mechanical skill to automatically and effortlessly
2) Should have conceptual knowledge according to required standard. VMT
3) Should fully comprehend the effects on helicopter performance and safety
4) Should have appropriate perceptual, judgment, and risk assessment skill.
5) Should be able to determine nature, relationships, critical issues, and
6) Should be able to reason clearly with conceptual knowledge when
7) Should be able to find, use, interpret, and draw conclusions from relevant
8) Should have conceptual knowledge of, comprehend, and exercise
9) Additional Training Objectives to Daily inspections. Only SI for NFH includec

Legend

I, Initial training
T, Train
O, Overtrain
R, Recommended (When serveral training media are recommended they complement each other)
X, Alternative training media that is strictly not required, but which will enhance and improve training results