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Swiss Transportation Safety Investigation Board STSB

Study No 3
by the Swiss Transportation Safety Investigation Board STSB

into the organisation and effectiveness of the civil aviation search and rescue (SAR) service in Switzerland

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General information about this study

This study by the Swiss Transportation Safety Investigation Board (STSB) includes the results from various investigations of accidents and serious incidents as well as other search and rescue investigations.

According to Article 3.1 of the 10th edition of Annex 13, valid since 18 November 2010, to the Convention on International Civil Aviation of 7 December 1944 and Article 24 of the Federal Act on Civil Aviation, the sole purpose of investigating an aviation accident or serious incident is to prevent such accidents or serious incidents from occurring. The legal assessment of the circumstances and causes of aviation accidents and serious incidents is explicitly not the subject of an investigation. It is therefore not the purpose of this study to establish fault or liability issues.

Should this study be used for purposes other than those of accident prevention, this statement should be given due consideration.

Unless indicated otherwise, all other information relates to the time of the accident or serious incident. Any general statements made about the issues discussed in this study are applicable as of 31 December 2015.

Unless otherwise stated, all times mentioned in this study are given in the applicable local time (LT) for Switzerland.

Contents

A Presentation of the study

A.1 Background

In recent years, there have been several accidents involving general civil aviation aircraft in which the aircraft and its occupants were found and recovered only after considerable delay. In several cases, the safety investigations into these accidents found that the organisations involved in the search and rescue (SAR) service were not able to provide a rapid search and rescue. It was also apparent that even many civil aviation stakeholders had insufficient knowledge of SAR and its particular requirements.

For this reason, the Swiss Safety Transportation Investigation Board (STSB) decided to conduct a comprehensive study into this issue in cooperation with the stakeholders involved.

A.2 Objectives of the survey

This study by the STSB, which is aimed at both experts and the general public, is intended to:

- provide a comprehensive overview of the standards and fundamental issues involved in SAR;
- explain the structure and organisation as well as the working methods of SAR in general terms and illustrate them with concrete examples;
- provide a factual and neutral analysis of the effectiveness of SAR;
- identify opportunities for both providers and beneficiaries to improve the effectiveness of SAR.

A.3 Structure

The study comprises three main parts:

Section B: Facts and figures

The following aspects are described:

- international and national specifications and guidelines for the establishment and operation of a search and rescue service for civil aviation;
- how these requirements and guidelines are implemented in Switzerland with detailed information on the organisations involved;
- selected data on the quantitative assessment of SAR;
- selected exemplary cases from recent years to clearly illustrate SAR's working methods and to provide a basis for analysis;
- possibilities and preparatory measures to speed up the initiation and execution of a search and rescue operation in an emergency.

Section C: Analysis

The analysis focuses on the organisation and efficiency of the search and rescue service in Switzerland. It shows how individuals and organizations involved in SAR can contribute to improving its effectiveness.

Readers who are in a hurry may like to start at Section C and then refer back to the points in Section B that are of particular interest.

Section D: Safety recommendations and safety advice

Specific safety recommendations and safety advice are addressed both to individuals and to the SAR organisation as a whole.

The study is complemented by an appendix with detailed additional information and a list of abbreviations and sources.

B Facts and figures

B.1 Specifications and guidelines

B.1.1 Background

On 7 December 1944, 52 States, including Switzerland, signed the Convention on International Civil Aviation, known as the Chicago Convention (hereinafter "Convention"). This created the framework for international aviation law and also established the International Civil Aviation Organization (ICAO) as a specialised agency of the United Nations organization (UN). The purpose of the Convention is to standardise the infrastructure and rules of air traffic at the international level. A total of 19 annexes containing binding international standards and recommended practices form an integral part of the Convention. The signatory states undertake to implement binding standards on their territory to the greatest extent possible; each state has the right to diverge from individual points but must notify ICAO of any divergences. To date, some 190 states have ratified the Convention.

Annex 12 of the Convention regulates the search and rescue (SAR) service (cf. Section B.1.2). Further aspects directly related to SAR can be found in Annexes 6 and 10, which contain specifications and recommended practices for the equipment of aircraft with emergency locator transmitters (ELTs) and their technical design (cf. Section B.1.3).

The ICAO specifications and guidelines are implemented in conjunction with domestic specifications and guidelines within Switzerland (cf. Section B.1.4).

B.1.2 ICAO Annex 12 – Search and Rescue

B.1.2.1 General

Annex 12 sets out the establishment and operation of a search and rescue (SAR) service within the contracting states' territories (hereinafter "Contracting States") and over the high seas, as well as the coordination of such services. It was first enacted in 1950 and has been revised and adapted several times since.

This annex is supplemented by a three-volume manual, the International Aeronautical and Maritime Search and Rescue (IAMSAR). It is intended to assist contracting states in establishing and operating their SAR services in accordance with ICAO requirements (cf. Section B.1.2.9).

Additional documents are issued by ICAO at the regional level (cf. Section B.1.2.10).

B.1.2.2 Organisation

Chapter 2 of the Annex requires the contracting states to address the following key points regarding the organisation of SAR services:

- Establishment and prompt provision of SAR services to persons in distress in aircraft related emergencies. The service can be provided individually or in cooperation with other contracting states and must be provided on a 24-hour basis.
- Basic elements of SAR services must include a legal framework, a responsible authority, organised available resources, communication facilities and a workforce skilled in coordination and operational functions.
- The SAR services must establish processes to improve service provision, including the aspects of planning, domestic and international cooperative arrangements and training.

They should undertake to do the following, as a minimum:

- Establish search and rescue regions (SRRs). A SRR may cover the territory of several contracting states and is determined on the basis of technical and operational considerations and is not necessarily related to the delineation of boundaries between States. Different SRRs must not overlap and neighbouring regions must be contiguous. It is recommended that SRRs should be coincident with flight information regions (FIRs) as far as practicable.
- Establish a rescue coordination centre (RCC) within each SRR. The RCC must be staffed 24 hours a day by trained personnel proficient in the use of the language used for radiotelephony communications.
- Ensure that each RCC has a means of rapid and reliable two-way communication with:
  - associated air traffic services units;
  - appropriate direction-finding and position-fixing stations;
  - neighbouring RCCs;
  - a designated meteorological office;
  - search and rescue units (SRUs);
  - alerting posts;
  - the COSPAS-SARSAT Mission Control Centre (MCC) servicing the SAR.[1]
- Designate search and rescue units (SRUs). These may be public or private service providers that are suitably located and appropriately equipped for search and rescue operations. The minimum requirements for the SRU for a particular SRR are set out in additional documents drawn up on a regional basis (cf. Section B.1.2.10).
- Designate other private or public services that are not suitable as an SRU but can nevertheless be involved in a search and rescue operation.
- Provide the SRU with the means for locating promptly, and for providing adequate assistance at the scene of an accident.
- Ensure that all search and rescue aircraft are equipped with a device for homing on international distress frequencies for efficient deployment in search and rescue operations.
- It is recommended that at least one of the aircraft participating in a search and rescue operation should carry droppable survival equipment. A further recommendation is for suitably packed survival equipment to be kept at appropriate aerodromes.

B.1.2.3 Cooperation and Coordination

Chapter 3 of the Annex deals with aspects of cooperation and coordination between neighbouring contracting states:

[1] The COSPAS-SARSAT system is an internationally supported project for the operation of satellites that can receive and decode 406 MHz signals from ELTs and similar systems (cf. Section B.2.4.7). It is thus possible to determine the position of the transmitter with a speed and accuracy that depends on the technical design of the transmitter and the current constellation of the satellites. The coordinates found are decoded by the MCC responsible for the area concerned and subsequently forwarded to the RCC responsible or the designated contact point servicing the SRR.

- Contracting states shall coordinate their SAR organisations with those of neighbouring states. It is recommended that they should develop common search and rescue plans and procedures to facilitate the coordination of search and rescue operations.
- Subject to conditions as may be prescribed by its own authorities, each contracting state must allow the SRU of other states immediate entry into its territory for the purpose of a search and rescue operations in connection with an aircraft accident.
- Each contracting state must publish and disseminate information necessary for this purpose.
- The authorities of a contracting state who wish their SRUs to enter the territory of another contracting state for SAR purposes must make a request to the RCC of the country concerned or to such other designated authority for this purpose. These authorities must immediately acknowledge the receipt of the request and, as soon as possible, indicate the conditions under which the projected mission may be undertaken.
- It is recommended that contracting states make arrangements with neighbouring states to enhance cooperation and coordination of their SRUs in the event of cross-border engagement so as to facilitate border crossings by minimising the formalities required. It is further recommended that the contracting states should authorise their RCCs to provide all the assistance necessary in this regard.
- It is recommended that the contracting states conduct joint exercises involving their SRUs and those of other states in order to promote search and rescue efficiency.
- Furthermore, they should make arrangements for periodic liaison visits by RCC personnel to the centres of neighbouring states.

The Convention also sets out aspects of cooperation and coordination with other possible services within a contracting state:

- Contracting states must make arrangements for all aircraft and local services that do not form part of the SAR organisation to cooperate fully with the latter in search and rescue and to extend any possible assistance to the survivors of aircraft accidents.
- Contracting states must ensure that their SAR services cooperate with the accident investigation authorities and with those responsible for the care of the victims. It is recommended that rescue teams be accompanied by persons from the accident investigation authority whenever practicable.
- Contracting states must designate a SAR point of contact (SPOC) for the receipt of COSPAS-SARSAT distress data.

B.1.2.4 Preparatory measures

Chapter 4 of the Annex describes the necessary preparatory measures:

- Each RCC must have readily available at all times up-to-date information on SRUs, air traffic services units, means of communication, addresses and telephone numbers of the operators involved and any other resources that are likely to be useful in search and rescue.
- It is recommended that each RCC should also have readily available any other information that might be useful in a search and rescue operation, as set out in detail in the Annex.

- Each RCC must prepare detailed plans of operations for the conduct of search and rescue in its SRR. It is recommended that these plans should be drawn up jointly with the representatives of the services that support or could benefit from SAR.
- To the extent possible, the plans must specify the facilities for servicing and refuelling of aircraft and vehicles involved in SAR, including those made available by other states.
- They must also include details of the actions to be taken by the persons engaged in SAR, in particular in relation to:
  - the manner in which search and rescue operations are to be conducted;
  - the use of available communication systems and facilities;
  - the actions to be taken jointly with other RCCs;
  - the methods of alerting en-route aircraft;
  - the duties and prerogatives of persons assigned to SAR;
  - the possible redeployment of equipment that may be necessary due to meteorological or other conditions;
  - the methods for obtaining essential information relevant to search and rescue operations, such as weather reports, weather forecasts, NOTAMs, etc;
  - the methods for obtaining assistance from other RCCs;
  - the methods for assisting SAR or other aircraft to proceed to aircraft in distress;
  - cooperative actions to be taken in conjunction with air traffic services units and other authorities to assist aircraft that have been, or are believed to be, victims of hijacking.
- The recommendation is to integrate the plans with airport emergency plans in order to provide for rescue services in the vicinity of aerodromes.
- Each SRU must be aware of all parts of these plans that are necessary for the effective conduct of its duties and must keep the RCC informed of its preparedness.
- Contracting states are required to maintain in readiness the required number of facilities and adequate supplies and materials required for SAR.
- Contracting states must also provide for regular training to ensure the maximum efficiency of their SAR operations.
- It is recommended that wrecks be removed after the accident investigation has been completed if these wrecks could pose a danger or a possible risk of confusion for subsequent search and rescue operations.

B.1.2.5 Operating Procedures

Finally, Chapter 5 describes in detail the procedures for a search and rescue operation:

- If there is reason to believe that an aircraft is in an emergency, the RCC concerned must be informed immediately. The RCC must immediately evaluate all available information and assess the extent of the operation required. If the RCC is not alerted via an air traffic service unit, it must determine to which

emergency phase[2] the situation corresponds and then apply the applicable procedures.

- Upon the occurrence of an uncertainty phase (INCERFA), the RCC must make every effort to cooperate with air traffic services units and other appropriate agencies in order that incoming reports may be speedily evaluated.
- Upon the occurrence of an alert phase (ALERFA), the RCC must immediately alert SRUs and initiate any necessary action.
- Upon the occurrence of a distress phase (DETRESFA), the RCC should take the following actions, in this order, unless circumstances dictate otherwise:
  - immediately initiate action by SRUs in accordance with the appropriate plan of operation;
  - ascertain the position of the aircraft and estimate the degree of uncertainty of this position; then determine the search area based on this information and the circumstances;
  - notify the operator and, where possible, keep them informed of developments;
  - notify other RCCs whose help may be required or which may be involved in the operation;
  - notify the associated air traffic services unit if the information on the emergency has been received from another source;
  - request at an early stage assistance from other aircraft or other services in helping the aircraft in distress, for example maintaining a listening watch for transmissions from the aircraft or an ELT, or informing the RCC of any developments;
  - from the information available, draw up a detailed plan of action for carrying out the SAR operation and communicate it to the authorities responsible;
  - amend this plan of action as necessary in the light of evolving circumstances;
  - notify the appropriate accident investigation authorities;
  - notify the State of Registry of the aircraft.
- In the case of an aircraft whose position is unknown and which may be in one of two or more SRRs, the following action must be taken:
  - an RCC which is notified of an emergency phase and is unaware of other RCCs taking appropriate action initiates the action described above and confers with neighbouring RCCs with the aim of designating one RCC to coordinate the action. Various criteria determine which of the RCCs concerned assumes the coordination activities;
  - after declaration of the distress phase (DETRESFA), the RCC responsible for coordination informs all other RCCs that may become involved in the operation of all the circumstances and developments. Likewise, all RCCs

[2] There are three emergency phases (cf. Annex 2):

Uncertainty phase:	There is uncertainty about the safety of an aircraft and its occupants.
Alert phase:	There is apprehension about the safety of an aircraft and its occupants.
Distress phase:	There is reasonable certainty that an aircraft and its occupants are in grave and imminent danger.

that become aware of information related to the emergency must forward it to the coordinating RCC.

- Whenever applicable, the RCC must forward information about the SAR action initiated to the air traffic services unit in the flight information region in which the aircraft is operating so that this information can be passed on to the aircraft crew.
- The authorities immediately directing an operation or any part of an operation must give instructions to the units under their direction and inform the RCC of these instructions and of any developments in the operation.

B.1.2.6 Duration of a SAR operation

Chapter 5 also contains details of the duration of a SAR operation:

- Search and rescue operations must continue, when practicable, until all survivors have been moved to a safe location or until all reasonable hope of rescuing survivors has passed.
- Normally, the responsible RCC decides when to discontinue an operation.
- When a search and rescue operation has been successful or when an RCC considers or is informed that an emergency no longer exists, the emergency phase is cancelled and the search and rescue operation terminated, and all authorities, facilities and services involved are promptly informed.
- If a search and rescue operation becomes impracticable and the RCC concludes that there may still be survivors, operations on the ground are temporarily suspended and all necessary agencies are informed immediately. Relevant information subsequently received is to be evaluated and the search and rescue operation resumed if it appears justified and feasible.

B.1.2.7 Procedures at the scene of an accident and for pilots-in-command

Regarding procedures at the scene of the accident and for pilots-in-command (PICs), Chapter 5 states:

- When multiple units are engaged in SAR operations on-scene, the RCC designates one or more units on-scene to coordinate the actions to help ensure the safety and effectiveness of the operations.
- When a PIC observes that another aircraft is in distress, they must, if possible and not deemed unnecessary:
  - keep the aircraft in distress in sight until compelled to leave the scene or advised by the RCC that observation of the aircraft is no longer necessary;
  - determine the position of the aircraft;
  - report as much detailed information as possible about the aircraft to the RCC or air traffic services unit; this information is listed in detail;
  - act as instructed by the RCC or the air traffic services unit.
- If the first aircraft to reach the scene of an accident is not a SAR aircraft, it must take charge of on-scene activities of all other aircraft until the first SAR aircraft reaches the scene of the accident.
- Furthermore, possible forms of communication between aircraft and survivors or ground-based rescue teams are described in detail.
- When a PIC receives a distress call from another aircraft, they must, if feasible:

- acknowledge the distress transmission;
- record the position of the aircraft in distress, if given;
- take a bearing on the transmission;
- inform the appropriate RCC or air traffic services unit of the distress transmission, giving all available information; and
- at the pilot's discretion, while awaiting instructions, proceed to the position given in the transmission.

B.1.2.8 Records

Recommendations on the records to be kept are also made in Chapter 5:

- Each RCC should keep a record of the operational efficiency of the SAR in their SRR.
- Each RCC should prepare appraisals of actual search and rescue operations in its SRR. These should contain any pertinent remarks on the procedures and equipment used and any suggestions for improving these procedures or the equipment. The appraisals should be submitted to ICAO for dissemination to other states.

B.1.2.9 Manual

In addition to the Annex there is a comprehensive three-volume manual, the IAMSAR Manual, jointly published by ICAO and the International Maritime Organization (IMO). The purpose of the manual is to assist contracting states in establishing and conducting SAR in accordance with their needs and the requirements of the Annex. Contracting states are encouraged to use the manual in order to develop and improve their SAR organisation and to cooperate with neighbouring countries.

Volume I of the manual *(Organisation and Management*) deals with the organisational and management aspects of SAR. It explains in detail the global concept of SAR as well as the necessary establishment of regional and national SAR systems and their mutual cooperation to enable efficient and economical SAR operations. Emphasis is also placed on the necessary personnel and on their training.

Volume II *(Mission Coordination*) is aimed at persons who plan and coordinate SAR missions and organise SAR exercises. Considerable emphasis is placed on describing possible strategies for searching for missing aircraft, ranging from techniques for determining possible positions to concrete search procedures by aircraft: *"Searching is the most expensive, risky, and complex aspect of the SAR system. Often, it is also the only way survivors may be located and assisted. Before a search is undertaken and at frequent intervals during its progress, all information received must be carefully analysed and evaluated. The primary concerns are ensuring all clues about the survivors' probable status and location are properly evaluated, and ensuring the safety of the search facilities and their crews."* In the Volume II appendix, extensive information, forms, checklists, procedures and tables are included for daily use in the RCC.

Volume III *(Mobile Facilities*) is intended to be carried on board aircraft conducting SAR operations. It is designed to assist crews in search and rescue or in a coordinating function at the scene of an accident. It has a number of appendices containing specific information, instructions and procedures.

B.1.2.10 Additional documents for Switzerland

Some more detailed ICAO specifications and guidelines are developed by subgroups of contracting states in order to address regional issues. These subgroups

are formed on a regional basis; Switzerland is a member of the Europe subgroup (EUR).

Regional Supplementary Procedures (SUPPSs) and Air Navigation Plans (ANPs) are issued for each subgroup region. The latter are further subdivided into Basic Air Navigation Plans (BANP) and Facilities and Services Implementation Documents (FASID).

With respect to SAR, the documents for EUR include the following points:

- SAR operations should be based as far as possible on existing services and infrastructures, even if these are not primarily intended for search and rescue purposes. A reasonable cost-benefit ratio should be maintained in keeping these services and infrastructures on the necessary alert.
- Agreements should be entered into with state services that could potentially be of use in a SAR operation so that these can be rapidly deployed on an ad hoc basis.
- Agreements should also be made with neighbouring states to facilitate and accelerate cooperation in border areas. Appropriately designed international exercises should be organised regularly to train SAR teams in coordination and procedures.
- SAR facilities should be located so that they can be activated with the least possible delay. Aircraft used in search operations may be used on a redeployment basis (i.e., after appropriate refitting).
- Whenever possible, there should be additional facilities over and above the minimum requirements (see below).

Furthermore, the minimum requirements for SRUs within each SRR in EUR are specified. An overview for Switzerland is shown in the following table:

Name of RCC	Location of each rescue unit	Minimum requirements			SPOC	Remarks
		Aircraft	Marine craft	Land rescue units		
1	2	3	4	5	6	7
SWITZERLAND						
ZURICH RCC	Zurich			MRU		* Aircraft/helicopters equipped with homer-antenna for ELT
	Bern	MRG*				
	Genève	HEL-L*				
	Bern	HEL-L*				
	Basel	HEL-M*				
	Erstfeld	HEL-L				
	Genève	HEL-L*				
	Interlaken	HEL-L*				
	Lausanne	HEL-L				
	Locarno	HEL-H*				
	Mollis	HEL-M				
	Samedan	HEL-L				
	Sion	HEL-L*				
	St. Gallen	HEL-L				
	Zermatt	HEL-L				
	Zürich	HEL-L				

Figure 1: Minimum requirements for SRUs for Switzerland in accordance with EUR ANP FASID, as of January 2015. The abbreviations are as follows:

MRU: mountain rescue unit
MRG: medium range; aircraft with action radius of 400 NM plus 2.5 h search time
HEL-L: light helicopter; action radius of up to 100 NM with the possibility of evacuating 1 to 5 persons.
HEL-M: medium-weight helicopter; action radius of 100 to 200 NM with the possibility of evacuating 6 to 15 persons.
HEL-H: heavy helicopter; action radius of up to 200 NM with the possibility of evacuating 15 to persons.

B.1.3 ICAO Annexes 6 and 10 – ELTs

B.1.3.1 General

Annex 6, comprising three volumes, describes the operation of aircraft. Among other things, it deals with the requirements for equipping aircraft with ELTs. Details of the technical design of ELTs can be found in Annex 10, which describes aeronautical telecommunications equipment and comprises five volumes.

B.1.3.2 Equipment

With regard to the equipping of aeroplanes with ELTs in international commercial air transport, Annex 6 states:

- It is recommended that all aeroplanes should carry an automatic ELT.
- All aeroplanes authorised to carry more than 19 passengers must be equipped with at least one automatic ELT or two ELTs of any type; aeroplanes for which the individual certificate of airworthiness is first issued after 1 July 2008 must be equipped with at least two ELTs, one of which must be automatic.
- All aeroplanes authorised to carry 19 passengers or fewer must be equipped with at least one ELT of any type; aeroplanes first issued with a certificate of airworthiness after 1 July 2008 must carry at least one automatic ELT.

With regard to the equipping of helicopters with ELTs in international operations, Annex 6 states:

- All helicopters must be equipped with at least one automatic ELT.

With regard to the equipping of aeroplanes with ELTs in international general aviation, Annex 6 states:

- It is recommended that all aeroplanes be equipped with an automatic ELT.
- All aeroplanes must be equipped with at least one ELT of any type; aeroplanes first issued with a certificate of airworthiness after 1 July 2008 must carry at least one automatic ELT.

Regarding the number, selection and installation of ELTs, for all of the above categories it is stated:

- The judicious choice of the number of ELTs, their type and placement on aircraft, will ensure the greatest chance of ELT activation in the event of an accident.

B.1.3.3 Technical specifications

With regard to the technical specifications of ELTs in aircraft, Annex 10 states:

- From 1 January 2005, ELTs must transmit simultaneously on 406 MHz and 121.5 MHz.
- The technical specifications for transmitting on 121.5 MHz are described in detail and include the minimum transmitted power and the signal indicator for a given frequency.
- The technical specifications for transmitting on 406 MHz are described in detail and include the transmitted power as well as the encoding of an individual identifier which can be received and transmitted by the COSPAS-SARSAT system.
- Contracting states should draw up a register of 406 MHz ELTs. The information this contains must be immediately accessible to SAR authorities in case of emergency. The information to be contained in the register is listed in

detail and includes, but is not limited to, ELT identification, contact details of the owner and operator of the aircraft, aircraft type and manufacturer, and the colour of the aircraft. Further information may be provided where appropriate.

B.1.4 National specifications and guidelines

B.1.4.1 General

The ICAO specifications and guidelines in Switzerland are implemented in national laws, ordinances and guidelines. SAR-related documents are the Civil Aviation Act (AviA), the Ordinance on the Civil Aviation Search and Rescue Service (SRSO) and the Ordinance on the Organisation and Use of the Civil Aviation Search and Rescue Service (OUSRSO).

European Union (EU) requirements apply with regard to the equipment carried on aircraft. In addition, various documents are published by the Federal Office of Civil Aviation (FOCA).

B.1.4.2 Federal Act on Aviation

The AviA enacted by the Federal Assembly includes the following points:

- Article 3 states that the Federal Council is responsible for the supervision of aviation throughout the territory of Switzerland. Immediate oversight is conducted by the FOCA.
- Article 3b states that the FOCA may conclude agreements on administrative or technical cooperation with foreign aviation authorities or international institutions, in particular with regard to search and rescue.
- Article 4 accords the FOCA the possibility to transfer individual areas of supervision or powers to suitable organisations or individuals under certain conditions.
- Article 6a states that the Federal Council may, in exceptional circumstances, declare individual annexes to the Chicago Convention, including the associated technical regulations, to be directly applicable.
- Article 22 states that the FOCA may issue regulations on the organisation of rescue and recovery services in the event of air accidents.

B.1.4.3 Ordinance on the Civil Aviation Search and Rescue Service SRSO

The SRSO is based on Articles 3, 4 and 7 of the AviA and was enacted by the Federal Council. It essentially contains the following points:

- Search and rescue activities for Swiss civil and foreign civil and military aircraft are carried out by the Civil Aviation Search and Rescue Service (SAR); in the case of search and rescue activities for Swiss military aircraft, the Air Force may call on the assistance of the SAR organisation.
- The FOCA is responsible for regulating SAR; it may delegate SAR to suitable organisations.
- Third parties may be called upon to carry out SAR operations.
- SAR cooperation with similar services abroad is governed by existing intergovernmental agreements.
- It is stated that the competent services should, as far as possible, facilitate the entry and stay of foreign persons participating in a SAR operation. Similarly,

there should be few or no barriers to goods and materials for SAR operations crossing the border.

- The FOCA regulates air traffic in areas where SAR operations are taking place and may restrict it if necessary.
- The costs of a SAR operation are borne by the FOCA and as a rule are subsequently reclaimed from the owner or third parties who have caused the costs.

B.1.4.4 Ordinance on the Organisation and Use of the Civil Aviation Search and Rescue Service (OUSRSO)

The OUSRSO is based on Article 22 of the AviA and on the SRSO. It was issued by the FOCA and includes the following points:

- The territories of Switzerland and the Principality of Liechtenstein form a single search and rescue region (SRR), the boundaries of which coincide with the respective national borders.
- Swiss Air-Rescue (Rega) acts as the Swiss SAR regional control centre. Search operations are conducted by the Air Force. Details are contractually agreed.
- Air traffic services units, aerodrome managers and other air policing bodies are required to inform the control centre by the quickest possible means should an aircraft lose contact with air traffic control or be overdue.
- It is stated which bodies the RCC should inform when a search operation is launched. As appropriate, the RCC should also inform RCCs in neighbouring countries and request their assistance if necessary.
- The RCC should attempt to obtain as much information about the aircraft as possible, determine the flight path and narrow down the search area.
- Air traffic services units should attempt to contact the aircraft and locate its position in the air or on the ground.
- The RCC may deploy aircraft to search the areas where the missing aircraft is believed to have crashed or made an emergency landing; the crews of these aircraft should attempt to establish radio communication with the aircraft or pick up its transmissions, if appropriate equipment is available.
- The RCC may appeal to the public to report observations that might assist in locating the aircraft.
- In spatially restricted search areas, searches may be launched by search groups on the ground.
- First aid is usually provided by the local authorities and, if necessary, supplemented by additional assistance from the RCC; in areas that are difficult to access, the RCC may order rescue measures by ground or air services.
- The contents and labelling of parcels dropped for the survivors are described in detail.
- The rescue teams should ensure that, apart from the necessary rescue and recovery work, no alterations are made to the accident site that could complicate the accident investigation; furthermore, all necessary measures should be taken to prevent the outbreak of a fire.
- Communication between ground and air services takes place by means of optical signs; these are explained in detail.

B.1.4.5 FOCA documents relating to ELTs

In January 2011, the FOCA published service bulletin 20.140-01 'Requirement to be equipped with emergency transmitter ELT 406 MHz'. This guideline is based in part on the requirements of ICAO Annex 6, EU requirements and national regulations. It includes the following points:

- In accordance with ICAO Annexes 6 and 10, only the frequencies 121.5 MHz and 406 MHz are used for ELT.
- As of 1 February 2009, COSPAT-SARSAT and any future satellite systems no longer process signals on 121.5 MHz and 243 MHz and therefore neither trigger alerts nor carry out localisations. Non-satellite alerting and tracking are still possible.
- For aircraft in commercial use, the specifications regarding equipping aircraft with ELT are the same as those in ICAO Annex 6 (cf. Section B.1.3.2).
- For aircraft in non-commercial use whose certificate of airworthiness was first issued before the service bulletin came into force, at least one ELT of any type must be installed by 8 April 2012; for aircraft whose certificate of airworthiness was first issued after the service bulletin came into force, at least one automatic ELT is required. The following are not subject to these requirements:
  - Gliders (including self-launching gliders);
  - Balloons;
  - Homebuilt aircraft;
  - Aircraft in the 'historic' category.

  Further exceptions may be approved by the FOCA in individual cases.[3]
- However, it is strongly recommended to install an automatic ELT in all aircraft.
- Details of approved ELTs are given; it is specifically stated that personal locator beacons (PLBs) do not meet the service bulletin requirements; however, they may be carried in addition to ELTs.
- Details are given of the necessary maintenance and servicing. ELTs must be checked at least every 12 months.
- The ELT identification number must be reported to the FOCA by means of a special registration form.

Furthermore, in May 2012 the FOCA published SAND-2012-001 'Installation and registration of an ELT' as part of its Safety Awareness Notification Data (SAND), a collection of safety-related instructions and recommendations. This includes the following points:

- Aircraft must be equipped with ELTs in accordance with the service bulletin and the ELTs duly registered; the current registration list is in some cases incomplete and incorrect.
- In periodic aircraft inspections and in supervisory activities, it was found that installed ELTs often do not function properly, possibly for the following reasons:
  - incorrect antenna or incorrect antenna cable fitted;

[3] Aircraft affected by the exemption often do not voluntarily install an ELT because administrative and technical hurdles make this complicated and expensive.

- servicing not carried out according to the manufacturer's documentation;
- ELT not operable due to outdated or dead batteries.

- It is strongly recommended to equip all aircraft with automatic ELTs.

B.2 Organisation of the search and rescue services in Switzerland

B.2.1 General

The organisation of SAR in Switzerland as described below is based on the national requirements and guidelines (cf. Section B.1.4) and was valid from 1 January 2002 to 31 December 2015 (cf. Section B.2.6 and Section B.2.7). The organisational changes that took place on 1 January 2016 are described in Section B.2.7; however, their effects cannot yet be assessed since the changes are too recent. All investigations in this study therefore refer to the period up to the end of 2015.

B.2.2 Organisational structure

The FOCA is responsible for regulating SAR in Switzerland. It is also responsible for the oversight of SAR.

The FOCA has delegated the operation of the RCC to Swiss Air-Rescue (Rega). This company operates the RCC at its headquarters at Zurich Airport based on a contractual agreement with the FOCA (cf. Section B.2.3).

The Swiss Air Force conducts search operations, as delegated by the FOCA. The RCC raises the alert. All details are contractually agreed (cf. Section B.2.3).

The RCC can call on the support of third parties if necessary.

B.2.3 Contractual agreements

A written agreement exists between the FOCA and Rega which regulates in detail the SAR services provided by the latter and how these are remunerated.

An integral part of this agreement is a schedule of duties setting out the division of tasks and responsibilities between the FOCA, Rega and the Swiss Air Force. This so-called FEMI list can be found in Annex 1.

Among other things, this agreement explicitly states that:

- Rega acts as the RCC in accordance with ICAO Annex 12.
- Rega is authorised to take the necessary measures on its own authority having received an alert.
- should the need for a rescue mission arise in the course of a search operation, Rega assumes this mission at the instigation of the Swiss Air Force.
- Rega draws up statistics on its SAR activities; these statistics include the number and type of alerts received and a brief description of the measures taken.
- the FOCA provides the necessary advisory services and documents to Rega and ensures access to required data.
- after missions, the RCC conducts a debriefing together with the Air Force, the FOCA and the civil authorities.

The agreement was renegotiated in January 2013 and replaced an earlier version from November 2001, which ran until the end of 2015.

B.2.4 Tasks and equipment

B.2.4.1 Federal Office of Civil Aviation

As the supervisory body, the FOCA carries out regular audits across all aspects of SAR.

Together with neighbouring countries and the Swiss Air Force, it regularly organises national and international exercises to train SAR and foster cooperation (SAR *Exercises* - SAREX). Various intergovernmental agreements exist with neighbouring countries to facilitate the crossing of borders for people and goods in the event of search and rescue operations.

The FOCA also organises an annual meeting with representatives of Rega, the Swiss Air Force and various other parties involved in order to exchange experiences, discuss lessons learned and consider future developments.

The FOCA has a fleet of helicopters which can be used for SAR operations if and when required. Some of these helicopters are equipped with a device for homing on ELTs, a phenomenon that can be traced back to the former SAR structure (cf. Section B.2.6).

The FOCA also maintains the ELT register; the data this contains is accessible to the RCC.

As of 1 January 2015, the FOCA entrusted two persons with the performance of these tasks, who had 15 % and 10 % of full-time equivalents available for this purpose in accordance with their job specifications.

The FOCA states that, in the event of an accident the costs of a SAR operation are where possible passed on to the originator (cf. Section B.1.4.3) or their insurance company, as provided for in the SRSO. However, in the case of an alert triggered as a precaution without an accident actually occurring or in the case of a false alarm, this practice is generally not observed.

B.2.4.2 Rega (Swiss Air Rescue)

As of 1 January 2015, seven Rega staff members were employed at the RCC at Zurich Airport, all of whom worked for the RCC on a part-time basis and were also deployed for Rega's core tasks. In total, the RCC employed approximately 3.6 full-time equivalents.

This means permanent RCC availability in two shifts during the day. The RCC is staffed by one person at a time, who is also responsible for flight planning for the three Rega ambulance jets. During the night, RCC on-call staff can be alerted when necessary, by the Rega's Helicopter Operations Centre (HEZ) and its head of operations.

The RCC staff have their own premises, appropriate means of communication and various computer systems with documents, databases and a range of aids at their disposal.

The RCC receives notifications concerning overdue aircraft and from activated emergency positions indicating radio beacons (EPIRBs) on aircraft (ELTs) and ships and from personal locator beacons (PLBs). The incoming alerts and messages are processed according to the FEMI list (cf. Section B.2.3 and Annex 1).

The RCC can call on all available regional service providers, including Rega helicopters, to conduct rescue operations. The majority of these are not equipped with devices for locating ELTs.

The Air Force primarily provides equipment during search operations. If necessary, e.g., in the case of urgently required emergency measures, the RCC can also draw on the resources of Rega, FOCA or third parties such as commercial helicopter companies.

In order to determine flight paths and locate accident sites, the RCC maintains contact with air traffic control (Skyguide), the Federal Office of Communications (OFCOM), the police, the Air Force, and the mission control centre of the COSPAS-SARSAT system in Toulouse, which is responsible for Switzerland. Depending on the circumstances, it may also be in touch with other appropriate agencies. Recently, the company Flarm Technology Ltd. has often been called on to provide additional resources.

The RCC may also contact the RCCs of neighbouring countries, the managers of the aerodromes involved, specialists from the Swiss Alpine Club (SAC) or Swiss Alpine Rescue (ARS), meteorologists as well as the entourage of the affected aircraft and its crew such as owners and holders, relatives, colleagues and acquaintances. The RCC also informs the FOCA and the STSB when an aircraft goes missing.

The structure and organisation of the RCC are described in a comprehensive operations & training manual, available to all RCC staff, which was first published in January 2007 and has since been revised several times. All SAR operations should be run in accordance with the criteria and procedures set out in this manual. It contains the following:

- Tasks, qualifications, education and training of RCC operation managers;
- Description of the possible types of SAREX and their importance for optimising SAR in emergencies;
- Description of the COSPAS-SARSAT system and the procedures to be followed when an alert is received;
- Description of how the international emergency frequency 121.5 MHz is to be monitored by air traffic control units or aircraft; the emergency frequency is not monitored by the RCC itself;
- Description of the possible ways in which notifications of overdue aircraft can be given and the emergency phases;
- Description of OFCOM's emergency transmitter direction-finding and positioning capabilities; OFCOM monitors the emergency frequency 121.5 MHz only on request;
- Instructions on keeping the SAR logbook;
- Information on facilitated crossing of borders by persons and goods in the context of cross-border SAR operations.
- Description of the procedure and conditions for locating mobile phones and for the use of IMSI-catchers;
- Explanation of how to reconstruct the flight path with the help of Flarm data and the necessary procedures;
- Description of the procedure for obtaining radar data of a missing aircraft and how to interpret it;
- Classification of incoming aviation alerts into four categories (with ELT on 406 MHz / with ELT on 121.5 MHz only / without ELT but with flight plan / without ELT and without flight plan) with corresponding checklists for further action;

- Checklists for initiating, conducting, interrupting, resuming and concluding search operations;
- FEMI list;
- Description of the procedures in the case of alerts triggered by EPIRBs and PLBs;
- Description of the procedures in the case of alerts triggered by SPOT;[4]
- Description of resources available on the internet, partly protected by login and password;
- Overview and description of existing documents, forms and checklists, and examples of various types of alert;
- Several annexes containing pertinent information.

B.2.4.3 Air Force

The Swiss Air Force operates a Super Puma helicopter around the clock, specially equipped for the purpose of SAR. This helicopter is usually stationed at the military airfields of Payerne, Alpnach or Dübendorf. It carries special equipment, including a thermal imaging camera (*forward looking infrared* – FLIR), various ELT direction-finding (homing) facilities, a powerful searchlight, a rescue winch and material for medical first aid. The crew consists of two pilots, a FLIR operator and two load-masters, all of whom are members of the Air Force with appropriate qualifications. As a rule, the crew is on standby duty for seven days at a time and is then replaced by another crew. The crew must arrive at the departure airfield within one hour of being alerted. Along with flight preparations, helicopters are generally ready for take-off within 90 minutes.

The RCC usually alerts the Air Force Senior Duty Officer (SDO), who makes an initial assessment of the situation. This often involves consultation with the FLIR operator. The pilot in command (PIC) and the remaining crew members are then called up as necessary. The SDO has available a manual containing instructions, forms and checklists for these procedures.

Search operations are conducted to locate missing aircraft, but also for other purposes. Where rescue is necessary, this usually involves the resources of third parties, such as Rega.

In addition to this Super Puma helicopter, the Air Force can provide other resources for search operations on request, depending on time and local availability. During normal military flying hours, a response to a request from the RCC is given within a few minutes: an aircraft that is already airborne may be able to scan an area for an ELT signal and home in on this. As a rule, helicopters are used for this purpose, but also other Air Force aircraft, most of which are also equipped with ELT direction-finding devices. The SDO usually decides on the use of equipment.

The details for SAR are set out in the Air Force operation manuals. The following points are included:

- The decision as to whether a mission is to be carried out is made by the SDO; the decision as to whether it is feasible to fly lies with the PIC; both are assisted in the decision-making process by the RCC.

[4] SPOT is a commercially operated satellite system with no connection to the COSPAS-SARSAT system. With it the GPS position and any emergency calls made by corresponding transmitters can be received and forwarded (see Section B.5.1.3).

- A basic distinction is made between searching by electronic means (direction-finding) and a visual search; detailed procedures are described for both methods, either of which is applied according to the circumstances.
- Rescue operations are primarily conducted by Rega; first aid is provided by the crew if required.
- Information is given on the special regulation of duty and rest periods during on-call times for SAR service crews as well as information on the required on-call readiness;
- It is usually up to the flight crew members to decide whether they want to stay at home or at the airfield while on call; in all cases, they should remain fit for a possible SAR mission.
- Any training flights necessary for SAR can be carried out during on-call duty in agreement with the SDO.
- Information on the qualifications required by pilots and other crew members;
- Planning and organisational implementation of SAR in the Air Force are the responsibility of the SAR Special Officer; he is also responsible for drawing up the necessary documents and planning training exercises (SAREX) in cooperation with the FOCA and the RCC.
- In the case of complex or larger search operations involving several helicopters, it is recommended that an on-scene commander (OSC) be deployed to take over on-site coordination; this commander is appointed by the SDO.

B.2.4.4 Skyguide

The air navigation service provider Skyguide is primarily responsible for air traffic control in the Swiss flight information region (FIR). The Swiss FIR is not congruent with the Swiss SRR.

One of the tasks of air traffic control is to provide the alerting service ALRS (cf. Section B.5.2.1). When an emergency is indicated, air traffic control informs the RCC and usually also communicates the emergency phase. The following will trigger an alert: a distress call sent out by a crew, loss of radio or radar contact, failure to close a flight plan within 30 minutes of arrival (overdue) or distress signals received from an ELT. Air traffic control may also obtain information from third parties about emergency calls received, signals received from an ELT or observed distress situations.

Air traffic management procedures for the above situations are set out in the Air Traffic Management Manual (ATMM Switzerland). This contains a summary of the emergency phases and the various criteria that must be met for them to be triggered (cf. Annex 2). Further procedures are set out in detail in so-called *work instructions* or *process descriptions*; locally applicable procedures can be found in the ATMM of the respective aerodromes.

Processes and procedures also exist between the RCC and the responsible air traffic control unit for obtaining information relating to radio traffic, radar plots and Mode S data, any signals received from an ELT and possibly flight plan data.

B.2.4.5 Federal Office of Communications

OFCOM is responsible for the regulation and oversight of telecommunications in the territory of Switzerland. Its support for SAR services takes place in the form of administrative assistance to the FOCA.

If necessary, the RCC can draw on OFCOM's technical capabilities and expertise to track an ELT. OFCOM operates a round-the-clock direction-finding service for this purpose. Both fixed stations and mobile devices can be used for direction-finding. Direction-finding vehicles are stationed in Biel, Châtonnaye, Zurich and Gudo and are moved to the area in question as required. Hand-held devices can also be used to track ELTs in the vicinity. Outside regular working hours, the direction-finding service requires a response time of about one hour. Depending on where the ELT being searched for is in relation to the position of the fixed stations, the latter may not be able to receive signals from the ELT.

OFCOM monitors the international emergency frequency 121.5 MHz only on request.

In general, mobile phones can only be traced in a process launched by the police. Such emergency searches are regulated in the Federal Act on the Surveillance of Post and Telecommunications (SPTA) and the associated ordinance (SPTO). At the request of the police and if the relevant technical data of the provider concerned are available, OFCOM may clarify further issues and draw up so-called cell coverage maps, which narrow down the search area and allow the area of operation for IMSI-catchers to be defined. The latter are operated by the police and, if successfully used, allow them to precisely locate a mobile phone.

B.2.4.6 Police

In emergencies and when sufficient reason is given, the RCC can request the tracking or location of mobile phones via the Federal Office of Police's operations centre. This emergency search process must always be initiated via the police and can only be triggered if certain criteria are met.

In a first phase, a request is made to the provider concerned to determine the base station into which the mobile phone concerned is currently logged. Previous base stations used can also be determined.

If the request is granted, OFCOM can use this data to narrow down the search area on the basis of the technical specifications of the base station concerned. These cell coverage maps define the area in which a connection with the base station is considered highly likely.

Since 2011, IMSI-catchers have been used to precisely locate mobile phones. In Switzerland these devices are operated by the Federal Criminal Police and the Zurich Cantonal Police. They can be carried in vehicles or on aircraft and simulate a base station. All mobile phones at a sufficiently short distance and in a suitable constellation to the IMSI-catcher log in to it. By changing the location of the IMSI-catcher, the position of the phone in question can be tracked and thus its location determined. When used in helicopters, the radius is limited to about two kilometres, and the log-in process takes up to 20 seconds.

The Zurich Cantonal Police have their own helicopter, which can be equipped with an IMSI-catcher and can also be used for SAR operations. Some of Rega's helicopters can also be equipped with IMSI-catchers. The IMSI-catcher is supplied by the police and is operated by a police specialist during deployment.

B.2.4.7 COSPAS-SARSAT:

The COSPAS-SARSAT system is an internationally supported project for the operation of several satellites – some geostationary, some polar-orbiting – that can receive and decode 406 MHz signals from ELTs, EPIRBs, PLBs and similar systems. It is thus possible to determine the position of the transmitter more or less

quickly and more or less accurately depending on the technical design of the transmitter and the current constellation of the satellites.

The time it takes to receive a signal depends primarily on the constellation of the satellites in relation to the transmitter; when this constellation is favourable, this can be less than 10 minutes and when unfavourable, up to 45 minutes. In areas with geostationary satellite coverage, such as Switzerland, an MCC usually receives the signal from an ELT within a few minutes. The identification number, the other data stored and the coordinates determined – or, in the case of a transmitter coupled to a GPS, received – are evaluated and transmitted to the RCC responsible for the country in which the ELT was registered. If a position could be determined, the RCC in whose area the position is located is also informed.

According to the COSPAS-SARSAT operators, a position can be determined with an accuracy of less than five kilometres if it is determined exclusively using Doppler technology. There are two different coding protocols for transmitting the coordinates of a transmitter coupled to a GPS: The *standard location protocol* transmits the coordinates determined by the GPS with an accuracy of plus/minus 4 arc seconds in latitude and longitude, which for Switzerland is in the range of about plus/minus 150 m. The *user location protocol* transmits the coordinates determined by the GPS with an accuracy of plus/minus 4 arc seconds in latitude and longitude, which for Switzerland is in the range of about plus/minus 5km. The advantage of the user location protocol is that the registration of the aircraft concerned is transmitted and is therefore immediately known, whereas with the standard location protocol, only the 24-bit aircraft address or the serial number is transmitted and must therefore be checked against a database to establish the aircraft's registration. In both cases, the GPS usually updates the position about every 20 minutes.

Since the reception of the ELT's signals depends primarily on the constellation of the satellites in relation to the transmitter, the system may require the passage of several satellites or several orbits of the same satellite in order to establish the position. It may therefore be that a signal is already being received, but no position can yet be determined. As time progresses and satellite constellations change accordingly, a position can be determined and gradually made more precise.

The MCC keeps the RCC concerned updated on the ELT's position at any given time.

B.2.4.8 Flarm

Flarm Technology Ltd. develops collision avoidance technology originally conceived for gliders but is now used increasingly in all areas of general aviation. Close to 100% of gliders and motor gliders registered in Switzerland are believed to be equipped with Flarm collision avoidance systems and approximately 60% of civilian helicopters.

The collision avoidance systems alert the pilot to other Flarm-equipped aircraft and to obstacles registered in a database.

The devices record both their own flight path and data received from other aircraft during flight, including the time and position at which a recording is made.

If a Flarm-equipped aircraft goes missing, provided that its identification number is known, its recorded positions can be identified by analysing as much data as possible registered by other Flarm-equipped aircraft that were flying in the vicinity at the same time. The missing aircraft's flight path can thus be plotted and conclusions drawn about where it may have crashed. The more recordings with registered data of the missing aircraft received, the more accurate the evaluation.

Only specialists from Flarm Technology Ltd. can analyse the recordings. The company officially offers this service on its website, but also warns of the limitations of this method and gives advice on what needs to be done in order to ensure the most efficient and successful results in an emergency.

More recently, this method has been increasingly used in the case of missing gliders. It can take several hours to collect the data, which is then analysed by specialists from Flarm Technology Ltd.

B.2.5 Aeronautical information publication

The following key information on SAR and ELTs can be found in Switzerland's aeronautical information publication (AIP). It is also found in abridged form in the VFR manual.

- Contact details of the rescue coordination centre (RCC);
- Delineation of the search and rescue region (SRR);
- Information on cooperation with SAR services of neighbouring states, including information on how the latter should proceed in the case of an operation within the Swiss SRR and which facilities are available;
- Details of frequencies for use in a SAR operation;
- Recommendation to carry an ELT on every flight;
- Note that a filed flight plan may form the basis of a SAR operation; it is therefore recommended to file a flight plan even for VFR flights over more remote areas in the Alps, Alpine foothills and Jura;
- Note that flight registration can only provide the basis for an international SAR mission to a limited extent;
- Advice on how to avoid false alerts caused by flight plans not being closed or ELTs being triggered by mistake or unknowingly;
- Note that the RCC or air traffic services unit responsible should be notified immediately when unintentional ELT activation is ascertained;
- Note that ELT batteries should be replaced as instructed to ensure optimum transmission performance in an emergency;
- Explanation of SAR signals as in ICAO Annex 12.

The AIP also contains the following overview of the services available:

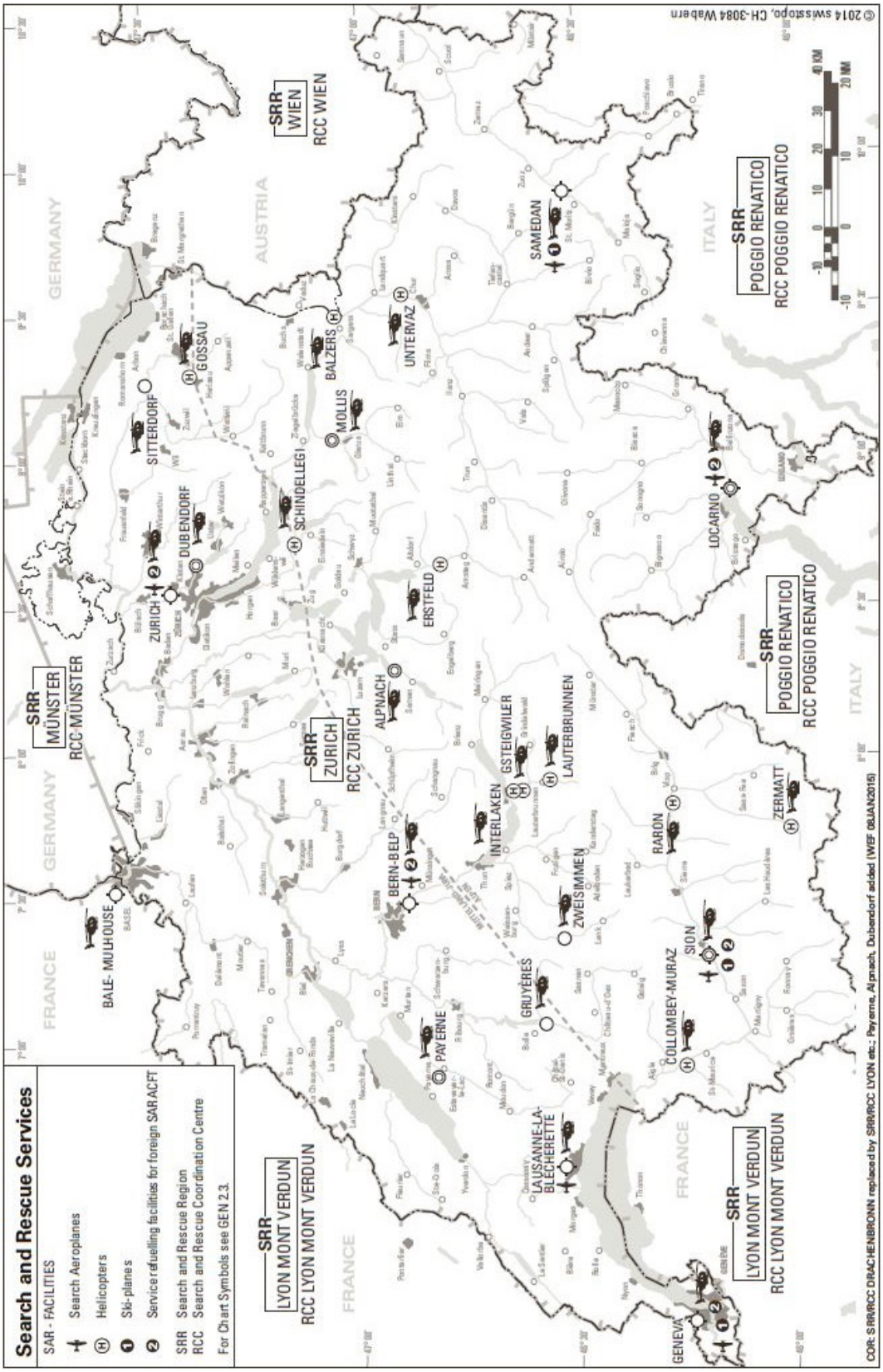

Figure 2: Overview of SAR services available as published in the AIP of January 2015.

B.2.6 Organisation before 2002

Before 1 January 2002, the FOCA operated the RCC, then located in Bern, and also carried out most of the search measures itself. If required, third-party services,

primarily from the Air Force and Rega, were used. The rescue missions were also organised by Rega at that time.

The reorganisation of SAR as of 1 January 2002, under which the RCC was outsourced to Rega and the search measures to the Air Force, took place as part of a comprehensive reorganisation of the FOCA and resulted in cost-savings for the Confederation.

A motion by the National Council Control Committee submitted in November 1995 may also have played a role in this context. Entitled "Transfer of the entire implementation of search and rescue measures for civilian aircraft to a private organisation", the motion called for the entirety of SAR operations to be transferred to Rega, with oversight remaining with the FOCA. One of the reasons given for the motion was that it would be logical if the organisation carrying out the rescue measures were also responsible for the search measures. This would allow the simplification of procedures and avoid duplication (two fleets of aircraft for search and rescue operations, two emergency services, etc.). In addition, it was felt that Rega had some advantages over the FOCA: bases throughout Switzerland (apart from Valais); an alert centre widely known to the public; pilots who knew their operational areas particularly well; and the ability to fly at night as well as during the day and in all weather conditions. The Federal Council rejected the motion on the basis of the following arguments, among others:

- Rega's fleet is equipped for the highly specialised purpose of rescue and the crews are trained accordingly; To use these resources for search purposes could hardly be justified from an economic point of view;
- Rega's fleet has too little flight-time autonomy for search flights as its extensive equipment is designed for rescue operations.
- As a search may last several days, Rega helicopters would be unavailable for their primary purpose. Rega would therefore again have to draw on third-party resources or procure its own new resources for this purpose.
- Cost considerations; federal expenses (FOCA, Air Force) do not have to be reimbursed, while expenses incurred by Rega would have to be. At the same time, not conducting search flights would generate few cost savings for the FOCA and the Air Force, since their fleets could not be reduced.
- Since a search alert is usually raised via professional institutions, it is irrelevant how well the alert centre is known to the public.
- Since the search for a missing aircraft is largely visual and is always so in the final phase, sufficient visual references are anyway necessary, regardless of the capabilities of the aircraft and crews deployed.
- If the FOCA were only to have oversight of SAR, it would lack the necessary practical experience to be able to perform a credible and appropriate supervisory function. The FOCA would therefore have to maintain its expertise in some other way.

B.2.7 Organisation from 2016 onwards

As of 1 January 2016, the operation of the RCC was transferred from Rega to the Zurich Cantonal Police. The organisational structure remained otherwise unchanged.

This change took place primarily because the existing contract between the FOCA and Rega expired at the end of 2015 and Rega was no longer prepared to operate

the RCC under the previous conditions (cf. Section B.2.3). Since the federal government was not willing to provide more money for the operation of the RCC, a new solution had to be found.

The FOCA asked various bodies, including the Air Force, if they would be interested in operating the RCC from 1 January 2016. The Air Force declared itself interested and saw this as a sensible solution, since it already had the task of carrying out search measures. However, at the time it lacked the financial and human resources to take over the operation of the RCC, but could possibly take over the running of the RCC at a later stage.

For this reason, the initial contract with the Zurich Cantonal Police to operate the RCC was limited to four years.

B.3 Search and rescue service in figures

B.3.1 Alerts

The following table shows the number of alerts received by the RCC in the years 2010 to 2015, by category:

Year	ELT	EPIRB	PLB	*Overdue*	Other	Total
2010	209	8	7	372	26	**622**
2011	345	9	25	458	37	**874**
2012	429	10	17	443	44	**943**
2013	380	26	14	466	51	**937**
2014	365	15	10	439	34	**863**
2015	345	29	18	429	58	**879**

Table 1: Number of alerts in RCC in the years 2010 to 2015.

There are no statistics on the number of deployments. However, an analysis for the years 2012 and 2014 of the alerts received and the investigations and measures taken shows that around 97 % of the alerts were false alarms not involving an emergency.

False alarms from ELTs typically occur when the device is triggered unintentionally, for example during hard landings or in the course of maintenance work. ELTs may also be intentionally triggered for testing purposes, though this is not permitted.

In the overdue category, a false alarm is typically triggered when the flight plan is not closed or is closed too late. In many instances, the actual flight time is significantly longer than that declared in the flight plan yet air traffic control is not informed of this change. Landings at alternate airfields (other than those originally planned) may also be made without the flight plan being closed afterwards.

Various measures have been taken by the authorities to reduce the number of false alarms. In each case, the originator is contacted in order to establish the exact cause of the false alarm and, if necessary, to introduce measures to prevent them from occurring. The FOCA has also developed an app called *Prevent Overdue – Close your Flight Plan* to prevent false alarms in the overdue category.

B.3.2 Time expenditure

The following table shows the expenditure in hours at the RCC for the years 2010 to 2015, broken down by different areas:

Year	SAR	Office	Refresher	Exercises	Total
2010	203	378	23	40	**644**
2011	240	259	83	9	**591**
2012	312	378	25	0	**715**
2013	227	344	142	0	**713**
2014	178	208	22	0	**408**
2015	215	203	9	11	**438**

Table 2: Expenditure in hours at the RCC 2010 to 2015.

This does not include presence time at the RCC to ensure permanent availability.

There are no statistics on the number of flying hours spent on SAR search and rescue operations.

B.4 Exemplary cases

B.4.1 General

Several exemplary cases from recent years are considered here in detail in order to shed light on the processes, how the interfaces operate and thus ultimately to assess the effectiveness of SAR. All of these cases have a strong but different SAR element. Cases from different aircraft categories and with different operational backgrounds were deliberately selected.

Considering the change in the SAR organisational structure from 2002 (cf. Section B.2.6) and from 2016 (cf. Section B.2.7), the cases here are taken from 2005 to 2015 only. They are presented in chronological order and are primarily based on records of the agencies involved and the investigation reports, if an investigation was conducted. The descriptions of the SAR operations are primarily based on the reports of the agencies involved. The original wording of the reports was deliberately retained to a large extent.

Over the period of time covered by the cases presented here, there were of course technical developments in the field of SAR, especially with regard to mobile phone searches. Certain processes and procedures were also adapted and optimised based on the debriefings after each case and general experience.

In these examples, the terms 'locating' and 'direction-finding' are often used in relation to mobile phone searches, referring to the result of an emergency search as described in Sections B.2.4.5 and B.2.4.6. Until a few years ago, this made it possible to narrow down the possible search area, but not to precisely locate the mobile phone in the true sense of the word. This only became possible with the introduction of IMSI-catchers.

The selection of cases here provides examples only; no generally applicable conclusions should be drawn from them.

B.4.2 HB-XNN accident on 14 April 2005

B.4.2.1 History of flight

On Thursday 14 April 2005, at 10:36, the pilot and one passenger took off on board the Bell 206 B helicopter, registration HB-XXN, from Zurich Airport (LSZH) on a commercial taxi flight to Bergamo-Orio al Serio (LIME) and then on to Modena (LIPM). The flight plan, which the pilot had drawn up with the help of other persons from the flight operations company, envisaged a route from Zurich to Bergamo via the Gotthard Pass, the Passo San Jorio and Lecco.

The filed flight plan contained a planned flight time of 01:40 hrs for the route from Zurich to Bergamo. The route was given as *City Gotthard Bellinzona Lecco*. A flight time of 50 minutes to Passo San Jorio was given. A maximum flying time (*endurance*) of 3 hours 30 minutes was recorded. Lugano (LSZA) was given as the diversion aerodrome.

After leaving the control zone of Zurich aerodrome control via the then Route 1 (now Route Sierra), the pilot duly logged out at 10:43 with Zurich Airport ground control. During the rest of the flight, he did not have contact with any other air traffic control or information services.

The helicopter collided with a rock face west of the Gotthard Pass and crashed at an unknown time, probably around 11:30, in poor visibility and difficult weather conditions. A fire broke out as a result of the impact. Both occupants lost their lives.

The 406 MHz emergency transmitter on board the helicopter was automatically triggered on impact and transmitted signals. However, the antenna of the emergency transmitter was torn off by the impact, as a result of which the signals could only be received in the immediate vicinity of the crash site.

The pilot was carrying a mobile phone, which remained undamaged.

The transponder was found set to standby.

B.4.2.2 SAR operation

The time of the accident was assumed to be 11:30; the exact time is not known.

Time	Interval since accident	Event
11:30	00:00	Accident
12:16	00:46	Based on the flight plan filed and the take-off radio transmission given at 10:36, HB-XXN should have arrived in Bergamo at approximately 12:16 (planned flight duration 01:40 h).
12:53	01:23	The Zurich area control centre (ACC) sent a fax to the Bergamo aerodrome control requesting details of HB-XXN's landing.
13:01	01:31	The Bergamo aerodrome control informed Zurich ACC by fax that it had no news about HB-XXN and requested the flight plan details. These were transmitted by Zurich ACC at 13:08.
--:--	--:--	The Bergamo aerodrome control probably informed the ACC Milan, at an unknown time.
13:52	02:22	When various enquiries by the Milan ACC into the whereabouts of HB-XXN failed to yield any information and it was also not possible to contact HB-XXN by radio, ACC Milan informed the RCC responsible for northern Italy, Poggio Renatico. The latter subsequently contacted the Bergamo and Modena airfields, who confirmed that HB-XXN had not arrived at either.
14:04	02:34	Milan ACC triggered the alert phase (ALERFA). This was communicated to Geneva ACC and Zurich ACC by fax.
14:06	02:36	Based on the flight plan filed and the take-off radio transmission given at 10:36, HB-XXN would have run out of fuel at approximately 14:06 (endurance 3 hours 30 minutes).
14:32	03:02	The Geneva ACC duty manager called Zurich RCC to enquire whether it had already been informed about ALERFA in relation to HB-XXN, to which the answer was no. Subsequently, Zurich aerodrome control was asked whether and when the HB-XXN had taken off there. A departure time of 10:38 was communicated.
14:35	03:05	Poggio Renatico RCC contacted Zurich RCC to inform them about the case and that they were preparing helicopters for the search.

14:40	03:10	Zurich RCC contacted Zurich ACC and was informed that the HB-XXN had at no point been in contact with the Zurich flight information service (FIS).
14:42	03:12	RCC Zurich contacted Locarno Airfield and was informed that its aerodrome control had had no contact with the HB-XXN.
14:45	03:15	Zurich RCC called the operator of the HB-XXN who knew nothing of the helicopter's whereabouts.
14:49	03:19	Zurich RCC requested Zurich ACC to send the exact details of the HB-XXN's flight plan. These arrived at the RCC at 14:56. In the meantime, Zurich RCC contacted other airfields along the planned route, including Lugano, but none of them had had radio contact with the HB-XXN.
14:50	03:20	Poggio Renatico RCC put two Italian SAR helicopters on alert.
14:55	03:25	Zurich RCC called the pilot's mobile phone. The phone switched to voicemail, whereupon a message was left.
14:56	03:26	The detailed flight plan arrived as requested at the RCC. Once this had been studied and analysed closely, the distress phase (DETRESFA) was declared, since it showed that the aircraft would have run out of fuel at 14:06. The DETRESFA message was sent by fax at 15:18.
15:05	03:35	Zurich RCC contacted the Air Force SDO and explained the current status of the situation. The SDO promised to deploy the SAR helicopter immediately and organise further resources for the search, if possible, as it had to be assumed that the search area would be large. It was also agreed that radar data and the location of the pilot's mobile phone would be requested via the RCC. The SDO subsequently alerted the SAR helicopter crew and arranged for two additional Alouette III helicopters to be put on standby in both Locarno and Alpnach to conduct a search operation if necessary.
15:10	03:40	The Poggio Renatico RCC increased the alert level of one of the two SAR helicopters from 120 minutes to 30 minutes.
15:18	03:48	Zurich RCC sent the DETRESFA message by fax.
15:20	03:50	Zurich RCC contacted the MCC in Toulouse. No signals from the HB-XXN ELT had yet been received there.
15:24	03:54	The Zurich RCC requested the Zurich ACC to send any radar records of the flight path it may have. The RCC receives relevant information at 15h50.
15:40	04:10	The SDO informed the Zurich RCC that the SAR helicopter would be ready for deployment at approximately 16:00.
15:42	04:12	The Poggio Renatico RCC discussed the search operation with the crew of the SAR helicopter stationed in Linate. The search area was set as the area between Lecco and Bellinzona over the Passo San Jorio.
15:44	04:14	The Zurich RCC asked the Zurich Cantonal Police to arrange for the pilot's mobile phone to be located. The results of this arrived at the RCC at 16:44.
15:45	04:15	The Zurich RCC was officially designated as the coordinating RCC for this operation. It informed the Poggio Renatico RCC that five Swiss Air Force helicopters would start the search and asked for support from the Italian SAR services. The Poggio Renatico RCC informed the Zurich RCC that it had a SAR helicopter ready for take-off.
15:50	04:20	The Italian SAR helicopter took off from Linate and flew to the agreed search area, which it reached at around 16:10.
15:50	04:20	The Zurich ACC informed the Zurich RCC that the radar data would show the flight track of HB-XXN only as far as the northern part of Lake Zurich. Only primary echoes were available.
16:02 to 16:08	04:32 to 04:38	The cantonal police of the cantons potentially affected were notified by the Zurich RCC.

16:05	04:35	The Poggio Renatico RCC alerted ground-based alpine rescue troops in the Lecco area for deployment.
16:10	04:40	The Italian SAR helicopter reached the assigned search area.
16:13	04:43	Zurich cantonal police notified the Zurich RCC that efforts were under way to locate the pilot's mobile phone.
16:15	04:45	The Air Force SAR helicopter took off from Dübendorf airfield and flew towards the search area.
16:20	04:50	The Poggio Renatico RCC informed the MCC in Bari, which is responsible for their area, of the incident in case signals from HB-XXN were received by the COSPAS-SARSAT system.
16:27	04:57	The SDO informed the Zurich RCC that the SAR helicopter was on the Emmen-Altdorf-Gotthard-Ticino route. Furthermore, two Alouette III helicopters would be ready to leave Alpnach at around 17:00 to search the northern side of the Alps; two more Alouette III helicopters would be made ready in Locarno to search the southern side.
16:30	05:00	The Zurich RCC informed its counterpart in the Poggio Renatico RCC of the pilot's mobile phone number. The Poggio Renatico RCC then called this number and got through to the automatic answering machine of a Swiss mobile phone provider. The Poggio Renatico RCC asked the Zurich RCC to inform them of the cell which the mobile phone was logged into.
16:40 to 17:20	05:10 to 05:50	The Poggio Renatico RCC made various preliminary inquiries about the possibility of tracking the pilot's mobile phone in Italy. A number of smaller airfields along the route were also contacted to enquire if HB-XXN had landed. The radar plots of the area in question were requested. Attempts were also made to call the passenger's mobile phone, but without success.
16:44	05:14	The Zurich Cantonal Police informed the Zurich RCC that the pilot's mobile phone had been located at 16:30 by an antenna in an area north-west of Andermatt at 190°, i.e., roughly in the direction of the Gotthard Pass. This was the only bearing possible. It was not possible to take a cross bearing.
16:46	05:16	The Zurich RCC communicated this information to the SDO, who subsequently sent the Air Force SAR helicopter to the area in question south of Andermatt. It was also decided to send the two Alouette III helicopters from Locarno as well as those from Alpnach to the area. The Poggio Renatico RCC was also informed of these events and the Rega base in Erstfeld alerted. The FOCA was also informed.
17:20	05:50	The crew of the Italian SAR helicopter asked the Poggio Renatico RCC if they could refuel in Locarno later. This was approved following clarifications with the Zurich RCC.
17:30	06:00	The four Alouette III helicopters from Locarno and Alpnach reached the search area and coordinated their search with the Super Puma helicopter already on the scene. A weak signal from an ELT was received intermittently, but it was practically impossible to take a bearing.
17:50	06:20	The Italian SAR helicopter left the assigned search area and landed in Locarno at 18:00 to refuel.
17:53	06:23	The RCC Zurich alerted members of the SAC Andermatt section and informed them that they may be required.
18:05	06:35	The crew of one of the Alouette III helicopters sighted a red plastic box just below the cloud cover and a short time later spotted the wreckage of the HB-XXN to the west of the Gotthard Pass. The Rega rescue helicopter was immediately called out from Erstfeld. The Super Puma helicopter then dropped a person at the scene of the accident, where the body of one of the two occupants was found. After the Rega rescue helicopter arrived, the body of the second occupant was also found. Because of the rapidly deteriorating weather conditions, the recovery operations had to be abandoned and postponed until the following day.

18:13	06:43	The Zurich RCC informed the Poggio Renatico RCC that the wreckage had been found. A short time after, the operation was declared over and the Italian SAR helicopter returned to Linate from Locarno. All involved agencies were subsequently informed by the Zurich RCC that the search operation had been concluded.

Table 3: Chronology of the search and rescue operation for HB-XXN.

B.4.2.3 Findings

Findings in relation to the HB-XNN and its pilots.

- The pilot filed a flight plan showing the route and the planned flight times.
- The transponder was found in the standby position, therefore no secondary radar echoes of the HB-XXN had been recorded.
- The pilot did not contact any other air traffic services unit after leaving the Zurich control zone; in particular, he had no contact with the Zurich FIS.
- The HB-XXN was equipped with an automatic ELT without GPS coupling; the ELT was triggered on impact and sent out signals. However, since the antenna was torn off during impact, these signals were only receivable in the immediate vicinity of the crash site.
- The pilot was carrying a mobile phone, which was not damaged in the crash.
- Both occupants suffered fatal injuries as a result of the impact.

Findings in relation to procedures in Italy:

- When the HB-XXN did not arrive in Bergamo as scheduled, the Milan ACC was informed at an unknown time.
- The Milan ACC initially investigated the whereabouts of HB-XXN without informing the responsible RCC Poggio Renatico or the Zurich RCC or any other agency in Switzerland.
- The Poggio Renatico RCC was informed by the Milan ACC at 13:52.
- The Zurich RCC was informed by chance at 14:32 by the Geneva ACC after the ALERFA had been triggered by the Milan ACC at 14:04 and this message had been sent to the Geneva ACC and the Zurich ACC.
- The Poggio Renatico RCC, in consultation with the Zurich RCC, subsequently deployed a SAR helicopter to participate in the search on Italian territory and at the border area.
- Following consultation with the Zurich RCC, the Poggio Renatico RCC allowed the Italian SAR helicopter to refuel at Locarno airfield.

Findings in relation to the Zurich RCC:

- The Zurich RCC was first alerted to the missing HB-XXN when it was informed at 14:32 by the Geneva ACC that the Milan ACC had triggered ALERFA.
- The RCC's investigations did not reveal any information about the whereabouts of the helicopter and its occupants. The pilot's mobile phone appeared to be in working order.
- Having received HB-XXN's detailed flight plan data at 14:56, the RCC Zurich declared the DETRESFA.

- A search was then launched by the Swiss Air Force and the Italian SAR service. The only indication the rescue teams had at this point was the route given in the flight plan, which is why, in view of the size of the search area, additional resources were organised for the search on both sides of the Alps in consultation with the Air Force SDO.
- The RCC was unable to discover anything new based on HB-XXN's radar data. Nor could any ELT signals be received by the COSPAS-SARSAT system.
- At 15:44, a good hour after the Zurich RCC received the alert, the police were asked to conduct an emergency search of the pilot's mobile phone. The result arrived at the RCC about an hour later and narrowed down the search area considerably.
- The RCC immediately communicated this to the SDO and a little later to the Poggio Renatico RCC.
- The RCC prepared for the deployment of a rescue helicopter as well as overland SAR measures.

Findings in relation to the search operation:

- When the search operation was triggered, the only indication was the route given in the flight plan, which is why, in view of the size of the search area, additional resources were organised for the search on both sides of the Alps. An Italian SAR helicopter was charged with searching on Italian territory and in the border area.
- A good hour after the alarm was raised by the RCC, the Air Force SAR helicopter took off from the Dübendorf airfield and flew towards the search area.
- Once the bearing of the pilot's mobile phone was known, the SAR helicopter was sent to the area in question south of Andermatt. It was also decided to send the additional helicopters from Locarno and Alpnach to the area in question.
- Weak signals from an ELT were detected. It was practically impossible to determine the bearing of the ELT.
- The wreckage of the HB-XXN was found a good hour after the RCC received the result of the mobile phone emergency search.
- The accident site was just below an area of thick cloud cover when the wreck was found.

Findings in relation to the rescue operation:

- The crew of the SAR helicopter was able to drop a person at the scene of the accident, who ascertained the death of one of the two occupants.
- The Rega rescue helicopter arrived at the scene of the accident a short time later and the death of the second occupant was established.
- Because of the rapidly deteriorating weather conditions, the recovery operations had to be abandoned and postponed until the following day.

B.4.3 HB-HFI accident on 17 April 2007

B.4.3.1 History of flight

On Tuesday 17 April 2007 at 09:22, aircraft AS-202/15-1, registered as HB-HFI, took off from Lausanne aerodrome (LSGL) with a student pilot and a flight instructor on board for a navigation flight to St Gallen-Altenrhein (LSZR). The flight was part of the student's commercial pilot training.

Before departure the crew filed a general flight notification giving details of the intended departure time, destination, return date and route. The latter was given as *"FRI WIL LSZR"* meaning the flight would go via the Freiburg (FRI) and Willisau (WIL) VOR. No flight plan was submitted.

At 09:38, the crew contacted Bern-Belp aerodrome control tower as it wished to transit the latter's control zone. The crew was assigned transponder code 6373 and was granted transit. After crossing the control zone, the crew signed out from Bern control and switched the transponder back to code 7000. It did not have contact with any other air traffic services unit during the rest of the flight.

The HB-HFI headed towards the area of the Ricken Pass via the Willisau VOR, the area north of Lake Zug, the Albis chain near Hirzel and the Linth plain. It then flew at a low altitude into the Necker Valley near Hemberg.

During a left turn in the valley basin at the end of the valley, the aircraft collided with the terrain at about 11:00 in perfect visual flight weather conditions. The aircraft was destroyed on impact. Both occupants lost their lives.

The ELT on board the aircraft, which was of an older design, was automatically triggered on impact and transmitted signals on 121.5 MHz and 243 MHz. The ELT antenna was mounted at the top left rear of the fuselage. The rear fuselage and the tail unit were overturned in the crash, so the signals from the ELT antenna were severely obstructed.

Both pilots were carrying a mobile phone. One of the phones remained functional.

B.4.3.2 SAR operation

Time	Interval since accident	Event
11:00	00:00	Accident
17:00	06:00	The flight instructor's colleagues realised that the HB-HFI had not returned to the Lausanne airfield. When telephone inquiries were unsuccessful, they contacted Rega at 18:30.
18:30	07:30	The Zurich RCC was alerted by the flight instructor's colleagues at the Lausanne airfield. They provided the details of the flight as appeared in the flight notification and also the two pilots' mobile phone numbers. The RCC subsequently made various enquiries; it was no longer possible to determine exact timings. Among other things, the following was established: • The HB-HFI had not arrived in St Gallen-Altenrhein • The HB-HFI had crossed the control zone of Bern-Belp airport on the FRI-WIL route and the crew had been in contact with the aerodrome control tower for this purpose • Otherwise, no air traffic control services units with which the crew had been in contact could be located, including the Zurich FIS and the Geneva FIS • The MCC in Toulouse could not receive any signals from the HB-HFI's ELT • OFCOM received no signals from an ELT at its fixed stations

		• The owner of the HB-HFI was contacted – this was the flight school from which the training flight had taken place • Various airfields along the specified route were contacted, but no information on the whereabouts of the HB-HFI could be provided by any of them • The flight instructor's mobile phone appeared to be in working order.
19:07	08:07	The RCC initiated the distress phase (DETRESFA).
19:50	08:50	The RCC contacted the Air Force SDO and explained the situation.
20:30	09:30	The RCC informed the cantonal police of the cantons that might be involved.
20:37	09:37	The RCC contacted the Zurich ACC and requested any radar plots of the HB-HFI that might be available. Initial information arrived at the RCC shortly thereafter and showed the HB-HFI's radar track about 8NM south-west of the WIL VOR.
20:50	09:50	The RCC contacted the owner again. The latter had no news to report, other than that the pilots' wives had been in touch to say that they had not heard from their husbands.
20:50	09:50	The RCC contacted the SDO again and asked if a search with the SAR helicopter could be conducted. The SDO declined on the grounds that the search area first had to be narrowed down. He offered to try to find out more about the flight path using Air Force resources and subsequently contacted the relevant units.
21:00	10:00	The RCC confirmed to the SDO that the HB-HFI had taken off from Lausanne at 09:20, had crossed the Bern-Belp airport control zone at approximately 10:00 with transponder code 6373 and the last position had been recorded 8NM south-west of the WIL VOR.
21:20	10:20	The RCC requested the Bern cantonal police to establish the position of the flight instructor's mobile phone. This information was received by the RCC at 22:30.
21:40	10:40	The SDO was informed by Air Force units that Air Force radar data tracked the HB-HFI to the Ricken Pass area, where it disappeared shortly before 11am.
22:00	11:00	The SDO informed the RCC of the result of the Air Force radar data evaluation.
22:00	11:00	The RCC was again in contact with the owner and informed him that the radar tracks had been consulted and showed the flight path to the Ricken Pass area; arrangements had also been made to locate the flight instructor's mobile phone.
22:10	11:10	The SDO was in contact with the FLIR operator and discussed with him the conditions under which it would be reasonable to conduct a search at night with the SAR helicopter.
22:15	11:15	The Bern Cantonal Police contacted the RCC and informed them that the flight instructor's mobile phone was being traced, but this was likely to take another hour or so.
22:30	11:30	The Bern Cantonal Police informed the Zurich RCC that at 22:17 the mobile phone's bearing had been identified in a westerly, possibly southwesterly direction by an antenna on the summit of the Säntis.
22:30	11:30	The RCC communicated this information to the SDO. Based on the radar data and the bearing, the search area could be narrowed down to the Säntis-Ricken Pass axis. The Air Force SDO did not feel that it was reasonable to conduct a search at night because of the size of the search area. He therefore suggested searching the area in question with the SAR helicopter as of 06:00 the next morning; the SAR helicopter would then be relieved by a FOCA search helicopter. According to the FOCA, the crew of the Air Force SAR helicopter had a restriction with flight duty time as it had to fly to Valais the following day for a FLIR mission for the fire brigade. It was therefore agreed to search

		with the SAR helicopter the next morning as of 06:00 and then to replace the SAR helicopter with a FOCA search helicopter.
23:15	12:15	The RCC again contacted OFCOM's direction-finding service and communicated the bearing of the flight instructor's mobile phone. OFCOM then checked again whether the signals of an ELT could be detected in the area concerned. The result was negative.
23:32	12:32	The RCC informed the Vaud Cantonal Police that the search would not begin until 6:00 the following morning because of the size of the search area. Two helicopters would be deployed. The RCC asked the Vaud Cantonal Police to pass on this information to the relatives via the aircraft owner.
06:05	19:05	The Air Force SAR helicopter took off from Dübendorf and began search flights in the Säntis-Ricken Pass area at approximately 06:30.
06:50	19:50	The FOCA helicopter took off from Bern-Belp and flew towards the search area. The pilot contacted the RCC and enquired about the current situation. He was informed of the SAR helicopter's registration number and working frequency.
07:00	20:00	The owner asked the RCC for up-to-date information.
07:06	20:06	The RCC alerted the FOCA crisis team via pager.
07:08	20:08	The student pilot's brother called the RCC for the latest information.
07:17	20:17	A member of the FOCA crisis team contacted the RCC and informed them that the crisis team would obtain information via the crew of the FOCA search helicopter.
07:25	20:25	The FOCA helicopter reached the search area and relieved the Air Force SAR helicopter, which then flew to Valais for the FLIR mission with the fire brigade.
07:28	20:28	The SDO contacted the RCC to say that the Air Force would provide additional helicopters for the search operation. It would also draw up a search plan with the FOCA helicopter crew.
08:19	21:19	The FOCA helicopter crew reported to the RCC that they were receiving signals from an ELT.
08:22	21:22	The FOCA helicopter crew discovered the wreckage of the HB-HFI and informed the RCC. The Rega 7 rescue helicopter, which is stationed in St Gallen, was immediately called out.
08:35	21:35	Rega 7 reached the crash site and established the death of both pilots. All involved agencies were subsequently informed by the Zurich RCC that the search operation had been concluded.

Table 4: Chronology of the search and rescue operation for HB-HFI.

B.4.3.3 Findings

Findings in relation to the HB-HFI and its pilots:

- The crew filed a general flight notification showing the approximate route and destination airfield. This flight notification did not result in the launch of search and rescue measures, in particular since the St Gallen-Altenrhein airfield was not informed about the planned flight.
- The transponder was operated in altitude transmission mode throughout the flight, which is why secondary radar echoes from the HB-HFI were recorded for long stretches of the flight.
- The crew did not contact any other air traffic services unit after leaving the Bern-Belp control zone; in particular, they were never in contact with the Zurich FIS.
- The HB-HFI was equipped with an automatic ELT of older design, which was triggered and transmitted signals upon impact; owing to the position of the

ELT's antenna after the accident, signal transmission was severely obstructed by wreckage.

- Both pilots were carrying a mobile phone. One of these phones remained functional after the crash.
- Both occupants suffered fatal injuries as a result of the impact with the ground.

Findings in relation to Lausanne airfield:

- A search and rescue operation was not launched based on the general flight notification submitted.
- The alarm was not raised until the evening, several hours after the accident, by colleagues of the flight instructor when they realised that the aircraft had not returned to Lausanne.
- For more than an hour, enquiries were made into the whereabouts of the HB-HFI without the RCC being informed.

Findings in relation to the Zurich RCC:

- The first alert regarding the HB-HFI was received by the Zurich RCC at 18:30, more than seven hours after the accident.
- The RCC's investigations did not reveal any information about the whereabouts of the aircraft and its occupants. The flight instructor's mobile phone appeared to be in working order.
- Notably, neither the MCC nor OFCOM could receive signals from the HB-HFI's ELT.
- The initial investigations having revealed nothing, the RCC declared DETRESFA at 19:07, more than half hour after the alarm was received.
- Subsequently, by now shortly before nightfall, the Air Force's SDO was contacted; he declined to conduct a search until the search area could be narrowed down.
- The Zurich ACC's radar plots showed the flight track of the HB-HFI as far as the area southwest of the WIL VOR; the radar plots available after the accident showed the flight track until shortly after 10:53 in the area of the Ricken Pass.
- Air Force radar data showed the HB-HFI's flight track as far as the Ricken Pass area, where it disappeared shortly before 11:00.
- At 21:20, almost three hours after the Zurich RCC received the alert, the police were asked to conduct an emergency search for the flight instructor's mobile phone. The result arrived at the RCC about an hour later and, along with the Air Force radar data, narrowed down the search area to the Säntis-Ricken Pass axis.
- The RCC informed the SDO and OFCOM of such and requested that the area in question be checked again for signals from an ELT. The result was negative.

Findings in relation to the search operation:

- At the time the SDO was alerted by the RCC, the only indication as to the whereabouts of the missing aircraft was the route given in the flight notification.
- Later, the Air Force radar data showing the flight track of the HB-HFI up to the area of the Ricken Pass provided a further indication.

- Still later, the bearing of the flight instructor's mobile phone was added, which, together with the radar data, narrowed down the search area to the Säntis-Ricken Pass axis.
- According to the Air Force, the SDO decided that a search at night would be inadvisable in view of the circumstances.
- According to the FOCA, the crew of the Air Force SAR helicopter had a restriction with flight duty time as it had to fly to Valais the following day for a FLIR mission for the fire brigade.
- At 06:05 the following morning, shortly after daybreak, the SAR helicopter flew to the search area and began the search. It was agreed that the SAR helicopter would later be relieved by a FOCA search helicopter, as the SAR helicopter had to fly to Valais for another mission.
- The FOCA helicopter took off from Bern-Belp at 06:50 and flew to the search area, where it replaced the Air Force SAR helicopter at 07:25 as agreed.
- The SDO indicated that further Air Force resources could be deployed in the search.
- The crew of the FOCA helicopter received weak signals from an ELT and took bearings on them. This enabled them to discover the wreck of the HB-HFI a short time later.
- Weather conditions were very good both on the day of the accident and the following day.

Findings in relation to the rescue operation:

- Immediately after the wreck was found, the Rega rescue helicopter was called out and arrived at the accident site soon after. The two pilots were declared dead.

B.4.4 HB-PGC accident on 16 September 2007

B.4.4.1 History of flight

On Sunday 16 September 2007, the Piper PA-28-181 Archer II, registered as HB-PGC, was fully refuelled at Florence-Peretola aerodrome (LIRQ). The pilot then took off with three other people on board for a flight to Marina di Campo (LIRJ) on the island of Elba. After a lunch break, the aircraft flew back to Florence-Peretola. The total flight time of the two flights was 1 hour 36 minutes.

The aircraft was not refuelled before the intended flight via Milan and the Gotthard Pass to Zurich Airport (LSZH). The flight plan indicated the direct route Galciana–Parma–Voghera–Locarno–Gotthard Pass–Lake Zug–W–Zurich. Wangen-Lachen (LSPV) was given as the alternate airfield. The pilot recorded a planned flight time for this route of 2 hours 15 minutes and endurance of 3 hours. At Florence-Peretola aerodrome, the pilot received a computer printout with aviation routine weather reports (METAR) and terminal aerodrome forecasts (TAF) for Florence, Parma, Milan-Linate, Milan-Malpensa and Zurich aerodromes.

Take-off from Florence-Peretola aerodrome was at 17:18. The flight proceeded as planned to Parma, after which the pilot flew on over Trezzo towards Lecco on Lake Como. At 18:45, the pilot signed out from ACC Milan and changed to the transponder code 7000 for VFR flights in Switzerland. The HB-PGC was over Lake Como at the time.

At 18:56, the pilot contacted the Zurich flight information centre (FIC) and informed them that he wanted to continue his flight according to visual flight rules over the

Gotthard Pass, Lake Lucerne and Lake Zug to Zurich Airport. At the time the aircraft was near Giornico, about 10NM south-east of Ambrì airfield at an altitude of about 2500m/M, or 8200ft AMSL. In response to the pilot's request, Zurich Information informed him shortly afterwards that the route over the Gotthard Pass was closed according to the general aviation forecast (GAFOR), and added that the route Biasca–Lukmanier Pass–Bad Ragaz was classed as marginal.

The HB-PGC then flew above a layer of cloud over Ambrì airfield in the direction of Airolo. After turning back when north of Airolo, the HB-PGC was set on an easterly course at an altitude of 2100m/M, or 6900ft AMSL. At 19:04:19 the pilot informed Zurich Information that he intended to fly to Lugano because of the prevailing weather conditions. At this point, the HB-PGC headed in a slight ascent into the Valle di Büi towards Lake Ritom. When asked by Zurich Information about the current position and altitude of the HB-PGC, the pilot replied "Abeam Ambrì" and wanted to know if other pass crossings were open. Shortly afterwards, at 19:05, the aircraft collided with the terrain approximately 20 to 25m below the Bocchetta di Föisc Pass west of Lake Ritom at an altitude of 2100m/M. Two of the four occupants were fatally injured on impact; the pilot and one passenger were seriously injured. The aircraft was destroyed.

The 406 MHz ELT on board the aircraft malfunctioned because its battery was not sufficiently charged.

The Zurich FIC tried in vain to contact the HB-PGC, until 19:44.

The pilot and passengers were carrying mobile phones.

B.4.4.2 SAR operation

Time	Interval since accident	Event
19:05	00:00	Accident
19:05 to 19:44	00:00 to 00:39	The Zurich FIC tried in vain to contact the HB-PGC.
20:25	01:20	The Zurich ACC reported to the RCC that the HB-PGC on the flight from LIRQ to LSZH was overdue.
20:36	01:31	The RCC declared the uncertainty phase (INCERFA).
20:48	01:43	The RCC checked whether the HB-PGC had landed in LSZS, LSMR, LSZA or LSZL.
20:51	01:46	Zurich FIC informed the RCC that the HB-PGC intended to fly to LSZA because of the weather conditions. The FIC had not issued a transponder code; the last contact had been at 19:04 1NM north of Ambrì airfield as the HB-PGC was at 7000ft and descending.
20:53	01:48	The RCC ordered a copy of the flight plan and enquired at the Poggio Renatico RCC, which is responsible for northern Italy, whether the HB-PGC had landed in northern Italy again.
20:55	01:50	The RCC received details of the pilot (name, mobile phone number, etc.) from the Zurich control tower and requested the emergency contact of the flying club that operated the HB-PGC.
20:58	01:53	OFCOM was instructed by the RCC to listen in on the Ticino region.
20:59	01:54	The MCC in Toulouse reported to the RCC that no signals had been received. The satellite would not be over Switzerland again until 21:30.
21:00	01:55	The RCC informed the FOCA. It also informed the Air Force SDO and enquired whether the Rega 6 rescue helicopter from the Locarno base could make a search flight, weather permitting. The SDO agreed and promised to deploy the SAR crew.
21:10	02:05	The pilot's wife called the RCC; she was waiting for the pilot at Zurich airport.
21:20	02:15	The RCC asked the Zurich ACC to analyse the radar track but was told that a technician would not be present to plot the track until the following morning.

21:25	02:20	OFCOM reported to the RCC that no ELT signals were audible.
21:25	02:20	The Poggio Renatico RCC reported to the Zurich RCC that the HB-PGC had not landed in northern Italy and offered its assistance.
21:30	02:25	The Zurich ACC called the RCC and described the HB-PGC's flight path according to the radar recording: overhead Ambrì at 8000ft heading north, then 180° left turn descending to 7000ft. Blip disappears about 1NM north of Ambrì airfield, heading south, time 19:04.
21:32	02:27	The RCC initiated the distress phase (DETRESFA).
21:40	02:35	Ticino Cantonal Police reported to the RCC the identification of the cell where the pilot's mobile phone was logged in, but also that the location of the provider's mobile antenna was unknown.
21:42	02:37	The RCC asked the SDO to deploy the SAR search helicopter and to initiate radar reconnaissance using FLORAKO. The SDO reported that the Payerne SAR helicopter with crew had been deployed, and that radar reconnaissance using FLORAKO was not possible due to a lack of personnel.
21:45	02:40	OFCOM reported to the RCC that no antenna directory of the mobile provider was available and the bearing was unknown.
21:50	02:45	The MCC in Toulouse reported to the RCC that no ELT signals had been received.
21:50	02:45	The SDO informed the FLIR operator and discussed the preparations for the mission with him.
21:55	02:50	The SDO informed the SAR helicopter PIC.
22:05	03:00	The RCC asked the SDO about the status of the SAR helicopter; the SDO reported that the crew had arrived.
22:12	03:07	The RCC informed the SDO of the antenna coordinates; it was agreed that Rega should be deployed, weather permitting.
22:13	03:08	The RCC was told by the Zurich Cantonal Police that a direction-finding expert might be able to say more about the mobile phone cell identified but would need about 30 minutes to get to the office.
22:15	03:10	The RCC informed the Rega 6 rescue helicopter crew based in Locarno of the HB-PGC's last known position.
22:42	03:37	The FLIR operator reported to the SDO that the SAR crew was at the airfield.
22:51	03:46	The RCC informed the SDO of the last position of the HB-PGC as seen on the radar records, and that the previously reported antenna location was incorrect.
22:58	03:53	The RCC asked the Graubünden Cantonal Police whether they had any information on the mobile phone cell identified.
23:05	04:00	The Graubünden Cantonal Police reported to the RCC that no information on the mobile phone cell was available.
23:15	04:10	The RCC forwarded the SAR dossier to the Rega HEZ so that the search could be coordinated between the helicopters, the SAC and the police.
23:20	04:15	The SDO asked the RCC about the weather situation and was informed about the Rega search flight that had been launched in the meantime, as well as an attempt to locate an Italian mobile phone.
23:25	04:20	The Valais Cantonal Police informed the RCC that it was sending a patrol to the Simplon Pass to reconnoitre the weather situation for the SAR helicopter.
23:34	04:29	The Poggio Renatico RCC reported to the RCC that the Italian mobile phone had last logged in near Florence.
23:35	04:30	The SDO told the SAR crew to wait up to 30 more minutes for a bearing, after which the mission would be aborted if this were unavailable.
23:48	04:43	Rega 6 returned to base because of fog in the search area.
23:50	04:45	The RCC reported to the SDO that the Rega mission had been aborted because of increasing fog.
23:52	04:47	The SAR crew's readiness was lifted by the SDO and the mission aborted.
23:55	04:50	The RCC was informed by relatives that the passenger with the Italian mobile phone also had a Swiss mobile phone, whereupon a request was immediately made to the Ticino Cantonal Police to locate the said phone.
00:04	04:59	The SAC informed the RCC that they would report as soon as the weather permitted a search flight.

00:23	05:18	The Ticino Cantonal Police reported to the RCC that the second mobile phone was logged into a cell with an antenna location above Airolo; it was not possible to take a bearing
00:25	05:20	The RCC informed the SAC of this outcome.
00:50	05:45	The SAC and OFCOM agreed that OFCOM would send someone from Ticino to the area to take bearings.
00:50	05:45	The Ticino Cantonal Police reported to the RCC the car patrols were in the Gotthard area.
01:19	06:14	An OFCOM direction-finding team informed the RCC that it would attempt to locate the ELT on the ground.
03:00	07:55	The employer of one of the passengers informed the RCC of the passenger's mobile phone number, whereupon a request was immediately made to the Ticino Cantonal Police to track the phone.
03:30	08:25	The Ticino Cantonal Police reported to the RCC that this mobile phone could not be located because it was not switched on.
05:02	09:57	The Ticino Cantonal Police reported that a briefing with the SAC and the police would be held at 05:30 in Airolo. If possible, the search should be carried out immediately by helicopter, otherwise three search teams would conduct a search on the ground. The Rega helicopter pilot subsequently coordinated the procedure directly with the SAC.
05:30	10:25	OFCOM's tracking team informed the RCC that the search for the ELT had ended unsuccessfully after searching in the Bedretto Valley, the Blenio Valley, the Leventina and around the Hospen Valley.
06:00	10:55	An SAC search party set off searching on the ground as the weather was very poor and there was fog.
06:09	11:04	The Rega helicopter pilot who came on duty reported to the RCC that flights would be made as soon as the weather permitted.
07:29	12:24	The Rega helicopter pilot reported to the RCC that the weather was still poor and that the SAC would be providing information about weather developments in the search area.
07:38	12:33	The SDO coming on duty asked the RCC for an update of the situation and asked if any soldiers from the Armed Forces were needed.
08:00	12:55	The FOCA asked the RCC for an update of the situation.
08:10	13:05	The FOCA asked the RCC for the positions of the mobile phones. As these were not known to the RCC, it instead provided information on the last known position on the radar track.
08:32	13:27	The MeteoSwiss weather service informed the RCC of the weather outlook, saying that there might be a short improvement in the weather over midday.
08:45	13:40	An SAC search party informed the RCC that ten persons would search the Punte di Vespero region.
09:00	13:55	The Zurich ACC gave the RCC the coordinates of the HB-PGC's last known radar position and altitude west of Lake Ritom in the Föisc area.
09:22	14:17	The Rega helicopter pilot was updated by the RCC.
09:46	14:41	An SAC search party asked the RCC for information about the HB-PGC's earlier positions.
10:00	14:55	The Zurich ACC reported the last seven radar positions of the HB-PGC's flight track to the RCC.
10:02	14:57	The crew of a FOCA helicopter reported to the RCC that it would fly over the suspected crash site. The FOCA helicopter had to be taken from Bern-Belp to Alpnach for maintenance that day, and it was decided that the flight would make a diversion via the Leventina. Because of the weather conditions, the helicopter navigated by GPS to the area in question, above the cloud cover at FL 130.
10:04	14:59	The FOCA helicopter crew reported to the RCC that they believed they had spotted the crashed aircraft west of Lake Ritom through a gap in the clouds. The crew then managed to land at the accident site. Two of the occupants were found alive and trapped in the wreckage.
10:08	15:03	The SAC search party could not be reached by the RCC. The Rega helicopter pilot was informed.
10:10	15:05	The FOCA helicopter crew informed the RCC of the position of the crash site and requested two rescue helicopters and material to cut open the

		wreckage. The rescue helicopters Rega 6 from Locarno and Rega 8 from Erstfeld were immediately called out by the HEZ.
		The RCC coordinated the deployment of the Rega helicopters, organised the procurement and transport of the cutting equipment and notified the agencies involved in the search.
10:48	15:43	Rega 8 informed the RCC that it had landed at the accident site; the weather was unsettled, the accident site was in fog, visibility was 200m.
11:02	15:57	Rega 6 informed the RCC that it had landed in Airolo, where it collected the cutting equipment. Rega 6 then also flew to the scene of the accident.
11:42	16:37	Rega 8 informed the RCC that it had taken off from the accident site with one of the two patients on board.
11:58	16:53	Rega 6 informed the RCC that it had taken off from the accident site with the other of the two patients on board.
		Several hospitals had to be contacted before suitable ones could be found that could accept the patients.
12:15	17:10	Rega 6 reported to the RCC that it had landed at the Ospedale Civico in Lugano.
12:16	17:11	Rega 8 reported to the RCC that it had landed at Zurich University Hospital.

Table 5: Chronology of the search and rescue operation for HB-PGC.

B.4.4.3 Findings

Findings in relation to the HB-PGC, its pilot and passengers:

- The pilot filed a flight plan showing the route and the planned flight times.
- The transponder was operated in altitude transmission mode. The last radar signal was recorded at 19:04. The position of this signal was a few hundred metres west of the accident site.
- The pilot was in radio contact with the Milan ACC and subsequently with the Zurich FIC.
- Immediately before the accident, after the pilot had turned back north of Airolo he informed the Zurich FIC that he wanted to fly to Lugano because of the prevailing weather conditions, and enquired whether a pass other than the Gotthard Pass was open.
- At the time of the accident, the aircraft had a fuel reserve sufficient for a maximum of 45 minutes of flight time.
- The 406 MHz ELT on board the HB-PGC malfunctioned because its battery was not sufficiently charged. The transmitter had a faulty output stage and this most likely caused excessive off-state current, draining the battery prematurely.
- Two of the passengers were killed instantly on impact. The pilot and one passenger suffered serious injuries.
- The pilot and passengers were carrying mobile phones. These phones could not be located; it was only the cell into which the phones were logged that could be determined.

Findings in relation to the RCC Zurich:

- The Zurich FIC attempted unsuccessfully to contact the crew of the HB-PGC until 19:44, yet the RCC was not directly alerted.
- According to the information in the flight plan, the HB-PGC should have arrived in Zurich at about 19:35; it would have run out of fuel at about 20:20. At 20:25, the Zurich ACC reported to the RCC that the HB-PGC was overdue. The RCC subsequently triggered the uncertainty phase (INCERFA) at 20:36.

- Enquiries by the RCC at possible alternate airfields along the flight route yielded no indications as to the whereabouts of the missing aircraft. No signals from a distress transmitter could be received either via COSPAS-SARSAT or via antennas on the ground.
- At 21:30 the RCC knew that the HB-PGC had disappeared from the radar screen north of Ambrì at around 19:04 at an altitude of approximately 7000ft AMSL, and that final radio contact had also been made in this area.
- The distress phase (DETRESFA) was triggered at 21:32.
- The RCC had no authority to request a plot of the flight track from ATC. As a result, the RCC did not receive the exact coordinates of the final radar position until 09:00 the following day. After the accident, it was possible for the RCC to be able to obtain such a plot. It is not easy to produce a radar plot at any time of the day or night, as it can only be produced by technicians, not by air traffic controllers. The latter can only look at the radar recordings again.

Findings in relation to other organisations involved:

- One of the mobile phone providers concerned was only able to establish which cell or mobile phone antenna the mobile phone for which a search was being made was logged into. It was not able to provide the antenna's transmission azimuth, which would have helped to locate the phone.
- The Air Force SDO stated that radar reconnaissance via FLORAKO was not possible because not enough personnel were available.

Findings in relation to the search operation:

- At 21:00, it was decided to deploy a Rega helicopter stationed in Locarno for the search; the SDO was alerted in advance.
- At 21:32, at the time the distress phase (DETRESFA) was announced, the search area was considered defined. There was dense fog in the area of the accident site.
- The Air Force SAR helicopter was in Payerne and the crew was called up.
- At 22:15, the Rega helicopter crew was informed of the last known position. This crew then carried out a series of search flights which were unsuccessful owing to the low-lying clouds. The search was aborted at around 23:50.
- The SDO subsequently decided not to allow the SAR helicopter to take off and aborted the mission.
- The Ticino Cantonal Police and mountain guides from the Swiss Alpine Club (SAC) rescue team were called out and deployed on a ground search during the night.
- The following day, a FOCA helicopter took a detour over the Leventina on a flight from Bern-Belp to Alpnach and happened to spot the wreckage of the HB-PGC through a gap in the clouds, about 15 hours after the accident and about 13.5 hours after the alarm had been triggered.

Findings in relation to the rescue operation:

- The FOCA helicopter crew was able to land at the accident site and found two people still alive. A request was made for two helicopters and special tools in order to rescue the trapped occupants.

- Two rescue helicopters from the nearest Rega bases were immediately called out; one of the crews was instructed to collect the necessary special tools and transport them to the accident site.
- The weather conditions in the area of the accident site were critical, yet both crews managed to land nearby.
- The rescue and recovery measures proved to be complex.
- More than 17 hours after the accident and about 2 hours after the discovery of the wreck the two patients were taken to two different hospitals.
- Several hospitals had to be contacted before suitable ones could be found that could accept the patients.

B.4.5 D-0251 and HB-3393 accidents on 19 May 2012

B.4.5.1 History of flight D-0251

On Saturday 19 May 2012, at 11:31, the glider pilot took off in his single-seater LS 1-0 glider, registered as D-0251, in aerotow on runway 34 at Schänis airfield (LSZX). After release, the glider flew via Mollis towards Chur. About one and a half hours after take-off, it circled along with some other gliders above the Calfeisen Valley in a wave, reaching an altitude of over 4000m/M. It then flew to Piz Linard in the Lower Engadine, where it turned around at an altitude of 3400m/M. On the return flight towards Schänis airfield, the pilot turned north at Bad Ragaz, flew over the Churfirsten and then back to Glarnerland. South of Schwanden, the pilot climbed to 3000m/M, from where he steered his glider in a slight descent towards the Klausen Pass. For about five minutes the glider flew along the rocky edges of the Jegerstöck and the Glatten at almost the same height.

At 16:22, D-0251 collided with the terrain north of the Klausen Pass, at an altitude of about 2400m/M, after a flight duration of 4:51 hours. The pilot suffered fatal injuries.

A Flarm collision warning device installed in the D-0251 registered the data points of the flight every four seconds until shortly before impact.

An ELT was not found at the accident site.

The pilot's mobile phone was not switched on.

B.4.5.2 History of flight HB-3393

The pilot who would later crash on board of the HB-3393 two-seater glider, flew with a flight instructor from Schänis airfield to Klosters and back on 19 May 2012. After about one and a half hours, the two landed back in Schänis at 14:20, having successfully completed the flight task as part of the Glider Cup.

At 16:59, the same glider pilot took off in the single-seat ASW 28-18 glider, registered as HB-3393, in aerotow on runway 34 of Schänis airfield with the intention of completing the same flight task again. After release, the flight proceeded in an altitude range between 2050m/M and 2640m/M north of Lake Walen along the Churfirsten to the Fulfirst. The glider crossed the Rhine north-east of Sargans, flying in a straight line towards Falknis.

At 17:35 HB-3393 collided with a steep, grassy rock slope at the west end of Falknistürm at approximately 2170m/M and subsequently slid several metres down the slope. The pilot suffered serious injuries on impact. Despite his injuries, he was able to free himself from the wreckage and deploy the unused rescue parachute at the front of the cockpit.

A Flarm collision warning device installed in the HB-3393 registered the data points of the flight every four seconds until shortly before impact.

The automatic ELT of older design on board the glider was triggered on impact and emitted a signal on 121.5 MHz.

The pilot was carrying a mobile phone and this continued to function after the crash.

B.4.5.3 SAR operations

Time	Interval since accident D-0251	Interval since accident HB-3393	Event
16:22	00:00		D-0251 accident
17:35	01:13	00:00	D-3393 accident
17:50	01:28	00:15	The RCC received a report from the Zurich ACC that the crew of a commercial aircraft had received ELT signals at FL 330-350, south of Lake Uri.
17:55	01:33	00:20	The RCC asked OFCOM to monitor the signals.
18:00	01:38	00:25	OFCOM reported to the RCC that no ELT signals were audible.
20:40	04:18	03:05	Persons at Bad Ragaz airfield (LSZE) reported to the RCC that an ELT signal was being received. The RCC informed OFCOM of this.
20:45	04:23	03:10	Persons at Schänis airfield reported to the RCC that two gliders were missing. The HB-3393's planned flight path and the pilot's mobile phone number were released and a request made to locate the phone.
21:02	04:40	03:27	The RCC informed the St Gallen Cantonal Police of the missing gliders, explaining that the pilot of HB-3393 could not be reached on his mobile phone.
21:05	04:43	03:30	The Zurich ACC reported to the RCC that several crews were receiving ELT signals.
21:05	04:43	03:30	St Gallen Cantonal Police used blind text messages to check whether the HB-3393 pilot's mobile phone was switched on.
21:07	04:45	03:32	OFCOM reported to the RCC that an ELT signal could be heard in the Chur/Rhine Valley area but could not be located.
21:13	04:51	03:38	Glider colleagues requested assistance from the manufacturer of the Flarm collision warning device and delivered the first IGC files for evaluation at 22:05.
21:15	04:53	03:40	The people in Schänis requested the presence of the St Gallen Cantonal Police at the airfield for the purpose of reporting a missing person.
21:20	04:58	03:45	The RCC asked the St Gallen Cantonal Police to go to the Schänis airfield; they were already on their way there.
21:30	05:08	03:55	The mobile phone number and the name of the pilot of D-0251 were reported to the RCC. When the number was dialled, voicemail was activated.
21:45	05:23	04:10	The RCC alerted the Air Force SDO, who promised to call up the crew of the SAR helicopter and to be ready for take-off in about one hour.
21:50	05:28	04:15	A person received an ELT signal in the Sargans area and drove in the direction of the signal.
22:00	05:38	04:25	The mobile phone of the pilot of D-0251 could not be located because it immediately switched to voicemail when the call was made.
22:15	05:53	04:40	The RCC informed the FOCA about the search operation.

22:25	06:03	04:50	The St Gallen Cantonal Police reported to the RCC that they would wait until the ELT had been found by the Air Force before attempting to locate the mobile phone.
22:35	06:13	05:00	The St Gallen Cantonal Police informed the RCC that the mobile phone of the pilot of HB-3393 had been located.
22:40	06:18	05:05	The people at Bad Ragaz airfield reported that the ELT signal was not being sent by an ELT at their airfield.
22:46	06:24	05:11	After evaluating many flight path records of other gliders, the manufacturer of the Flarm collision warning device provided the RCC with the coordinates of the site at which HB-3393 was believed to have crashed; these coordinates were about 250m west of the actual site.
23:00	06:38	05:25	The coordinates of the site at which HB-3393 was believed to have come down were passed on to the Air Force by the RCC.
23:02	06:40	05:27	The SAR helicopter took off from Dübendorf airfield.
23:05	06:43	05:30	OFCOM informed the RCC that it would produce a cell coverage map and that this would initially require approximately 30 minutes of travel time.
23:15	06:53	05:40	The SAR helicopter received a radio message from the HEZ with the coordinates of the probable site of the accident as determined by the manufacturer of the Flarm device.
23:15	06:53	05:40	The St Gallen Cantonal Police passed the coordinates on to the RCC and gave the azimuth angle of the mobile phone antenna from which the HB-3393 pilot's mobile phone had been received. The antenna was in Bad Ragaz; the azimuth angle was 290°.
23:45	07:23	06:10	The FOCA checked that the RCC had received the coordinates determined by the manufacturer of the Flarm device.
			While the SAR helicopter was flying over the search area, the crew received an ELT signal early on and was also able to take bearings. The crew of the Rega 5 rescue helicopter, which is stationed in Untervaz, was informed of the search operation by the HEZ and called to the base as a precaution.
23:50	07:28	06:15	The SAR helicopter crew informed the RCC that they had found HB-3393 and transmitted the exact coordinates of the accident site. Owing to strong winds (Föhn) and the steep terrain, it was considered too dangerous to lower the loadmaster with the winch in the dark and so this was not done. The crew agreed to stay on site until Rega 5 arrived at the site of the crash.
00:05	07:43	06:30	The RCC informed the people at Schänis airfield that a glider had been found. The people at Schänis airfield confirmed that HB-3393 was equipped with an ELT. They were unable to say whether the D-0251 was also equipped with an ELT; moreover, no results of the Flarm evaluation were yet available for the D-0251.
00:15	07:53	06:40	It was confirmed that the glider that had been found was HB-3393.
00:15	07:53	06:40	The RCC asked the people at Schänis airfield to indicate the possible glider routes from Piz Nuna to Schänis airfield, assuming that the two gliders had crashed independently of each other.
00:20	07:58	06:45	The RCC informed the FOCA of the status of the search operation and that the first glider had been found. The search for the second glider was to resume early in the morning.
00:27	08:05	06:52	Rega 5 took off from Untervaz with a helicopter rescue specialist (HRS) on board and headed for Falknis. The Rega helicopter remained in constant radio contact with the SAR helicopter.
00:30	08:08	06:55	When the Rega helicopter arrived at the accident site, the SAR helicopter lit up the wreckage of HB-3393 and the accident site: visibility was good. The SAR helicopter crew detected a heat source below the wing of HB-3393 using the infrared camera. Having consulted with the crew of the Rega helicopter, the SAR helicopter then left the accident area.

			The Rega helicopter flew close to the accident site several times to reconnoitre. However, due to the very strong, gusty winds near the ground, no rescue operations could be carried out at night and it was decided to try again at daybreak.
01:00	08:38	07:25	The RCC informed the SDO of the deployment. It was agreed that a Rega helicopter should start searching for the second glider at the scene of the HB-3393 crash early in the morning (scenario: collision of the two gliders). The SAR helicopter crew would be called up again for 10:00 in case there had actually been two unrelated accidents. If necessary, a FOCA helicopter could also be called in for the search.
01:08	08:46	07:33	The RCC Münster asked the RCC Zurich what was happening and offered support. It explained that, as of 07:30 onwards, a helicopter could be ready for action from Landsberg am Lech within 15 minutes and could be in Switzerland within 45 minutes.
01:26	09:04	07:51	The people at Schänis airfield were informed by the RCC that the search had been called off for the time being. It was agreed that a glider colleague who had also flown that day could be called in to Schänis at 11:00 to answer questions and provide information.
01:30	09:08	07:55	The SAR helicopter landed in Dübendorf.
01:40	09:18	08:05	The RCC informed the STSB about the status of the SAR activities. The options for assessing whether there had been two independent aircraft accidents or a single collision were discussed.
02:00	09:38	08:25	The FLIR operator informed the RCC of his observations from the SAR helicopter regarding the wreckage of HB-3393.
02:36	10:14	09:01	The manufacturer of the Flarm collision warning device informed the RCC that they had determined the flight path of a glider carrying an unknown Flarm device. Based on the take-off time, the flight path was likely that of D-0251. The last position determined was at some time between 14:30 and 14:50 in the Klosters area. The manufacturer assumed that there had been two independent events.
05:43	13:21	12:08	Rega 5 took off from Untervaz with two HRSs on board. Several attempts to drop the HRSs near the HB-3393 crash site failed due to the strong and gusty winds (Föhn).
06:30	14:08	12:55	The RCC asked the HEZ to call up the Rega 12 rescue helicopter stationed in Mollis and for it to fly over the Mürtschenstock region. Provisional flight credit of 30 minutes was approved.
06:50	14:28	13:15	The two HRSs could finally be dropped off in turn by Rega 5 above the Enderlin mountain hut, from where they set off on foot to the scene of the HB-3393 crash.
06:55	14:33	13:20	The RCC sent the maps regarding D-0251 produced by the Flarm device manufacturer to the Mollis operations base (EBMO).
07:20	14:58	13:45	Rega 12 reported to the HEZ that it had taken off on a search flight.
07:23	15:01	13:48	A glider pilot who had taken off from Schänis the previous day attributed the reconstructed flight path of an unknown glider to D-0251 and wanted to confirm this by asking the tow pilot.
08:00	15:38	14:25	Rega 12 reported to the HEZ that the search flight had ended unsuccessfully. It was difficult to conduct the search because of the strong wind.
08:01	15:39	14:26	The SDO asked the RCC about Rega's operational resources and what was required from the Air Force. He proposed that the SAR helicopter and two additional EC635 helicopters if needed could be ready for deployment from 10:00.
08:20	15:58	14:45	The FOCA discussed the resources to be deployed with the RCC.
08:30	16:08	14:55	The SDO informed the RCC that two EC635s would be sent to Mollis by 11:00. The briefing of the helicopter crews in the presence of glider pilots was scheduled for 12 noon.

08:40	16:18	15:05	The people at Schänis airfield were informed that the glider pilots should be in Mollis at 11:00.
08:40	16:18	15:05	The two HRSs told the HEZ that the body of the HB-3393's pilot had been found lying under the wing root, and described the situation at the crash site.
08:45	16:23	15:10	The Air Force discussed the deployment of its resources with the FOCA. Because of the wind, the Air Force wanted to fly with a Super Puma rather than with the EC635.
10:35	18:13	17:00	The SAR helicopter landed at Mollis airfield.
10:55	18:33	17:20	The Flarm manufacturer confirmed that the reconstructed flight path was that of the D-0251. However, the final position of this flight path was not necessarily the crash site.
11:00	18:38	17:25	An Air Force on-scene commander (OSC) took up duty at the EBMO.
11:00	18:38	17:25	The SAR helicopter reported to the HEZ that it had taken off on a search flight in the Mürtschenstock area.
11:50	19:28	18:15	The D-0251's presumed flight path was discussed based on confirmed positions.
13:00	20:38	19:25	The SAR helicopter reported to the HEZ that it had returned to the Mollis airfield to refuel.
13:19	20:57	19:44	Based on the analysis of new flight path records from other gliders, the Flarm manufacturer informed the RCC: "*There is new data. Last contact now 16:12 local time, 6km south-south-west of Schwanden, approx. 3000m AMSL*."
13:30	21:08	19:55	The OSC reported to the RCC that the first search flight had been terminated; three new search sectors, namely Mürtschenstock, Wiggis and Gulderen, were defined.
13:36	21:14	20:01	Following a telephone conversation with the Flarm manufacturer, the OSC suggested flying over the area from Schwanden to Urnerboden and then returning to Dübendorf.
13:50	21:28	20:15	The SAR helicopter reported to the HEZ that it had taken off on a search flight in the Glärnisch area.
13:55	21:33	20:20	The FOCA recommended that the OSC still search as much and as long as possible on 20 May.
14:00	21:38	20:25	The RCC management wanted a map to be made of the areas already searched and the OSC in charge to be announced for the next few days. It also wanted to know who would be in charge of the search operations.
14:17	21:55	20:42	It was agreed between the FOCA, the OSC and the SDO how to proceed: the Air Force was to fly in the Urnerboden area; the FOCA would arrive in Mollis at 16:30 with its own helicopter and then continue the search until dark. The Air Force would continue the search from Mollis the following day with several helicopters.
14:39	22:17	21:04	The Flarm manufacturer sent an email to all involved in the SAR operation with the last reconstructed position of D-0251 at 16:12:03, 46° 56' 29.04" N, 9° 02' 22.32 "E, 3023m AMSL, heading 215°. This position was a good 10km from the actual crash site. In addition, the email contained the opinion that, based on the information from the gliders that had been included to reconstruct the flight, the D-0251 could not have flown north from this last known position from the main valley of Glarus between 16:12 and 18:20. It recommended focusing the search on the entire northern side of the valley from Braunwald to Klausen Pass in an altitude band between 1500 to 2800m.
15:30	23:08	21:55	The Zurich ACC reported to the RCC that several crews were receiving ELT signals. The RCC reported that the ELT in the crashed HB-3393 could not yet be switched off.
15:35	23:13	22:00	The SAR helicopter reported to the HEZ that it had landed in Braunwald.
15:51	23:29	22:16	The FOCA helicopter reported to the HEZ that it would be landing in Mollis in 25 minutes.
15:53	23:31	22:18	The Flarm manufacturer resent the information in the email originally sent out at 14:39 to those involved in the SAR, this

			time in two separate emails as Rega's mail server had not accepted the first email owing to the excessive amount of data in the maps attached.
16:30	24:08	22:55	A briefing took place in Mollis at which the OSC function was transferred from the Air Force to the FOCA.
16:49	24:27	23:14	The FOCA helicopter reported to the HEZ that it had taken off on a search flight.
16:50	24:28	23:15	The Air Force OSC informed the RCC that the FOCA helicopter would fly until about 21:00 and that the Air Force's SAR helicopter would return to Dübendorf.
16:55	24:33	23:20	The RCC received a report from an eyewitness via the St Gallen Cantonal Police that a glider had been seen near the Alvier on 19 May between 18:00 and 18:30.
17:00	24:38	23:25	The SDO informed the RCC that a briefing would be held on 21 May at 08:00 and that a search would be conducted with two EC635s from 10:00, as agreed with the FOCA; he also reported that nothing had been found on the reconstructed flight path of D-0251 over Schwanden and Urnerboden.
17:08	24:46	23:33	The SAR helicopter reported to the HEZ that it had landed in Dübendorf.
18:00	25:38	24:25	The HEZ informed the RCC that the recovery of HB-3393 had been postponed until the following day because of high winds.
18:40	26:18	25:05	The RCC received another report from an eyewitness that a low-flying glider had been spotted near Kerenzerberg at 16:00 on 19 May.
18:50	26:28	25:15	The crew of the FOCA helicopter was informed of the eyewitness's observation. The helicopter was in the area east of Braunwald-Betschwanden but had found nothing. The next area to be searched was Näfels-Mollis-Weisstannen.
19:15	26:53	25:40	The SDO informed the RCC that the new OSC/SDO would report at 08:30 the following morning to coordinate the search flights.
19:30	27:08	25:55	The FOCA helicopter reported to the HEZ that it would fly towards Kerenzerberg and then return to Bern-Belp.
19:55	27:33	26:20	The RCC received a further report from an eyewitness that a glider had been observed near Eggbergen.
20:15	27:53	26:40	The Flarm manufacturer explained to the staff member on duty at the RCC how the flight path was reconstructed and that the last position on this flight path was not necessarily the crash site.
20:25	28:03	26:50	The RCC received a further report from an eyewitness that a glider had been observed near Isleten.
20:35	28:13	27:00	Two further eyewitness reports were received by the RCC from Schänis airfield.
20:45	28:23	27:10	The FOCA helicopter reported to the HEZ that it had aborted the search flights without success and was on its way back to Bern-Belp.
21:15	28:53	27:40	The crew of the FOCA helicopter told the RCC about the large amounts of snow in the search area and that they had not been systematic in their search that day and had mainly considered the flight path reconstruction from the Flarm data. The strategy recommendation made to the Air Force for the following day's search was to systematise and narrow down the search area. That day the search had been conducted in the Kerenzerberg, Glärnisch, Schwanden and Lake Klöntaler area.
21.05.12	2 days	2 days	The body of the HB-3393's pilot was recovered by Rega at 13:00 and the ELT was switched off.
21.05.12	2 days	2 days	Various indications as to the whereabouts of the missing D-0251 were received by various agencies and were logged by the RCC. The search tactics were discussed with glider pilots. Several Air Force helicopters were involved in the search. An evaluation of additional Flarm data did not yield any new findings regarding the D-0251's flight path.
21.05.12	2 days	2 days	A reconnaissance of the accident site was carried out in preparation for the recovery of the wreckage of the HB-3393.

22.05.12	3 days	3 days	Glider pilots and relatives of the missing pilot of the D-0251 were involved in the SAR operations. The pilot's wife, who was herself a glider pilot, defined flight areas that might come into question: west of the Klausen Pass, Muota Valley, Klausen Pass-Lake Klöntaler, and Klausen Pass/Clariden, Lake Glattal. The Air Force searched in two helicopters; the wife flew in one and an experienced gliding instructor in the other.
23.05.12	4 days	4 days	Flight records of the missing pilot's last 32 flights were provided by relatives. This information was taken into account when defining the search strategies. The Air Force did not take off on search flights because of the weather conditions. The information provided by various persons was evaluated. The operational strategy for searching the following day with two Air Force helicopters was discussed.
24.05.12	5 days	5 days	Further search flights were undertaken with two Air Force helicopters. The search areas that were flown over were marked on maps, as were the search areas planned for the following day. The FOCA offered the Air Force the use of a FOCA search helicopter for the following day. The SDO was of the opinion that the two Air Force helicopters were sufficient.
25.05.12	6 days	6 days	The Air Force searched again with its two helicopters, without success.
25.05.12	6 days	6 days	The wreckage of the HB-3393 was recovered by the Air Force mountain detachment.
27.05.12	8 days		In response to a witness report, the Sevelen/Rhine canal area was flown over, but without success.
29.05.12	10 days		A new witness report concerning the area east of Landquart was received.
30.05.12	11 days		Persons from Schänis airfield enquired at the RCC about the status of the search operations and told the RCC that colleagues of the D-0251 pilot wanted to conduct a private search operation. The Air Force did not fly because of poor weather.
31.05.12	12 days		The Air Force again sent out a search helicopter. Regarding the passing on of information to the colleagues of the missing pilot, the SDO reminded the RCC of the Air Force's search authority and offered to provide his contact to the pilot's colleagues.
04.07.12	46 days		Uri Cantonal Police informed the RCC that a person had reported seeing debris from a glider north of the Klausen Pass. The RCC immediately informed the SDO, who contacted this person and subsequently went to the site, where the wreck of the D-0251 was found. Rega was immediately entrusted with recovering the pilot's body. This was no longer possible on that day owing to the difficult local conditions.
05.07.12	47 days		The body of the pilot of the D-0251 was recovered by Rega.
09.07.12	51 days		Reconnaissance of the accident site was conducted in preparation for the recovery of the widely scattered debris from D-0251.
16.07.12	58 days		The wreckage of the D-0251 was recovered by the Air Force mountain detachment.

Table 6: Chronology of search and rescue operations for D-0251 and HB-3393.

B.4.5.4 Findings

Findings in relation to the D-0251 and its pilot:

- The pilot did not want to decide on his exact flight path until he was in flight.
- The pilot did not radio his intended flight path to anyone after take-off.
- It could not be determined whether the ELT of older design, which was alternately carried by the pilot in the D-0251 and in another aircraft, was on board the D-0251.

- A Flarm collision warning device was installed in the D-0251, which recorded the flight path.
- The pilot's mobile phone was not switched on.
- The pilot suffered fatal injuries on impact with the ground.

Findings in relation to the HB-3393 and its pilot:

- At 16:31, the pilot informed his wife by text message that he would again take off on a solo flight.
- The pilot announced his intended flight route Schänis-Klosters-Schänis before taking-off at 16:59 from Schänis airfield.
- The HB-3393 was equipped with an automatic ELT of older design which was triggered on impact and broadcast a signal on 121.5 MHz.
- A Flarm collision warning device was installed in HB-3393, which recorded the flight path.
- The pilot was carrying a mobile phone and this continued to function after the crash. However, phone calls were not answered by the pilot.
- The pilot was able to free himself from the wreckage after the impact, pull out the unused rescue parachute and lie down next to the fuselage under the left wing.
- The pilot's wife was expecting him back at about 20:00, as he usually came home from flying at that time and had not announced any delay.
- The pilot succumbed to his injuries before the arrival of the emergency services.

Findings in relation to Flarm:

- By evaluating the Flarm devices of other gliders that received signals from the D-0251's device, it was possible to reconstruct the D-0251's flight path.
- By evaluating the Flarm devices of other gliders that received signals from HB-3393's device, it was possible to reconstruct the glider’s flight path.

Findings in relation to the RCC Zurich:

- Fifteen minutes after HB-3393 crashed, the RCC received a report from the Zurich ACC that the crew of a commercial aircraft had received ELT signals at FL 330-350, south of Lake Uri.
- OFCOM's direction-finding service, which was alerted immediately, was unable to receive any signals at this time. At the time OFCOM reported this, no aircraft had been reported missing.
- At 20:45, two gliders were reported missing by persons at the Schänis airfield. Practically at the same time, people at Bad Ragaz airfield reported that signals from an ELT could be heard.
- It was initially thought that the two gliders may have collided.
- The RCC immediately informed the St Gallen Cantonal Police and arranged for an emergency search of the HB-3393 pilot's mobile phone.
- Further reports of audible ELT signals were received by the RCC; in addition, OFCOM reported that a signal was now being received in the Chur/Rhine Valley area.

- At 21:45, one hour after Schänis airfield reported the gliders missing, the RCC alerted the Air Force SDO.
- At 22:46 the RCC received the position of the HB-3393's suspected accident site from the manufacturer of the Flarm collision warning device; this was about 250m west of the actual accident site. The RCC immediately forwarded this position to the Air Force and subsequently coordinated the search for the HB-3393 between the SAR helicopter and the Rega rescue helicopter.
- The RCC coordinated the search for the missing D-0251 for 12 more days. At 14:39 on the day following the accident, the manufacturer of the Flarm collision warning device provided the RCC as well as the other SAR entities involved with the last position determined based on a reconstruction of D-0251's flight path, and proposed a primary search area. The last position was a good 10km from the actual crash site; the recommended primary search area included the area where the glider had come down.
- Some of the missing pilot's relatives and fellow glider pilots also speculated about the chosen flight path. Their hypotheses were taken into account by the RCC and the individuals were allowed to fly on the SAR flights. The RCC also reviewed numerous pieces of information received and forwarded the information to those entrusted with the search.
- Following the report of the sighting of the debris on 4 July 2012, the RCC had the site confirmed, arranged for the recovery of the body and informed all parties involved.

Findings in relation to the search operation:

- The Air Force SAR helicopter took off from the Dübendorf airfield at 23:00, a good hour after the SDO was alerted by the RCC, and received the coordinates of the suspected accident site of HB-3393 in flight.
- During the flight into the deployment area, the HB-3393's ELT signal was received soon on and could be tracked. The SAR helicopter crew found the wreckage at 23:50.
- In the days following the accident, numerous search flights were carried out by several Air Force helicopters and a FOCA helicopter. The D-0251 accident site was located in a search area mapped for Air Force search flights on 21 May 2012 and in another for search flights on 22 May 2012. Moreover, it was located in an area that was flown over on 24 May without results and marked on a map.
- The search for the D-0251 proved difficult due to the wind and weather conditions and the large amounts of snow.
- The search was stopped without result at the end of May.
- On 4 July 2012, 46 days after the D-0251 came down, someone reported seeing debris from a glider north of the Klausen Pass. The Air Force checked the site and confirmed that the wreck of D-0251 had been discovered.

Findings in relation to the rescue operation:

- Before midnight, while the Air Force SAR helicopter was en route to the deployment area on the Falknis, the crew of the rescue helicopter at the Rega base in Untervaz was alerted and called to the base.
- At 00:27, the rescue helicopter took off and was directed by the SAR helicopter to the scene of the HB-3393 accident.

- The rescue helicopter then tried to land near the accident site or to drop a person, but this was not possible because of the strong and gusty winds.
- Having detected a heat signal, the SAR helicopter crew decided to make another rescue attempt at daybreak.
- The helicopter took off again from Untervaz at 05:43 and reconnoitred the accident site once more. Several attempts to drop the HRS in the immediate vicinity of the accident site failed because of the wind.
- The two HRSs could finally be dropped off in turn by Rega above the Enderlin mountain hut, from where they set off on foot to the scene of the HB-3393 crash.
- After a walk of about two hours, the HRSs reached the wreckage of HB-3393 and found the now-deceased pilot under the left wing of his glider. About 15 hours had passed since the crash occurred.
- On 4 July 2012, after the wreckage of D-0251 had been found, Rega was tasked with recovering the pilot's body. Because the local conditions were so difficult, this could not be done until the following day.

B.4.6 HB-ZHX accident on 8 December 2013

B.4.6.1 History of flight

On Sunday 8 December 2013, at 12:55, the pilot took off alone from La Côte airfield (LSGP) on a private training flight in the Robinson R44 Raven II helicopter, registered as HB-ZHX. The pilot wanted to carry out training approaches at various mountain landing sites in the Valais. The pilot was also the owner of the helicopter, but not the holder.

The pilot submitted a general flight notification at La Côte airfield. No flight plan was submitted.

After five landings on the Glacier du Tsanfleuron and Theodul Glacier mountain landing sites, the pilot took a break of about 45 minutes on the latter. At around 14:45, the pilot took off again and flew to the Unterrothorn mountain landing site, where he carried out two landings and then continued towards the Glacier du Brenay mountain landing site located south-west of the Pigne d'Arolla at around 3600m/M.

After a reconnaissance flight pattern, the pilot refrained from landing and instead decided to fly over the area in order to take a closer look. The pilot flew closer and closer to the surface and was unable to avoid colliding with the glacier; the helicopter hit the glacier at around 15:15. The helicopter was destroyed on impact. The pilot was slightly injured. He was only wearing light clothes and decided to stay with the wreck. He was able to construct a makeshift shelter from the wind with parts of the wreckage.

Both the helicopter's radio system and the pilot's mobile phone were destroyed on impact.

The 406 MHz emergency transmitter on board the helicopter was automatically triggered on impact.

B.4.6.2 SAR operation

Time	Interval since accident	Event
15:15	00:00	Accident
15:30	00:15	The MCC in Toulouse received for the first time a signal from the HB-ZHX's ELT. It was not possible to locate the ELT at the time. This information was reported to the Zurich RCC at 15:41.
15:41	00:26	The RCC received the first message from the MCC. At the same time, the Geneva ACC reported that signals from an ELT had been received on 121.5 MHz by airliners in the Matterhorn area at FL 330 as well as in the Mont Blanc area at FL 380.
15:42	00:27	The RCC alerted OFCOM's direction-finding service. The staff member on duty promised to investigate the situation and call back.
15:44	00:29	The RCC could see from the data in the ELT directory that HB-ZHX was normally based at La Côte airfield. Calls to the deposited contact numbers, which in this case were those of the helicopter owner, did not get through: a message is left at the mobile phone number with a request to call back.
15:48	00:33	The ACC Geneva reported to the RCC that signals from an ELT on 121.5 MHz had been received in the Sion area at various altitudes.
15:49	00:34	OFCOM called back and reported that it was not receiving anything.
15:53	00:38	The MCC again received signals from the ELT via another satellite and initial information about the location of the accident using the Doppler technique. The position determined, given with a confidence level of 54%, was about 7.7km west-southwest of the actual accident site. The Zurich RCC received the information at 15:58.
15:58	00:43	The RCC received the second message from the MCC.
16:00	00:45	The RCC contacted La Côte airfield and learned that the HB-ZHX was often parked on the owner's property and was not currently at the airfield. Another phone number for the owner was given to the RCC. When called, this number was engaged.
16:27	01:12	The Geneva ACC reported to the RCC that signals from an ELT on 121.5 MHz had been received in the Mont Blanc area at FL 350. The RCC alerted OFCOM's direction-finding service.
16:30	01:15	OFCOM called back to say that nothing was being received in the Valais area and that the area around Mont Blanc was now being checked.
17:01	01:46	The MCC again received signals from the ELT via a third satellite and further information about the location of the accident using the Doppler technique. The position determined was given a confidence level of 50% and was about 40km in a south-westerly direction from the actual accident site, in the French-Italian border area north of Courmayeur. The reliability of the location was classed as 'suspect'. The Zurich RCC received the information at 17:06.
17:06	01:51	The RCC received the third message from the MCC.
17:32	02:17	The RCC tried unsuccessfully to contact the owner of the HB-ZHX.
17:45	02:30	The Poggio Renatico RCC (Northern Italy) contacted the Zurich RCC to report that they had received a position for HB-ZHX from COSPAS-SARSAT at 17:01. This position was a good 22.6km from the actual crash site. Furthermore, the Poggio Renatico RCC said that it had received reports from various aircraft that an ELT was audible.
17:48	02:33	The holder of the HB-ZHX called the RCC back and informed them that the HB-ZHX was being flown privately.
18:00	02:45	The head of operations at the RCC asked a Rega staff member for assistance as he had received several ELT messages and was unable to get hold of the pilot and therefore felt uneasy. The staff member was too busy to help at the time.

18:00	02:45	The Zurich RCC tried several times to contact the neighbouring RCC in Lyon. The line was constantly engaged.
18:05	02:50	The RCC informed the police and asked them to go by the house of the owner of HB-ZHX to check if everything was alright.
18:06	02:51	The RCC alerted the Air Force SDO and described the current state of affairs, and gave the latest coordinates known. The Aosta-Grand Combin region was defined as a possible search area. The SDO replied that his crew would get ready and set off as soon as possible.
18:16	03:01	The SDO informed the FLIR operator.
18:20	03:05	The RCC informed the FOCA about the current state of affairs. The FOCA representative knew the owner of the HB-ZHX and promised to call one of his colleagues to ask if he knew anything. He would then call back.
18:27	03:12	The RCC was again in contact with the SDO. The latter also knew the owner of the HB-ZHX, as he was a former military pilot. The SDO reported that the SAR helicopter crew was getting ready and would soon report back.
18:30	03:15	The SDO was able to get hold of the PIC and call him up.
18:30	03:15	The Poggio Renatico RCC called the RCC and reported that they had found out that the owner was a former military pilot.
18:40	03:25	The FOCA representative contacted the RCC and reported that he could not get hold of the owner's colleague.
18:41	03:26	The MCC again received signals from the ELT via a same satellite as at 17:01 and further information about the location of the accident using the Doppler technique. The position determined, given with a confidence level of 50%, was about 2.9km south-east of the actual accident site. This information was passed on to the RCC at 18:48.
18:46	03:31	The police called the RCC and described the situation encountered at the owner's residence: There was only one domestic worker on site. The owner was not there, his wife was abroad on holiday. Moreover, the HB-ZHX was not on the property.
18:48	03:33	The RCC received a fourth message from the MCC. The new coordinates were passed on to the SDO.
19:03	03:48	The SDO gave the SAR helicopter crew the prepare-to-deploy order.
19:15	04:00	The crew of the SAR helicopter held a briefing.
19:15	04:00	The RCC also wanted to alert Air Zermatt but could not reach anyone.
19:27	04:12	The RCC involved the HEZ. The latter took over the organisation and implementation of the search operation using Rega resources.
19:32	04:17	The SAR helicopter took off from Payerne military airfield and headed to the search area.
19:35	04:20	The HEZ called La Côte again and learnt that the HB-ZHX was not in the hangar; furthermore, a flight notification with the destination *"ZZZZ"* (i.e. landing on terrain) had been filed.
19:42	04:27	The HEZ alerted the Rega 15 rescue helicopter, which is stationed in Geneva, and sent it out to search the area in question. This helicopter was equipped with a direction-finding system for locating ELTs. The pilot was briefed on the phone by the RCC head of operations and the latest coordinates were passed through.
19:45	04:30	The son of the HB-ZHX's owner called the RCC and informed them that his father was flying alone in the HB-ZHX and they had last had contact when his father was in the Zermatt area.
19:46	04:31	The crew of the SAR helicopter informed the HEZ that they would be in the search area in about 20 minutes. The HEZ informed the crew that Rega 15 would also be coming to the search area.
19:50	04:35	The Valais emergency medical services and Air Zermatt were alerted. The refuelling possibilities in Zermatt for the two search helicopters were clarified.

19:55	04:40	The pilot of Rega 15 informed the RCC that the Air Force had dispatched the SAR helicopter.
19:57	04:42	The SAR helicopter crew reported that they would be in the search area in five minutes.
20:02	04:47	The owner's colleague called the RCC to say that he had tried to call him on his mobile phone but that he was not answering the call, which was unusual.
20:07	04:52	The pilot of Rega 15 asked the HEZ to organise refuelling facilities in Sion or Zermatt. Air Zermatt was then contacted and confirmed that this was possible. In addition, the crew of the rescue helicopter there was preparing for deployment. At 20:10 this information was transmitted to the SAR helicopter crew, who replied that they were out searching.
20:11	04:56	The SAR helicopter crew was able to locate the accident site. The pilot of the HB-ZHX had indicated his position by shining a lamp.
20:15	05:00	The SAR helicopter crew reported to HEZ that they had found the accident site. They asked the HEZ to call up Air Zermatt. Rega 15 was then instructed to fly back to base.
20:20	05:05	The SAR helicopter crew reported that someone was waving a torch. The HEZ decided not to call on further resources for the time being and to keep the Air Zermatt helicopter on standby. The SAR helicopter crew decided to land at the accident site and rescue the pilot. There was clear visibility, the temperature was about -12 °C and there was a gusty wind of about 20kts. The crew reckoned that landing at this location and at this altitude was, despite the weight and strong wind, just about feasible. The pilot of the HB-ZHX was slightly hypothermic and was taken to the hospital in Sion for assessment. Air Zermatt was informed that the operation had ended. All involved agencies were subsequently informed by the Zurich RCC that the search operation had been concluded.
		As the HB-ZHX's ELT continued to operate, the MCC continued to receive its signals at irregular intervals and provided position reports with increasingly higher confidence probabilities. The positions given were within a few kilometres of the actual accident site. The ELT was switched off the following day during the recovery operations.
		Two days later, OFCOM asked the RCC for the exact coordinates of the accident site in order to clarify why OFCOM had not been able to receive the ELT signals.

Table 7: Chronology of the search and rescue operation for HB-ZHX.

B.4.6.3 Findings

Findings in relation to the HB-ZHX and its pilot:

- The pilot filed a general flight notification from which the exact route and landing sites were not apparent.
- The HB-ZHX was equipped with an automatic ELT without GPS coupling; the ELT was triggered on impact and sent out signals.
- The contact number stored in the ELT registration directory was the pilot's mobile phone number.
- The mobile phone carried by the pilot was destroyed in the crash, as was the radio equipment of the HB-ZHX.
- The pilot suffered minor injuries on impact with the ground.
- The pilot was not carrying adequate mountain equipment.

- The pilot decided to stay with the wreckage and made a makeshift shelter from the wind using wreckage parts.
- The pilot signalled his presence by shining a lamp when the SAR helicopter arrived.

Findings in relation to the RCC Zurich:

- The RCC received the first alert regarding the activated ELT of the HB-ZHX about 25 minutes after the accident, still without location. At the same time, distress signals were reported to have been heard in the Matterhorn and Mont Blanc area.
- OFCOM's direction-finding service, which was alerted immediately, was unable to pick up any distress signals on its fixed stations.
- The RCC's investigations did not reveal any information about the whereabouts of the helicopter and its owner.
- The first localisation of the ELT by the COSPAS-SARSAT system, received about 40 minutes after the impact, was some 7.7 km from the crash site. The other reports from the MCC, which arrived at irregular intervals, provided coordinates that were in the range of several kilometres around the accident site, in some cases up to 40km away.
- At the same time, distress signals picked up by airliners continued to be registered several times, although OFCOM's direction-finding service with its fixed stations was unable to receive anything.
- Just under two and a half hours after the initial alert, the SDO was alerted and given the latest coordinates.
- A good three and a half hours after the first alert, the HEZ became involved and additional Rega resources were called in to join the search.

Findings in relation to the search operation:

- About an hour after the RCC had given the alert, the SDO gave the SAR helicopter the prepare-to-deploy order.
- The SAR helicopter took off from the Payerne airfield about 30 minutes later and arrived at the mission area a further half hour later.
- The Rega helicopter, which had only been alerted after the SAR helicopter had taken off, was still enroute to the search area at the time.
- The SAR helicopter crew was able to locate the accident site within a few minutes.
- The weather was good and the night was clear.

Findings in relation to the rescue operation:

- The SAR helicopter crew was able to land at the accident site and rescue the pilot, who had minor injuries.
- The Rega rescue helicopter and an Air Zermatt helicopter were on standby in the air, respectively on the ground, for any necessary rescue measures.

B.4.7 HB-3364 accident on 1 July 2015

B.4.7.1 History of flight

The pilot who had the accident with HB-3364 was a competitor in the 2015 Junior Swiss Championships held at Schänis Airfield (LSZX) from 1 to 5 July 2015. On the first day of the competition, the Schänis-Serfaus-Zernez-Schänis triangular route was to be flown. The pilot took off at 12:14 in the single-seat glider LS-8-18, registered as HB-3364, in aerotow and released 14 minutes later in the release area at Mattstock. After releasing, the pilot explored the expected flight path along the Churfirsten as far as the Chäserrugg and then flew back to the release area at Mattstock. At 13:19, the pilot did a second reconnaissance flight up to Gamsberg, turning back towards the release area at 13:32 at 2560m/M. Shortly after arriving in the release area, the glider crossed the start line at 14:33 above Durschlegi near Amden. The pilot was in a team flight with a second glider.[5] The route led along the Churfirsten. At 14:52, HB-3364 climbed to 2650m/M at the Alvier, after which the pilot set off across the Rhine valley. Here the team flight partner separated from the pilot of the HB-3364 as he had too little altitude for the valley crossing. On the western flank of the Vilan, the pilot gained altitude and at 15:21 flew on the northern side of the Prättigau towards Schesaplana, Drusenfluh and Sulzfluh. He then flew on via St. Antönien to Älpetispitz. Here the pilot climbed in good thermals to 3360m/M and then flew on towards the Engadine. At an altitude of 3270m/M and shortly before reaching the Fuorcla Vermunt east of the Piz Buin, the pilot decided to fly back to Prättigau. At 16:18 the HB-3364 reached the Chlein Seehorn at 3075m/M. After a short climb, the flight continued towards the Silvretta reservoir. At the Lobspitze the pilot turned around again, reaching the Chlein Seehorn at 16:27 at 2990m/M.

The further flight trajectory could not be reconstructed. At an unknown time, probably around 16:30, the HB-3364 collided with terrain on the western flank of the Chlein Seehorn. The glider was destroyed on impact. The pilot was killed.

The aircraft had an on-board computer with an integrated Flarm system.

The 406 MHz ELT was torn out of the glider on impact, damaged and disconnected from its transmitting antenna, so that no emergency signals could be received.

The pilot's mobile phone was not found.

B.4.7.2 SAR operation

The time of the accident was assumed to be 16:30; the exact time is not known.

Time	Interval since accident	Event
16:30	00:00	Accident
18:00	01:30	People at Schänis airfield tried to get hold of the pilot of the HB-3364 by air radio and mobile phone.
19:00	02:30	Two pilots attempted to contact the pilot of the HB-3364 via the air radio frequencies 132.57, 123.67 and 122.47 MHz from gliders in the air.
19:45	03:15	First Flarm files were selected from glider pilots.
19:50	03:20	A touring motor glider (TMG) took off from Schänis airfield on a search flight to the Schesaplana/Madrisa area.
19:57	03:27	The manufacturer of the Flarm collision warning system was notified by people at Schänis airfield.

[5] Team flying is a flight tactic in cross-country championships in which several pilots fly a given route. Tactical decisions such as route or in-flight speed selection are discussed and information about weather, climb rates, etc. is shared.

20:03	03:33	A second TMG took off from Schänis airfield on a search flight to the area south of Prättigau as far as Samedan.
20:15	03:45	People at Schänis airfield informed the RCC.
20:20	03:50	People at Schänis airfield informed the RCC.
20:27	03:57	The RCC logged the report from Schänis airfield that the HB-3364 was missing, noting that the pilot was a participant in the Junior Swiss Championship. The pilot's name and mobile phone number had been provided, and the Flarm manufacturer had already been informed.
20:30	04:00	People at Schänis airfield received initial evaluation results from the Flarm manufacturer.
20:31	04:01	The Flarm manufacturer reported to the RCC that Flarm data received from other gliders was being analysed and that the RCC would be informed of the results.
20:36	04:06	The manager of Amlikon airfield (home airfield of the pilot and the HB-3364) reported to the RCC that he also had no information on the whereabouts of the glider.
20:45	04:15	The Flarm manufacturer sent an email to the people at Schänis airfield and the RCC: *"subject: Last Posi (2), importance: High, Nombre total de points: 568 Nombre de vols utilisés pour l'analyse : 5 Dernière position connue 46°53.537' N 010°03.342' E Heure du dernier contact 14:25:04 UTC Dernière altitude connue 2799 m"* This position was about 3km from the actual crash site.
20:47	04:17	Fedpol reported to the RCC that the pilot's mobile phone was not logged in anywhere.
20:50	04:20	The St Gallen Cantonal Police contacted the RCC to enquire about the search possibilities and informed them that they would go to Schänis airfield. The RCC reported that it was waiting for flight path evaluation from the Flarm manufacturer.
20:55	04:25	The Zurich FIC informed the RCC that there had been no glider on their frequency.
21:00	04:30	The RCC told the Air Force SDO that an operation was to be expected; the Flarm manufacturer's flight path evaluation was still being awaited.
21:00	04:30	Persons from Schänis airfield informed the pilot's family.
21:03	04:33	The Vienna RCC also had no information on the whereabouts of the missing glider. It would seek information from the airfields near the border and report back.
21:05	04:35	The people at Schänis airfield were told by the RCC that the pilot's mobile phone could not be located.
21:08	04:38	The SDO informed the SAR helicopter crew. The crew then headed towards the military airfield in Payerne.
21:10	04:40	The persons at Schänis airfield contacted the representative of the pilot's resp. HB-3364's gliding group.
21:17	04:47	The Flarm manufacturer sent an email to the people at Schänis airfield and the RCC: *"subject: Last Posi (4), importance: High, 14:27:23 UTC 46°53.207' N 010°01.316' E 3031m apparently on the way back west, already back on the CH side (nrthn Seetal SAC hut)".* This position was about 100m from the actual crash site.
21:18	04:48	The Vienna RCC reported to the RCC that no information was available.
21:20	04:50	The Flarm manufacturer advised the RCC to search while it was still daylight from the transmitted position on the Swiss side as far as the Vilan.
21:30	05:00	The St Gallen Cantonal Police arrived at Schänis airfield.
21:30	05:00	The SDO asked the RCC for an update on the situation.
21:37	05:07	The HEZ called up the Rega 5 rescue helicopter stationed in Untervaz for a search flight.
21:40	05:10	Relatives of the pilot arrived at Schänis airfield.
21:42	05:12	Schänis airfield asked the RCC to start the search as soon as possible.
21:44	05:14	The Flarm manufacturer reported to the RCC that it had no new coordinates. The RCC reported that the pilot of the rescue helicopter would call to discuss the search procedure.
21:45	05:15	The SDO informed the SAR helicopter crew of the assessment provided by the Flarm manufacturer.
21:52	05:22	The Rega pilot was briefed by the Flarm manufacturer by phone.

21:55	05:25	The persons at Schänis airfield enquired whether the Rega helicopter was already on its way and asked for the Air Force SAR helicopter to be called out as well.
22:00	05:30	In a conference call between the Flarm manufacturer, the Rega pilot and the HEZ, the primary search area was defined from Chlein Seehorn to Schlappintal along the southern flank of the mountains along the border, no lower than 2400m/M.
22:06	05:36	The SDO reported to the RCC that the SAR helicopter crew was in Payerne and ready to receive information in about 10 minutes. The RCC replied that the crew should contact the Flarm manufacturer.
22:16	05:46	The people at Schänis airfield insisted that the Air Force SAR helicopter should take off.
22:20	05:50	The RCC told the SDO to deploy the SAR helicopter. The SDO passed on the SAR pilot's mobile phone number.
22:20	05:50	The SAR pilot was briefed by the Flarm manufacturer by phone.
22:32	06:02	The St Gallen Cantonal Police asked the RCC for an update and said that it might be possible to carry out an emergency search of the mobile phone using a cell coverage map.
22:33	06:03	In Payerne, the SAR helicopter crew discussed whether FLIR should be used.
22:50	06:20	The SDO informed the RCC that the SAR helicopter would take off from Payerne at 23:00.
23:10	06:40	The FOCA was informed about the measures taken so far. The ACC should ask commercial aircraft in the vicinity if they were receiving distress signals. The RCC should ask OFCOM to carry out monitoring of the relevant sites.
23:12	06:42	OFCOM accepted the request from the RCC to monitor all sites in Graubünden.
23:20	06:50	The Zurich ACC reported to the RCC that no distress signals had been reported.
23:24	06:54	The SDO reported to the RCC that the SAR helicopter was on its way to the area of operation and that the search would continue early the next morning.
23:28	06:58	OFCOM reported to the RCC that nothing had been heard.
23:38	07:08	The FOCA reported to the RCC that a FOCA helicopter would be at the Untervaz base at 07:00, and told the RCC to get in touch with the Vienna RCC again.
23:45	07:15	The mission was discussed with the crew of the Rega helicopter in Untervaz in case the SAR helicopter should find something during the night. The Rega helicopter was unsuccessful in its search. It had searched from the Chlein Seehorn area along the southern flank of the mountains along the border as far as the Falknis and Vilan.
23:45	07:15	The RCC informed the Vienna RCC about the search operation.
23:50	07:20	The RCC obtained information from the persons at Schänis airfield about the competition route to be flown and the pilot's flying background.
00:17	07:47	The St Gallen Cantonal Police informed the RCC that an IMSI-catcher would be available from the Bern region if required. The RCC said it would send the Rega 10 rescue helicopter stationed in Wilderswil for this case. However, it would take about 90 to 120 minutes from the time of the alert to install the IMSI-catcher and get to the search area.
01:15	08:45	The SDO asked the RCC whether the mobile phone had been located. The RCC informed him that it had not been possible to track the phone, but that hopefully an IMSI-catcher could be used. The SDO reported that the SAR helicopter was still searching; it would land later in Frauenkirch and continue the search at dawn.
01:23	08:53	The SAR helicopter crew informed the RCC they were still searching but so far without success; they still had fuel for about 30 minutes.
01:45	09:15	There was further coordination between persons at Schänis airfield and the RCC, and information from the Flarm manufacturer that the missing glider pilot had made several attempts to reach the Engadine via unsual glider routes. The Air Force and the FOCA agreed to coordinate again at 07:00.
01:54	09:24	Fedpol and the RCC agreed that the search area was still too large for the use of the IMSI-catcher.
02:15	09:45	The SAR helicopter landed in Frauenkirch.

02:22	09:52	The SDO was informed by the RCC that the briefing with the FOCA and the SAR helicopter crew would take place at 07:00 in Untervaz.
02:25	09:55	A crew member of the SAR helicopter reported to the RCC from Frauenkirch. Based on the new information from the Flarm manufacturer, the SAR crew decided to set off at 05:00 to search in the Vereina Pass area and attend the briefing in Untervaz at 07:00.
02:30	10:00	The SDO and the RCC exchanged information; there was some confusion about the use of the IMSI-catcher. Fedpol felt that the area was still too large for the use of the IMSI-catcher. The SDO mentioned that the St Gallen Cantonal Police wanted to have the IMSI-catcher at least on standby during the night.
04:37	12:07	The SAR helicopter crew informed the RCC that they would take off for the search flight before 05:00.
06:10	13:40	The FOCA helicopter informed the RCC that it was enroute to the base at Untervaz; expected landing time in Untervaz 07:00.
07:08	14:38	The RCC asked the Vienna RCC if they could send one or two helicopters to the area south of the Bielerhöhe. The request was forwarded and they promised to call back.
07:15	14:45	The Graubünden Cantonal Police informed the RCC that they had been informed, saying that the St Gallen Cantonal Police were in charge, as HB-3364 had started there.
07:43	15:13	The RCC informed the people at Schänis airfield about the planned further search operations and that support from the RCC Vienna had also been requested. The persons reported that they were at Schänis airfield and could be contacted for coordination.
07:49	15:19	The Rega pilot at the Untervaz base informed the RCC that a briefing had taken place with the FOCA and the crew of the SAR helicopter. The FOCA helicopter crew would now take off on a search flight.
08:10	15:40	The FOCA helicopter pilot informed the RCC that he was taking off on a search flight in the area of southern Schlappintal-Älpeltispitz; three more Air Force helicopters would follow; the SAR frequency was 123.10 MHz.
08:11	15:41	The Vienna RCC informed the RCC that they had an ongoing mission in the Montafon Valley and that they would be able to fly the area south of the Bielerhöhe/Gross Litzner/Piz Buin afterwards, as of about 09:30. The RCC gave them the SAR frequency.
08:30	16:00	Persons at Schänis airfield obtained the pilot's personal log-in to help locate his Android mobile phone.
08:50	16:20	The Zurich Cantonal Police helicopter pilot was briefed by the Flarm manufacturer by phone. The helicopter was equipped with an IMSI-catcher. In the end, the helicopter did not take off.
08:58	16:28	The RCC was informed which three additional Air Force helicopters would be used for the search; these were three EC635s.
09:02	16:32	The St Gallen Cantonal Police informed the RCC that they had not been able to track the pilot's mobile phone; the search area was too large for the use of the IMSI-catcher, and that the ball was in Fedpol's court. The RCC reported that a FOCA helicopter, three Air Force helicopters and one helicopter of the Vienna RCC were involved in the search.
09:24	16:54	The RCC asked the Vienna RCC for the Austrian search helicopter's registration; this information would be provided.
09:26	16:56	The Air Force informed the RCC that the three EC635s had landed in Untervaz at 09:15.
09:52	17:22	The persons at Schänis airfield reported that two experienced mountaineers, both glider pilots themselves, were preparing for search flights with the Air Force helicopters and would be ready for the briefing in Untervaz at 11:30.
10:12	17:42	The RCC was informed that the Air Force had noticed aircraft searching on Swiss territory.
10:37	18:07	The Vienna RCC communicated the registration of the Austrian search helicopter, explaining that it was in Hohenems for refuelling, whereafter it would again search in the Silvretta area (south of the Bielerhöhe). They did not know whether it had entered Swiss territory. They also reported that a Citation would depart from Vienna at 11:00. This information was forwarded to the FOCA as the RCC and Air Force felt this did not make sense. The Austrian helicopter subsequently searched around the Chlein Seehorn on Swiss territory, among other places.

10:53	18:23	The RCC was informed of the names of the glider pilot and mountain guide who was to fly in one of the Air Force helicopters from Untervaz.
10:55	18:25	The make of the pilot's mobile phone was disclosed, including the information that the phone was equipped with a tracking app.
11:15	18:45	The St Gallen Cantonal Police informed the RCC that an IMSI-catcher might be called in.
11:15	18:45	The glider pilot flying in one of the Air Force helicopters reported to the people at Schänis airfield that the wreckage had been found.
11:20	18:50	The Air Force helicopter reported the coordinates of the accident site to the RCC and explained that specialists would have to be called in for recovery; the helicopter would remain on site at Chlein Seehorn.
11:22	18:52	The rescue specialists and the Rega 5 rescue helicopter from the Untervaz base were called out by the RCC and the HEZ.
11:31	19:01	Rega 5 radioed that specialists would definitely be needed for the rescue operation.
11:42	19:12	The RCC confirmed to the people at Schänis airfield that the wreckage had been found and informed them that a Rega helicopter was on its way to the accident site.
12:00	19:30	At the scene of the accident, a doctor confirmed the pilot dead.
		The RCC then informed all units involved and coordinated the recovery of the pilot's body.

Table 8: Chronology of the search and rescue operation for HB-3364.

B.4.7.3 Findings

Findings in relation to the HB-3364 and its pilot:

- The intended flight route was known in broad outline from the daily task set at the competition.
- During the flight, the pilot was in radio contact with several glider pilots also taking part in the competition. He made no contact with air traffic services. It could not be determined when he last had radio contact with a glider pilot.
- HB-3364 was equipped with an automatic ELT which was damaged in the impact and thus was unable to emit any receivable signals.
- The HB-3364 had a Flarm system integrated into the on-board computer.
- The pilot did not carry a device that would have enabled online tracking (such as SPOT).
- The pilot was carrying a mobile phone, but this could not be found at the scene of the accident.
- The pilot suffered fatal injuries on impact.

Findings in relation to Flarm:

- By evaluating other gliders' Flarm devices that received signals from HB-3364's device, it was possible to reconstruct HB-3364's flight path.

Findings in relation to Schänis airfield:

- From 18:00, HB-3364 having failed to return to Schänis airfield within the time window provided for the competition task and no message having been received that the pilot had landed elsewhere, attempts were made by people at Schänis airfield to get hold of the pilot via air radio and mobile phone.
- From 19:45 the first Flarm data was collected from other gliders and the Flarm manufacturer became involved.
- At around 20:00, two search flights were made with motor gliders.

- Only when all these attempts to establish the whereabouts of HB-3364 had been unsuccessful was the RCC informed at 20:15.

Findings in relation to the RCC Zurich:

- The missing person report regarding HB-3364 was received by the RCC at 20:15, approximately 3:45 hours after the accident.
- The RCC's enquiries regarding the emergency search of the pilot's mobile phone were inconclusive.
- The FIC Zurich and the Vienna RCC were unable to provide any information about the whereabouts of the glider and its pilot.
- The HB-3364's last presumed positions determined by the manufacturer of the collision warning system Flarm were received by the RCC by email at 20:45 and 21:17; the first position was just under 3km from the actual accident site, the last position determined at 16:27:23 was about 100m from the actual accident site.
- At 21:37, the Rega 5 rescue helicopter was called out on a search flight by the HEZ; the pilot was briefed by the Flarm manufacturer.
- At 21:00 the RCC informed the Air Force SDO that a search operation was to be expected. After several consultations with the Air Force, the SAR helicopter took off from the Payerne military airfield at 23:00.
- The RCC coordinated the measures with the FOCA. OFCOM was instructed to listen for distress signals in Graubünden. Neither OFCOM nor commercial aircraft in the area received any distress signals.
- At 01:54 the RCC, in agreement with Fedpol, judged the search area to be too large for the deployment of an IMSI-catcher.
- The RCC asked the Vienna RCC for support in the search measures; an Austrian helicopter subsequently participated in the search, partly also on Swiss territory.
- The following morning, the RCC coordinated a large-scale search operation with several helicopters from a number of organisations, in which glider pilots were also called in to provide support.
- Once the wreckage had been found, the RCC immediately called up the rescue helicopter and specialists to recover the pilot's body.

Findings in relation to the search operation:

- The Rega 5 rescue helicopter from the Untervaz base took off on a search flight before the end of civil twilight; the area flown was from the Chlein Seehorn along the southern flank of the Grenzberge to the Falknis and Vilan.
- The Air Force SAR helicopter took off from Payerne military airfield at approximately 23:00 and searched for the missing HB-3364 until 02:15.
- Search efforts were resumed by the SAR helicopter crew before sunrise.
- The use of a mobile IMSI-catcher was considered and discussed several times, but not carried out.
- In the morning of the following day, several Air Force helicopters and one helicopter from both the FOCA and the Austrian SAR took part in a large-scale search operation.

- The wreckage of HB-3364 was spotted by the crew of an Air Force helicopter on the western flank of Chlein Seehorn about 19 hours after the accident occurred.
- The weather in the area of the accident site was good both on the day of the accident and the following day.

Findings in relation to the rescue operation:

- The rescue helicopter from the Rega base in Untervaz and recovery specialists were called out shortly after the wreck was found.
- About 30 minutes later, the pilot was confirmed dead by a doctor at the scene of the accident.

B.5 Means to rapidly locate missing aircraft or persons

B.5.1 Technical possibilities

ICAO has provided for and drawn up regulations on the installation of ELTs in aircraft as a technical aid to alert SAR units in case of an aircraft accident and to locate the missing aircraft.

With the spread of satellite-based global positioning systems (GPS) and the miniaturisation of electronic components, further technical aids for the rapid location of missing aircraft and persons have continuously become available in recent years.

B.5.1.1 Emergency location transmitter

When activated, ELTs emit a distress signal that can be received by satellites, aircraft and ground-based receiving stations. An ELT installed in an aircraft is automatically activated in the event of an impact with an acceleration of 5 g or more lasting at least 11 milliseconds. All ELTs can also be activated manually. Various alerting and locating services are available on the internationally agreed emergency transmitter frequencies 121.5 MHz and 406 MHz.

Emergency signals sent out on emergency signal frequency 406 MHz are received and evaluated around the clock by satellites in the COSPAS-SARSAT system (cf. Section B.2.4.7), regardless of the position of an activated ELT. The determined position and other aircraft identification data are automatically forwarded to the MCC responsible. The position is usually more accurate if the aircraft's ELT is equipped with a GPS receiver or coupled to one. The possible positional accuracy depends to a large extent on the coding protocol configured for the device and, depending on the setting, ranges from 150m to 5km for Switzerland. The constant monitoring and evaluation of 406 MHz signals results in shorter reaction times for the initiation of SAR measures.

Following a change on 1 February 2009, COSPAS-SARSAT no longer processes signals on the emergency signal frequency 121.5 MHz, nor does it trigger alerts or perform localisations on this frequency. Non-satellite alerting and tracking are still possible, however. This means that these signals can still be received by aircraft and ground-based receiving stations. This emergency signal frequency is still used by search helicopters and from ground-based receiving stations to locate an activated ELT.

ELTs operating on 406 MHz must be registered in Switzerland with the FOCA (cf. Section B.1.4.5).

B.5.1.2 Personal locator beacons

Personal locator beacons (PLBs) are small, portable transmitters designed for personal use. They are not intended for installation in aircraft and must be activated manually in an emergency. They also transmit on the emergency signal frequencies 121.5 MHz and 406 MHz, and function in practically the same way as an ELT. In Switzerland, when a distress signal is received from a PLB, the same SAR units are activated as when a distress signal is received from an ELT.

PLBs in Switzerland must be registered with OFCOM.

B.5.1.3 Satellite messengers

Satellite messengers, like PLBs, are portable devices for personal use. Unlike PLBs, they transmit the device position determined by means of GPS receivers to orbiting commercial satellites. Their signals are not received by satellites in the COSPAS-SARSAT system.

Depending on the provider (for example with SPOT), various device functions can be triggered manually. For example, the location and a predefined text message or email can be sent, or an emergency call can be transmitted to a private international emergency call centre. The emergency call centre then alerts the local SAR services.

In the case of missing aircraft or persons, the tracking functions are of particular interest. The GPS positions can be automatically transmitted at predefined time intervals and viewed on specific personalised websites to reconstruct the flight path.

The functions described are only available with a paid service subscription to the private provider.

B.5.1.4 Mobile applications

If a person is missing and their mobile phone number is known, the police can conduct an emergency search and find out in a relatively short time from the mobile phone provider whether a given device (mobile phone, smartphone, tablet, etc.) is logged into the network in Switzerland. When a mobile phone is logged into an antenna, OFCOM can use the provider's information on the location and main beam direction of the antenna to produce a cell coverage map on the basis of which the area in which the mobile phone can most likely be found can be narrowed down. IMSI-catchers can then be used to track the device (cf. Section B.2.4.6).

Furthermore, apps can be installed on smartphones by means of which the phone can be located at any time and its position displayed on a website. In order to be able to locate a smartphone in this way, the access data for the app website must be known.

B.5.1.5 Transponder

A *secondary surveillance radar* (SSR) is used by air traffic control to monitor and guide air traffic. An SSR actively communicates with a switched-on, functional transponder on board an aircraft and, in addition to position and altitude, can transmit information such as aircraft registration, speed, etc. The information appears on the air traffic controller's radar screen as radar label. The radar images are refreshed every four seconds.

If an aircraft is involved in an accident, communication between the SSR and the transponder is interrupted. As a result, when the radar image is renewed, no more radar labels are generated by the aircraft, the latter disappears from the air traffic

controller's radar screen and the flight track ends at the position of the last radar label.

When an aircraft disappears from the radar screens, ATC cannot necessarily assume that there has been an accident; there may be other reasons, such as insufficient radar coverage due to terrain or transponder non-functioning etc.

Radar recordings are stored by air traffic control and can be reconstructed afterwards. When a search is made for a missing aircraft that was flying with a functioning, switched-on transponder, the radar recordings can provide important clues as to the possible site of the accident.

B.5.1.6 Flarm

Flarm is a technical system that has been on the market since 2004 and was originally designed to avoid collisions between gliders (cf. also Section B.2.4.8). The Flarm collision warning system uses position and altitude data from an integrated GPS receiver. Each second it transmits the data, as well as a unique identification number (ID), via radio over a radius of a few kilometres as a short digital message. Other aircraft within range that are equipped with Flarm technology can receive the data and analyse it in real time, meaning surrounding traffic is displayed and crews can be warned of approaching traffic.

Besides this primary function, Flarm stores a flight path record of each flight in the form of a so-called IGC[6] file, which can be evaluated for example in competitions. In addition to their own flight path, most Flarm devices also record the time-stamped 3-D vectors and IDs of Flarm messages received from other aircraft. This means that aircraft flying in the vicinity of another aircraft in flight, even for just a short time, leave their traces in the Flarm system or in its IGC file. Using specific software, the reception range can be analysed on the basis of the recorded data and thus the quality of a Flarm installation can be ascertained.

If an aircraft is missing whose Flarm ID is known, the Flarm system manufacturer can reconstruct the flight path of the missing aircraft from the IGC files of enough other aircraft equipped with Flarm systems. The reconstruction is all the more successful when more aircraft have flown in approximately the same area at the same time and whose IGC files are available and contain data on the missing aircraft.

Experience shows that reconstruction works best at large gliding competitions, on weekdays and in structured topography (chains of hills, mountain ranges, airspaces), resulting in similar flight paths.

Live tracking is not possible with Flarm alone (cf. Section B.5.1.7).

B.5.1.7 Open Glider Network

The Open Glider Network (OGN) is a Flarm- and internet-based tracking system for gliders and other aircraft. It is used to track aircraft on the internet in real time. The organisation, a loose association of private volunteers, has built up a tracking system using mainly publicly available (open source) internet technologies.

The ground stations receive data on an aircraft's position and speed from the Flarm/OGN trackers twice a second on a radio frequency of 868 MHz and feed it into the internet. The data is analysed on servers and processed for presentation on websites.

Between May 2012, when the first ground station went into operation in Challe-les-Eaux, France, and October 2015, approximately 400 ground stations had been

[6] IGC: International Gliding Commission

added. This meant it was possible to track more than 1,000 aircraft in real time on the internet on high-traffic days in 2015.

With the increasing number of ground stations continually improving coverage, as well as the possibility of indirect data communication across several devices, such a ground-based receiver network will, in the future, be able to provide valuable services in the search for missing aircraft. Firstly, SAR organisations will be able to obtain information online about the flight path of a specific aircraft in real time; secondly, it is conceivable that automatic alert-raising services will be made available according to well-defined criteria.

B.5.2 Organisational possibilities

Besides the technical possibilities, there are organisational possibilities for locating an aircraft or a person quickly in the event of an accident.

B.5.2.1 Skyguide alert service

Skyguide's alert service (ALRS) notifies the search and rescue authorities responsible when an aircraft is in distress. Skyguide guarantees the ALRS for all flights (IFR and VFR) for which a flight plan has been filed or which are otherwise known to air traffic control in some way.

A flight plan (FPL) is a formal notification of a flight to air traffic control. Among other things, it contains information about the aircraft, expected take-off time, flight route, flight times, destination airport, the number of passengers and the emergency equipment carried. So that the SAR service can be activated in an emergency, the Aeronautical Information Service ensures that the flight plan details and any follow-up messages are forwarded correctly and in full to all air traffic control units concerned.

Provided regular radio contact is maintained with air traffic control units during a flight, in the event of an accident Skyguide's ALRS can usually also notify the SAR service, and the search area can be narrowed down. Radio contact with other aircraft can be helpful in narrowing down the search area, but does not result in automatic activation of the ALRS.

B.5.2.2 Local and personal alert systems

At many Swiss airfields, it is habitual for crews to submit a local flight notification, similar to a flight plan, before a flight. Unlike a flight plan, local flight notifications for overdue aircraft do not automatically trigger SAR measures. Usually no systematic check that an aircraft has arrived at its destination is made on the basis of a local flight notification. Local air traffic controllers and airfield controllers only take action when an aircraft does not return to its point of departure. Even in such cases, the SAR services are only alerted if the people involved – who usually carry out their activities as a leisure activity – are sufficiently conscientious.

Crew members may take additional personal precautions to ensure that an aircraft is recognised as being overdue and that, in the event of an emergency, as little time as possible is lost before the alert is raised. Trusted persons from the crew's personal entourage may, for example, be told of the planned flight path and the expected landing time at the destination, and what to do if they do not receive a message by a pre-set time.

C Analysis

C.1 Time taken for SAR units to arrive at the site following an accident

C.1.1 Background

In the event of an accident, the time that passes before first aid can be administered at the scene of the accident or admission to a suitable hospital is crucial for the victims' chances of survival or the best possible chances of recovery. Keeping this time period as short as possible should therefore be the overriding objective, both in the interests of the victims and in terms of the SAR services providing their best possible service.

This period essentially consists of three phases:

- Phase 1 – Alert raised: Duration from the accident to the alert being raised.
- Phase 2 – Search: Time period from the alert being raised to the moment the exact position of the accident site is known or the wreckage is found.
- Phase 3 – Rescue: The time that passes between the wreckage being found and the rescue services arriving at the scene of the accident or until any survivors are admitted to a suitable hospital.

The focus of the following analysis will therefore be on these individual phases and the extent to which both the persons directly involved and the organisation of SAR services can influence them.

C.1.2 Influence of persons directly involved

C.1.2.1 Objective

Those directly involved influence phases 1 and 2 to a considerable extent. They can make arrangements to ensure that the alert is raised immediately in the event of an accident, and that the exact location of the accident is communicated. For once it is clear that help is required and where, the SAR services can usually provide assistance rapidly.

The persons directly involved must therefore urgently endeavour to take the technical and organisational precautions necessary to ensure that the alert is raised immediately in the event of an accident. The location of the accident should ideally be transmitted as soon as the alert goes out. At the very least, it should be easy to establish or narrow down the location. This can be done by providing as much information as possible about the flight during flight preparation and the actual flight so that these can be reconstructed and the accident site located quickly and easily by the SAR services.

C.1.2.2 Technical measures

To achieve this goal, technical devices can be permanently installed in the aircraft (cf. Sections B.5.1.1, B.5.1.5 and B.5.1.6). As the official ICAO SAR tool, ELTs are of particular importance here. They were developed exclusively for this purpose and, assuming they function correctly, usually trigger an alert and transmit the position of the accident site with sufficient accuracy for it to be found quickly and efficiently by search helicopters with direction-finding systems. It is important to have an adequate and properly installed device, appropriate configuration of the coding protocol and for the device to be appropriately maintained in order to ensure the best conditions for correct functioning in an emergency. The ELT data registered also need to be up to date and clear. The FOCA has repeatedly emphasised all these points – also in response to unsatisfactory SAR actions (cf. Section B.1.4.5). The fact that ELTs and their antennas in particular can be destroyed in

an accident or that signal transmission can be obstructed or impeded has led to the widespread view that these devices are fundamentally of no use and do not fulfil their purpose. This conclusion is certainly incorrect and should not result in no longer installing ELTs in aircraft when not mandatory. Rather, further measures should be taken in addition to the ELT in order to be covered even in the event of ELT failure. However, provided the ELT functions correctly, it remains the most effective tool for the rapid and targeted initiation of a SAR operation. In addition, efforts should be made to improve the design and installation of ELTs so that they function correctly at all times, if possible.

Unlike ELTs, systems such as transponders, radio or Flarm were not developed for SAR purposes, or at least not primarily. However, depending on the case, they allow important conclusions to be drawn about the course of the flight and flight path. The advantage of these systems is that they can be used to track the flight path retrospectively, either completely or at least partially, whereas ELTs only communicate the final position. Since these systems do not automatically trigger an alert in the event of an accident, they can only serve as supplementary aids in a SAR operation. Also, the reconstruction processes require a relatively large amount of time and the use of external specialists. Going forward, systems that allow live tracking, such as the OGN (cf. Section B.5.1.7), are therefore likely to be preferred. Such systems could provide SAR services with a record of the flight path very quickly, for example via web-based applications. However, the fact that they do not trigger an alert remains problematic.

Furthermore, individuals can take technical measures independent of the aircraft (cf. Sections B.5.1.2 to B.5.1.4). Systems such as PLB or SPOT were not developed specifically for aviation but can also be useful tools to support SAR. However, users should be clearly aware of the systems' respective advantages and disadvantages. For example, both PLBs and SPOT require the alert to be triggered manually, which may not be possible depending on the events of the accident. Finally, mobile phones can be a great help in a SAR operation nowadays. Firstly, for the police there are now relatively low administrative hurdles to launching an emergency search, allowing the search area to be narrowed down considerably. If an IMSI-catcher is used, it may even be possible to locate the mobile phone. Secondly, specific apps on smartphones make it possible to locate these phones at any time, provided that the access data to the apps is known and the mobile phone is within the reception range of mobile phone antennas. Such apps should therefore be installed and the access data stored in a suitable place. The phone number should also be deposited in a suitable place and the phone battery fully charged before departure.

Because individual technical precautions may remain ineffective per se or owing to the events of the accident, as the examples in this report clearly demonstrate, it is crucial to take as many different precautions as possible in parallel in order to have one or more back-ups –according to the maxim 'one system is no system'.

C.1.2.3 Organisational measures

Persons directly involved also have institutionalised organisational aids at their disposal, such as flight plans (cf. Section B.5.2.1). Extensive precautions can also be taken on an individual basis (cf. Section B.5.2.2).

In addition to notifying air traffic control, the explicit purpose of flight plans is to lead to an alert being automatically raised in specific, clearly defined circumstances. A flight plan should therefore be submitted before a flight, but discipline is required to ensure that the alert is not falsely raised (cf. Section C.1.2.5). Furthermore, it is important to realise that flight plans do not result in the alert being raised immediately in the event of an accident. This only happens after certain time limits have

expired; depending on the flight, this may be several hours after the accident, as the examples in this report clearly demonstrate. Flight plans are therefore not suitable for ensuring that the alert is immediately raised. However, they contain essential information about the flight and should therefore be completed in as much detail as possible. Additional information such as the mobile phone numbers of the pilot or passengers can prove essential in the event of a SAR operation.

Flying groups and clubs can set up well-functioning local alarm systems with little effort. For example, when take-off lists are kept consistently or local flight notifications are submitted, essential flight information is available that can lead to an alert being automatically raised under agreed criteria. Moreover, the information that is essential in a SAR operation, such as mobile phone numbers, access data to tracking systems such as smartphones or SPOT, Flarm ID, emergency contacts, etc. can be collected and managed centrally.

In addition, each pilot can make arrangements on an individual basis, which can also play a role in the alert being raised under predefined criteria and the flight path being tracked.

Because individual precautions can be ineffective under certain circumstances, it is crucial to take as many different precautions as possible in parallel in order to create a back-up, as already mentioned above. Ideally, both technical and organisational measures should be combined in order to ensure that the alert can be raised as quickly as possible and via several different channels, making it much easier to recognise it as genuine (cf. Section C.1.3.2).

C.1.2.4 Raising the alert

Persons close to those directly involved or even uninvolved third parties who suspect that there has been an accident involving an aircraft should inform the RCC immediately. The RCC and the informants can then investigate the matter more closely.

The examples above demonstrate that, when it is first suspected that there has been an accident, those involved initially make their own enquiries, and this in a sequential manner – one step at a time. This is time-consuming and inefficient. Moreover, proceeding in this way means the SAR services cannot conduct enquiries in parallel or make the necessary preparations for a possible SAR operation, meaning that time is lost unnecessarily.

Therefore, even if the initial suspicion is not a clear one, the RCC should always be alerted immediately as a precaution. The persons involved should not hesitate. Should the alarm turn out to be unfounded, there will be no consequences, either as regards the SAR organisation or costs.

C.1.2.5 Avoiding a false alert

Crews and technical staff, on the other hand, should do their utmost to prevent false alerts from triggering a SAR operation. The figures show that false alerts primarily occur when an ELT is unnecessarily triggered or because of overdue flight plans (cf. Section B.3.1).

The current large number of false alerts (approx. 97%, cf. Section B.3.1) results in the RCC having to conduct complex and therefore often time-consuming enquiries in order to recognise when an alert is genuine (cf. Section C.1.3.2). In other words, if every alert in the RCC were genuine, SAR services could be provided in a much more targeted way and therefore more rapidly. Especially with regard to ELTs, which are explicitly designed to trigger an alert immediately in the event of an accident, much time can be lost in making the necessary enquiries.

Crews and technical personnel who realise that they may have raised a false alert or have actually done so should inform the RCC immediately. The RCC can then recognise the false alert as such and time-consuming further enquiries are no longer necessary; in this way, RCC resources are available again for other tasks. Furthermore, detailed information about why the alert was falsely raised generates greater understanding of its cause, and so appropriate measures can be taken in future to prevent the same thing happening again.

C.1.3 Impact of organisations providing SAR services

C.1.3.1 Objectives

The way in which SAR services are organised has an impact on all three phases of a SAR operation.

Firstly, when the alert has not been clearly triggered and there are merely initial indications of an accident, steps must be taken to analyse and filter all the information. This includes recognising a false alarm. It must, therefore, be the goal of a well-functioning SAR organisation to carry out these steps efficiently and purposefully.

Secondly, if the exact location of the accident is not known and a search needs to be conducted, this must be organised in a targeted and coordinated manner. ICAO itself states on this point (cf. Section B.1.2.9): *"Searching is the most expensive, risky, and complex aspect of the SAR system. Often, it is also the only way survivors may be located and assisted. Before a search is undertaken and at frequent intervals during its progress, all information received must be carefully analysed and evaluated. The primary concerns are ensuring all clues about the survivors' probable status and location are properly evaluated* […]." A well-functioning SAR organisation must be in a position to organise an efficient and targeted search to determine the position of the accident as quickly as possible.

Thirdly, the SAR organisation should aim to carry out rescue operations quickly and with appropriate means as soon as the exact position of the accident site is known.

C.1.3.2 Dealing with false alerts

Even though it may be possible to reduce the currently high number of false alerts (approx. 97%, cf. Section B.3.1), the RCC will always be required to rapidly recognise genuine alerts and eliminate false ones. Genuine alerts can be more readily identified if they are received multiple times on different channels. For this reason, too, it is crucial for those directly involved to take as many precautions as possible in parallel (cf. Sections C.1.2.2 and C.1.2.3).

RCC staff with the necessary competence and focused working methods (cf. Section C.1.3.3) can recognise most false alerts within a reasonable period of time by asking the right questions and making the right enquiries. In the remaining unresolved cases, it must be asked whether the SAR services should be alerted automatically after a certain period of time – i.e. costs should be weighed up against the possible risk to human life.

The cases described in this report show that this was not the case in the RCC and that the SAR services were not alerted until after investigations indicated that there was a high probability of an emergency. As a result, valuable time was lost in some cases.

C.1.3.3 Competence and working methods

The task of coordinating in the RCC requires considerable competence in all areas of aviation in order to be able to correctly assess and classify the incoming information and to initiate the further steps to be taken. Detailed investigations into narrowing down the flight path necessarily require the involvement of external specialists, and the information gained has to be correctly interpreted and applied by the RCC staff.

RCC staff, therefore, need to have the appropriate competence and experience in order to ensure efficient operations. Moreover, wherever possible the necessary investigations should be conducted by external specialists, in parallel, in order to save time.

The examples above show that the RCC investigations often took place sequentially and not in parallel, and that the results of one enquiry were first awaited before the next enquiry was made. As a result, in some cases valuable time was lost. In this context, it must be asked whether it is sufficient in all cases to have only one staff member who is able to make all the necessary enquiries in parallel in a timely manner, or whether the RCC should be organised in such a way that would allow other trained staff members to be specifically involved in an operation if necessary. It is also difficult for an individual to acquire the necessary competence in all areas of aviation.

With regard to having a parallel working method, as mentioned above it should be taken into consideration whether the SAR services should not as a rule be alerted after a certain period of time even if it is still only suspected that an accident has occurred, so that preparations can be made even as further investigations are ongoing. In the case of an accident being confirmed, the SAR services would then be immediately ready for deployment.

Furthermore, the examples above demonstrate that RCC staff members only acquired the skills necessary to use and exploit the possibilities of newly emerging technical aids such as Flarm or IMSI-catcher specifically for SAR purposes after some time, and only after real cases had occurred (cf. also Section C.1.3.4).

The examples also indicate that there is potential for optimisation in organising and systematising the search procedure, especially in the case of operations that last a long time.

In recent cases, pilots with expertise relating to the missing aircraft type have been allowed to fly in the Air Force search helicopters. This indicates that the importance of expertise in a specific area of aviation or aircraft category in the search measures was also recognised. A glider moves very differently from a powered aircraft or a helicopter. The search helicopter crews usually do not have the required expertise from all areas of aviation, which is why it makes sense to call on the appropriate specialists.

C.1.3.4 Overlap between the different organisations involved

The provision of SAR with its multi-layered and complex processes inevitably requires the cooperation of various specialists. Persons are often found in existing organisations that specialise in providing specific services. ICAO also proposes basing the organisation of SAR on such existing organisations in the interests of efficiency (cf. Sections B.1.2.2 and B.1.2.10).

However, the cooperation of specialists from different organisations inevitably leads to some overlap. The FOCA, as the SAR supervisory body, and the RCC, as the coordination centre of a SAR operation, have, therefore, the important task of

organising any overlap expediently before an operation and of maintaining constant communication so that in an emergency the respective organisations and the expertise they provide can be called upon immediately and they can work in parallel without any efficiency losses. It is, therefore, very important to define processes and share experiences.

The question here is whether this can be optimised by introducing suitable measures. Regular meetings take place, especially between the main players FOCA, RCC and Air Force, but no institutionalised meetings or practical exercises involving all interface partners have been planned so far. As a result, many processes and procedures have only been defined following actual SAR operations. These debriefings are important in order to be able to identify and improve weaknesses after the event. However, regular meetings and practical exercises involving all partners would make it possible to proactively identify and improve at least some of the weaknesses in advance of real actions.

Exchanges between the different organisations could also be improved by working in a fundamentally different way. For example, it might be possible to work in an interdisciplinary team at a common location, at least for more complex cases. This would enable direct exchange, permanent interaction and also critical enquiry, thereby benefitting all the different organisations involved. Ultimately, this could help foster competence in the RCC and in all the participating organisations.

C.1.3.5 Rescue

In Switzerland, a small country with well-developed infrastructure coverage, the third phase, rescue, does not usually pose many problems. Once it is known that an incident has occurred and its exact location, targeted and professional help can usually be provided with adequate resources.

The examples given in this study demonstrate this, although circumstances such as weather and terrain can make a rescue operation considerably more difficult, complex and time-consuming – a fact that cannot be altered.

C.1.4 Survival from the moment of the accident until arrival of rescue teams

Persons affected by an accident should be aware that because procedures are complex, it can take several hours for rescue teams to arrive at the scene of the accident, even if the SAR operation runs smoothly.

In addition to the precautions described above that individuals can take to help to keep this period as short as possible (cf. Sections C.1.2.2 and C.1.2.3), the necessary attention should also be paid to personal equipment. Such equipment should enable a person to survive for several hours at the scene of the accident and should contain aids with which survivors can make their presence known to search parties.

If the accident site is in rough or Alpine terrain, it is always advisable to stay with the wreckage and wait for the rescue services to arrive.

C.2 Lack of information

During the research for this study, it was found that there is apparently a widespread lack of information regarding SAR among those potentially directly affected, i.e. airspace users of all kinds.

For one thing, this concerns the organisation of SAR per se and its possibilities and limits. For example, it was assumed that the Air Force SAR helicopter would

be ready to take off within a few minutes once the RCC was alerted. Such inaccurate assumptions may lead to inadequate action and false expectations on the part of airspace users.

Moreover, deficits were also identified in the technical and organisational possibilities for triggering and accelerating SAR action that are available to individuals. In gliders, for example, ELTs of older design, which only transmit on 121.5 MHz, were removed in the belief that they were no longer of any use since this frequency is no longer monitored by the COSPAS-SARSAT system. The fact that these ELTs can be located in an emergency with OFCOM resources and by search helicopters was not known or was forgotten. Such misconceptions, which are probably based on a lack of knowledge or incorrect knowledge, can have serious consequences in an emergency.

There is, therefore, an acute need to ensure that those potentially affected acquire information on all aspects of SAR. This should be part of a pilot's training and be the subject of both refresher and advanced training seminars.

The persons responsible for SAR at the FOCA are open and willing to actively provide information, with the involvement of the SAR partners if possible. Organisers of training courses, further training and refresher seminars etc. are invited to contact the FOCA directly in this regard (elt@bazl.admin.ch).

In addition to this comprehensive study, the STSB has decided to produce and publish a short summary of the main points for persons affected by a SAR operation. Likewise, a microsite for quick and easy information has been set up, and the STSB also offers training support where possible (info-av@sust.admin.ch).

D Safety recommendations and safety advice

Safety recommendations

As required by Annex 13 of the Convention on International Civil Aviation and Article 17 of Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC, all safety recommendations listed in this study are addressed to the regulatory authority of the responsible State, which has to decide on the extent to which these recommendations are to be implemented. All authorities, companies and individuals are called upon to work towards improving flight safety in relation to safety recommendations issued.

The Swiss Ordinance on the Safety Investigation of Transportation Incidents (OSITI) contains the following provision on safety recommendations:

"Art. 48 Safety recommendations

[1] The STSB shall submit the safety recommendations to the competent federal office and notify the competent department of the recommendations. In the case of urgent safety issues, it shall notify the competent department immediately. It may send comments to the competent department on the implementation reports issued by the federal office.

[2] The federal offices shall report to the STSB and the competent department periodically on the implementation of the recommendations or on the reasons why they have decided not to take measures.

[3] The competent department may instruct the competent federal office to implement recommendations."

The STSB publishes the responses of the competent federal office or supervisory authorities abroad at www.sust.admin.ch, providing an overview of the current status of implementation of the relevant safety recommendation.

Safety advice

In response to safety deficits identified during the investigation, the STSB may publish safety advice. These are drawn up when a safety recommendation under Regulation (EU) No 996/2010 does not appear to be appropriate, is not formally possible or when it would appear that the freer form of safety advice might have a greater impact. The STSB's safety advice have their legal basis in Article 56 OSITI:

"Art. 56 Information on accident prevention

The STSB may prepare and publish general information on accident prevention."

D.1 Safety recommendations

D.1.1 Emergency location transmitters

D.1.1.1 Safety deficit

Emergency locator transmitters (ELTs) are the ICAO's official means of search and rescue (SAR). When they function correctly, they usually lead to both an alert being triggered rapidly and the position of the accident site being transmitted with sufficient accuracy to be found quickly and efficiently by search helicopters with direction-finding systems.

In Switzerland, it is not mandatory for all aircraft to be equipped with an ELT. However, it is strongly recommended. Reasons for not installing an ELT include administrative and technical hurdles that lead to complex and thus expensive installation procedures.

Several cases are known in which the ELT was destroyed or signal transmission was impaired or obstructed by the accident.

Operating an aircraft not equipped with an ELT represents a safety deficit, as it involves deliberately not carrying an essential and efficient SAR instrument, thus inevitably reducing the chances of a successful SAR operation. ELTs are only useful and accepted by users if they function reliably.

D.1.1.2 Safety recommendation No 513

The Federal Office of Civil Aviation (FOCA) should consider making the installation of Emergency Locator Transmitters (ELTs) or comparable devices mandatory for all aircraft operating in Switzerland.

D.1.1.3 Safety recommendation No 514

The Federal Office of Civil Aviation (FOCA) should reduce the administrative and technical hurdles for installing ELTs as far as possible.

D.1.1.4 Safety recommendation No 515

The Federal Office of Civil Aviation (FOCA), together with the European Aviation Safety Agency (EASA), should undertake to improve the design and installation of ELTs in such a way that their correct functioning is guaranteed in as many cases as possible.

D.1.2 Organisation

D.1.2.1 Safety deficit

The provision of SAR services, which involves multi-layered and complex processes, inevitably requires the cooperation of a range of specialists. Specialists are often found in existing organisations that specialise in providing specific services. However, when specialists from different organisations cooperate, there are inevitably some overlaps.

The FOCA as the SAR oversight body and the RCC running a SAR operation therefore have the important task of expediently organising any overlap before an operation and of maintaining constant communication so that, in an emergency, the organisations involved and the expertise they provide can be called upon immediately, and they can work in parallel without loss of efficiency.

Regular meetings take place, especially between the main players FOCA, RCC and the Air Force, but no institutionalised meetings or practical exercises involving

all interface partners have been planned so far. As a result, many processes and procedures are only defined following actual SAR operations.

For more complex cases, working in an interdisciplinary team at a joint location could be envisaged. This would enable direct exchange, uninterrupted interaction and critical enquiry, thereby benefitting all the different organisations involved.

A structured, parallel way of working is of utmost importance in the RCC. A single staff member is unlikely to be able to make all the necessary clarifications in parallel and quickly enough in all cases. It is also difficult for an individual to acquire the necessary knowledge in all areas of aviation. It may therefore be asked whether the RCC should not strive for an organisational form that allows additional trained staff to be involved in an operation if and when necessary. Furthermore, SAR services could be alerted automatically after a specific period of time when an aircraft goes missing.

An overlap between services inevitably means that processes take longer and there is a risk of information loss or misunderstandings. When overlap processes are not defined, valuable time can be lost when working sequentially rather than in parallel.

D.1.2.2 Safety recommendation No 516

The Federal Office of Civil Aviation (FOCA), together with the rescue coordination centre (RCC), should examine the extent to which the organisation of search and rescue (SAR) can be optimised regarding the interface issues between organisations.

D.1.2.3 Safety recommendation No 517

The Federal Office of Civil Aviation (FOCA), together with the rescue coordination centre (RCC), should assess and, if necessary, adapt the organisation and operation of the RCC.

D.2 Safety advice

D.2.1 Lack of information

D.2.1.1 Safety deficit

The research for this study showed that there is a widespread lack of information regarding search and rescue operation on the part of those potentially directly affected by it, i.e., airspace users in all areas. On the one hand, this concerns the organisation of SAR per se and its possibilities and limits. Deficits were also identified in the technical and organisational possibilities available to individuals for triggering and expediting a SAR operation.

Inaccurate assumptions about SAR may lead to inadequate actions and false expectations on the part of those directly affected. Ignorance or incorrect knowledge about SAR can have serious consequences in an emergency.

D.2.1.2 Safety advice No 13

Subject: Knowledge of all aspects of SAR

Target group: Airspace users from all sectors, training centres, flight instructors

All airspace users should have adequate knowledge of the SAR organisation and the technical and organisational means of initiating and expediting a SAR operation. Training centres and flight instructors should ensure that the necessary

knowledge is imparted during pilot training and during further training and refresher seminars.

The persons responsible for SAR at the FOCA can be contacted directly for support in providing information (elt@bazl.admin.ch). The STSB has also published a summarised version of this study with the most essential points for those directly affected, and is also available to provide information (info-av@sust.admin.ch).

Payerne, 25 October 2016 Investigation Bureau of the STSB

This final report has been approved by the Swiss Transportation Safety Investigation Board STSB (Art. 10 let. h of the Ordinance of 17 December 2014 on the Safety Investigation of Transportation Incidents).

Bern, 25 October 2016

Annexes:

Annex 1: FEMI list (as of 1 August 2012)

E	*Entscheid*	F	*Federführung*	M	*Mitarbeit*	I	*wird Informiert*

1.	Aufsicht	BAZL	RCC	LW	ZivBeh[1]
a)	Regelt den Such- und Rettungsdienst (Regulator)	E / F	M	M	-
b)	Vertritt die Schweiz an COSPAS - SARSAT Sitzungen	E / F	M	M	-
c)	Führt das 406 MHz ELT Register	E / F	I	-	-
d)	Erlässt Rechtsgrundlagen inkl. AIP	E / F	M	M	-

2.	Alarm- und Meldestelle	BAZL	RCC	LW	ZivBeh[1]
a)	Nimmt Meldungen entgegen				
	COSPAS - SARSAT ELT Meldungen	-	F	-	-
	Overdue's	-	F	-	M / I
	Übrige Meldungen	-	F	-	I
b)	Führt Statistik über Meldungen	I	F	I	I
c)	Pflegt die www.swiss-sar.ch Daten	E/F	M	-	M
d)	Betreibt die www.swiss-sar.ch Datenbank	I	E/F	-	I
e)	Trifft weitere Abklärungen	-	E / F	M	M

3.	Suchmassnahmen	BAZL	RCC	LW	ZivBeh[1]
a)	Veranlasst Peileinsatz (ELT)	M	E / F	M	M
b)	Veranlasst Handy Notsuche / Einsatz IMSI Catcher	I	E / F	I	M
c)	Einleitung von SAR Massnahmen	I	E / F	M	M / I
d)	Durchführung von Suchmassnahmen terrestrisch	-	E / F	I	M / I
e)	Durchführung von Suchmassnahmen aviatisch	M	M	E / F	M
f)	Fordert zusätzliche Unterstützung an	-	F	E	-
g)	Benachrichtigt (Suchmassnahmen ausgelöst)				
	Bei ausländischen Flugzeugen den Herkunftsstaat	-	F	-	I
	Bei schweizerischen Flugzeugen den Halter	-	F	-	I
	Die SUST	-	F	-	I
h)	Unterbruch der Suchmassnahmen terrestrisch	I	E / F	I	M
i)	Unterbruch der Suchmassnahmen aviatisch	M	M	E / F	M
j)	Abschluss von SAR Massnahmen	E	F	M	I

4.	Information	BAZL	RCC	LW	ZivBeh[1]
a)	der Medien während SAR Massnahmen	I	F	M	M
b)	der Medien nach Abschluss SAR Massnahmen	I	M	M	F
c)	Debriefing nach Einsätzen	M	F	M	M

5.	Betreuung von Angehörigen	BAZL	RCC	LW	ZivBeh[1]
a)	Initialisierung während Abklärungsphase	-	F	M	M
b)	Initialisierung während SAR Suchphase	-	F	M	M
c)	nach Abschluss des SAR Einsatzes	-	-	-	F

6.	SAR Übungen	BAZL	RCC	LW	ZivBeh[1]
a)	Organisiert und leitet SAR Übungen in der Schweiz	E	M	F	-
b)	Nimmt an SAR Übungen im In- oder Ausland teil	I	M	E / F	-
c)	Betreibt Prävention, Information, Ausbildung	F	M	M	M

[1] BAKOM, Skyguide, Flugplatzleiter, ausl. RCC, Polizeibehörden, Rettungsdienste, SAC/ARS, kommerzielle Helikopter-Unternehmen , SUST u.a.

SAR Aufgabenaufteilung BAZL / REGA / LW Version 1.1 vom 01.08.2012 2/2

Annex 2: Criteria for triggering emergency phases (extract from the ATMM)

3.7 ALERTING PHASE TIMING TABLE

The following table is simply a summary of the time periods relevant to the INCERFA-ALERFA-DETRESFA phases. For full details, refer to § 3.4, § 3.5 and § 3.6 , above.

<table>
<tr><th></th><th>INCERFA</th><th>ALERFA</th><th>DETRESFA</th></tr>
<tr><td>Uncertainty as to the safety of an aircraft and its occupants</td><td>Immediate</td><td colspan="2" rowspan="3">Upgrade by RCC</td></tr>
<tr><td>No COMs</td><td>30 mins[1]</td></tr>
<tr><td>Overdue</td><td>30 mins[1]</td></tr>
<tr><td>Operating efficiency impaired</td><td></td><td>Immediate[2]</td><td rowspan="3">Upgrade by RCC</td></tr>
<tr><td>Unlawful interference</td><td></td><td>Immediate</td></tr>
<tr><td>Apprehension as to the safety of an aircraft and its occupants</td><td></td><td>Immediate</td></tr>
<tr><td>Cleared to land but fails to arrive & no COMs</td><td></td><td>5 mins from expected landing[2]</td><td></td></tr>
<tr><td>Insufficient fuel</td><td></td><td></td><td>Immediate[3]</td></tr>
<tr><td>Likely forced landing</td><td></td><td></td><td>Immediate[3]</td></tr>
<tr><td>Reasonable certainty that an aircraft and its occupants are threatened by grave and imminent danger or require immediate assistance</td><td></td><td></td><td>Immediate</td></tr>
</table>

[1] Except when no doubt exists as to the safety of the aircraft and its occupants
[2] Except when evidence exists that would allay apprehension as to the safety of the aircraft and its occupants.
[3] Except when there is reasonable certainty that the aircraft and its occupants are not threatened by grave and imminent danger and do not require immediate assistance

List of abbreviations

ACC	Area Control Centre
AIP	Aeronautical Information Publication
ALERFA	Alert phase
ALRS	Alerting service
ANP	Air Navigation Plan
ARS	Alpine Rescue Switzerland
ATMM	Air Traffic Management Manual
AviA	Federal Act on Aviation
BANP	Basic Air Navigation Plan Part of the Air Navigation Plan
BFU	*Büro für Flugunfalluntersuchungen,* Aircraft Accident Investigation Bureau, amalgamated into the STSB in 2012
COSPAS	*Cosmicheskaya Sistyema Poiska Avariynich Sudov*; formerly Soviet, now Russian component of COSPAS-SARSAT
COSPAS-SARSAT	International satellite search and rescue system
DETRESFA	Distress phase
ELT	Emergency locator transmitter (on aircraft)
EPIRB	Emergency position-indicating radio beacon (on ships)
EU	European Union
FASID	Facilities and Services Component of the ANP Documents
FCP	Federal Criminal Police
fedpol	Federal Office of Police
FEMI-Liste	*Federführung – Entscheid – Mitarbeit – wird informiert* Lead – decision – cooperation – information: table regulating allocation of SAR tasks between the FOCA, Rega and the Air Force
FIC	Flight information centre
FIR	Flight information region
FIS	Flight information service
FL	Flight level
FLIR	Forward looking infrared Thermal imaging camera
FLORAKO	Florida radar replacement; Air Force air radar and communication system
FOCA	Federal Office of Civil Aviation
FPL	Flight plan
GPS	Global Positioning System
HEZ	Rega Helicopter operations centre
IAMSAR	International Aeronautical and Maritime Search and Rescue Manual

ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
IGC	International Gliding Commission File format used in flight recorders, e.g., Flarm devices
IMO	International Maritime Organization
IMSI	International Mobile Subscriber Identity
INCERFA	Uncertainty phase
MCC	Mission Control Centre (of COSPAS-SARSAT)
NOTAM	Notice to Airmen Information about current state of flying
OFCOM	Federal Office of Communications
OGN	Open Glider Network Flarm- and internet-based tracking system for gliders and other aircraft
OM	Operation manual
OSC	On-scene commander
OUSRSO	Ordinance on the Organisation and Use of the Civil Aviation
PIC	Pilot in command
PLB	Personal Locator Beacon
RCC	Rescue Coordination Centre
Rega	Swiss Air Rescue
SAC	Swiss Alpine Club
SAND	Safety Awareness Notification Data Safety-related instructions and recommendations
SAR	Search and rescue
SAREX	Search and rescue exercises
SARSAT	Search and rescue satellite aided Western part of COSPAS-SARSAT tracking
SDO	Senior Duty Officer
SPOC	search and rescue point of contact
SRR	Search and rescue region
SRSO	Ordinance on the Civil Aviation Search and Rescue Service
SRU	Search and rescue unit
STSB	Swiss Transportation Safety Investigation Board
SUPPS	Regional Supplementary Procedures
UNO	United Nations Organization
VFR	Visual flight rules
VFRM	VFR-manual
VOR	VHF omnidirectional radio range

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