Schweizerische Eidgenossenschaft
Confédération suisse
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Eidgenössische Flugunfallkommission
Commission fédérale sur les accidents d'aviation
Commissione federale sugli infortuni aeronautici
Federal Aircraft Accident Board

Final Report Nr. 2037
by the
Federal Aircraft Accident Board

concerning the serious incident (AIRPROX)

involving the Tupolev Tu-154M aircraft, registration UN85713

Berkut State Air Company, Kazakhstan

under flight number BEC 016

and

the Lockheed C-130 aircraft

operated by the Algerian Air Force

registration 7T-WHB

on 8 February 2007

near KOGAS (Lake Annecy)

30 NM SOUTH-SOUTH-WEST of Geneva

This final report has been prepared of the Federal Aircraft Accident Board according to art. 22 – 24 of the Ordinance relating to the Investigation of Aircraft Accidents and Serious Incidents (VFU/SR 748.126.3), based on the Investigation Report by the Air Accident Investigation Bureau on 3 June 2009.

General information on this report

In accordance with art 3.1 of the 9th edition, applicable from 1 November 2001, of Annex 13 to the Convention on International Civil Aviation (ICAO) of 7 December 1944 and article 2001 of the Federal Air Navigation Law, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is no concern of the incident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

If this report is used for purposes other than accident prevention, due consideration shall be given to this circumstance.

The definitive version of this report is the original in the French language.

All times in this report, unless otherwise indicated, follow the coordinated universal time (UTC) format. At the time of the accident, Central European Time (CET) applied as local time (LT) in Switzerland. The relation between LT, CET and UTC is: LT = CET = UTC + 1 hours.

For reasons of protection of privacy, the masculine form is used in this report for all natural persons, regardless of their gender.

Final Report

Aircraft		Registration UN85713 under flight number BEC 016, Tupolev Tu-154M
	Operator	Berkut State Air Company
	Owner	Berkut State Air Company
		Lyon St-Exupéry (LFLL) – Almaty (UAAA)
		Type of use: IFR commercial flight
		Registration 7T-WHB, Lockheed C-130 Hercules
	Operator	Algerian Air Force
	Owner	Algerian Air Force
		Pardubice (LKPD) – Boufarik (DAAK)
		Type of use: IFR cargo flight
Crews		BEC 016 Commander: Kazakh citizen, born 1955
		Pilot instructor: Kazakh citizen, born 1960
		Navigator: Kazakh citizen, born 1956 Flight engineer: Kazakh citizen, born 1949
		7T-WHB Commander (in charge of mission): Algerian citizen
		Commander: Algerian citizen
		Pilot: Algerian citizen
		Flight engineer: Algerian citizen
Location		Near KOGAS, 30 NM South-South-West of Geneva
Date and time		8 February 2007, 18:37 UTC
ATS unit		Swiss Radar Upper Area Control West
Controllers		Radar controller (coach): Swiss citizen, born 1968
		Radar controller (trainee): Swiss citizen, born 1983
		Radar coordinator: Serbian citizen, born 1969
Airspace		A

0 Synopsis

On Thursday 8 February 2007, a serious incident occurred at night in the region of Lake Annecy involving a Lockheed C-130 Hercules type aircraft, which was maintaining its flight level and a Tupolev Tu-154, which was passing the same flight level in a climb heading in the opposite direction. The incident took place within a sector of the Swiss upper area control centre, Geneva, UAC West.

Preamble

Since 22 December 2005, the upper area control centre UAC West has been using a new 'stripless' control system. The information concerning controlled aircraft which was previously entered on paper flight progress strips is integrated into the electronic labels displayed on the radar screen. This system includes conflict detection tools, one of which is the dynamic scanning tool – DST. It enables medium-term conflicts in the vertical plane to be detected.

An explanatory glossary of the terms and abbreviations used in this report is provided as an appendix.

1 Factual information

1.1 KL12 sectorisation at the time of the incident

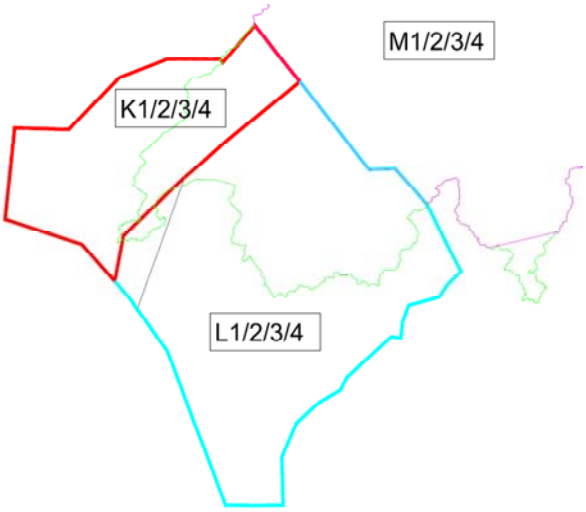

Fig. 1

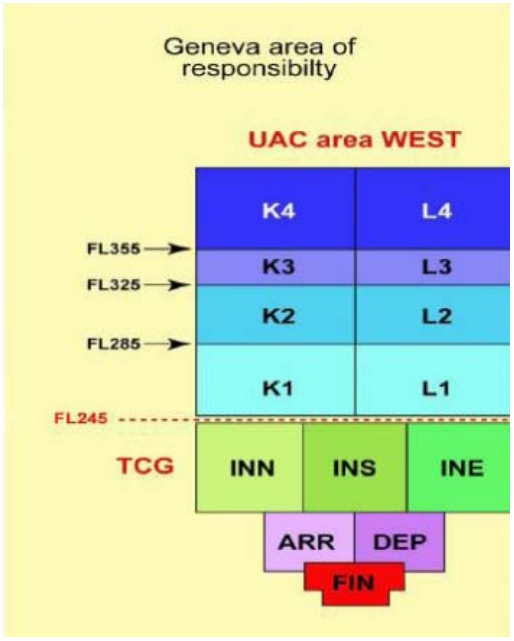

Fig. 2

At the time of the incident, the configuration of sector KL12, which combines four sectors, incorporated flight levels FL 245 to FL 324 inclusive. This grouping is usual for this time of day. The three control positions in charge of the sector KL12 airspace were manned by a trainee radar controller, a supervising radar controller (coach) and a radar coordinator. The trainee occupied the centre position, whilst his coach was sitting to his left and the radar coordinator to his right. The three control positions are each equipped with a radar screen.

In the vertical plane, sectors K1 and L1 are delimited by flight level FL 245 and flight level FL 284, within the Geneva CTA control area. They are responsible for managing aircraft in transit, Geneva arrivals and departures and aircraft entering or leaving the Reims FIR and the adjacent TMAs.

Sectors K2 and L2, delimited in the vertical plane by flight level FL 285 and flight level FL 324, are within the Geneva control area. It is in these sectors that flights departing from the adjacent terminal management areas (TMAs) reach their cruising level or that flights with destinations within the adjacent TMAs begin their descent (ref.: ATMM UAC WEST, AIR, Organization).

Essentially, therefore, these sectors handle traffic moving in the vertical plane.

Below sectors K and L are the initial approach sectors – INI – split geographically into NORTH, SOUTH and EAST.

1.2 History of the incident

On the afternoon of 8 February 2007, an Algerian Air Force transport aircraft, type Lockheed C-130 Hercules, registration 7T-WHB, took off from Pardubice, in the Czech Republic, destination the Boufarik airbase in Algeria.

At 18:12 UTC, the crew contacted control sector KL12 of the Geneva upper area control centre UAC West. The aircraft was cruising at flight level FL 250 and was approximately 10 NM north-east of waypoint BENOT. It was cleared by control to maintain this flight level and to proceed direct to waypoint BALSI.

Because of a strong headwind, the C-130 was flying at a ground speed of approximately 225 kt. Between the time of the first call and the instruction given to the crew to make contact with Marseille control centre, no radiocommunication exchange took place.

At about 18:30 UTC, a Tupolev 154M type airliner belonging to the Berkut company, registration UN85713 under flight number BEC 016, took off from Lyon Saint-Exupéry airport, destination Almaty, Republic of Kazakhstan.

At 18:30:52, flight BEC 016 was handed over by LYON DEPARTURE to the 124.225 MHz frequency of Geneva sector INI South.

At 18:33:19 UTC, the radar coordinator of sector INI South called Marseille sector Y1, whose floor flight level is FL 200 in order to obtain clearance to continue flight BEC 016's climb. The latter was still flying in the airspace controlled by Marseille. Sector Y1 assigned it flight level FL 240. Sector INI South then cleared flight BEC 016 to climb to this flight level.

At 18:33:51 UTC, aircraft 7T-WHB was transferred to the Marseille Control frequency 133.425 MHz when it was 19 NM before passing the transfer of control point between Geneva and Marseilles; this represents some five minutes of flying time.

The trainee stated that he had carried out the early transfer of communication of aircraft 7T-WHB to the Marseille control centre in order to relieve the control frequency and expedite traffic management.

At 18:36:01 UTC, the crew of flight BEC 016 called sector KL12 on frequency 134.850 MHz and reported that it was climbing to flight level FL 240 direction waypoint KORED. The trainee accepted flight BEC 016 by applying the AoC function and cleared it to climb to flight level FL 260. The crew read back this clearance correctly.

On clearing flight BEC 016 to flight level FL 260, the trainee entered this flight level into the system. This caused a DST alert window to open on the radar screen; it warned the trainee of a conflict between aircraft 7T-WHB and flight BEC 016. At the same time a visual alert was activated on the radar labels; the crossing point as well as the speed vectors were displayed on the screen. The trainee validated this information by clicking on the VALID function about a second later; the window closed and the vector alerts of the aircraft involved disappeared.

Fig. 3

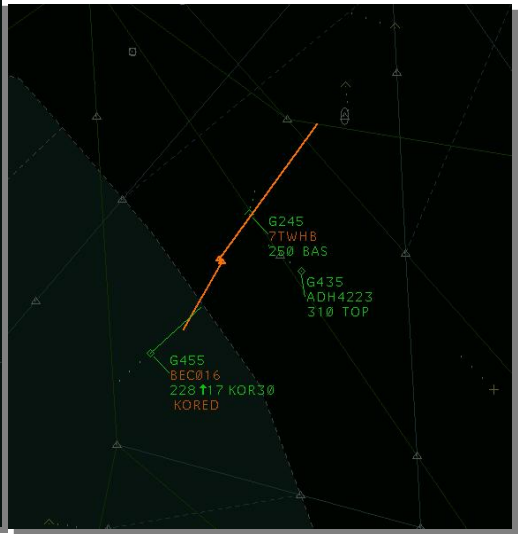

Fig. 4

Figure 3 shows the DST alert window. It should be noted that the distance between the two aircraft at the time of maximum convergence is calculated and displayed in this window (0.4 NM).

Figure 4 shows the speed vectors and the crossing location.

According to his statements, the trainee assigned flight level FL 260 to BEC 016 because of an aircraft which had taken off from Milan and which was maintaining flight level FL 270. The trajectory of this flight was convergent with that of flight BEC 016 in the region of waypoint MOLUS. The position of this traffic on the radar screen was off-centre in relation to the location at which the conflict between flight BEC 016 and aircraft 7T-WHB would take place.

Aircraft 7T-WHB, still visible on the Geneva control radar screen, was in contact with Marseille and was maintaining flight level FL 250. Flight BEC 016, in contact with Geneva, was approximately 17 NM away flying in the opposite direction. It was passing flight level FL 227 and climbing towards flight level FL 260.

According to his statements, the trainee accepted this alert by validating it, but without being fully aware of the content.

The conflict with aircraft 7T-WHB, which was maintaining flight level FL 250 and on a route opposed to that of flight BEC 016, escaped the attention of the coach and the radar coordinator. The coach stated that at the moment the trainee had cleared flight BEC 016 to climb to flight level FL 260, his attention had been diverted by a separation in the Aosta region which had triggered an STCA alert. Once he was certain that this was assured, he resumed systematic traffic surveillance and became aware of the conflict situation between flights 7T-WHB and BEC 016 a few seconds before the corresponding STCA alert was triggered.

The radar coordinator stated that he had not heard the content of this clearance because he was in the process of consulting the flight plan data for aircraft BEC 016 in order to ascertain its route, requested cruising level, destination and any flow control restrictions. Since he did not know the destination, he consulted the ICAO document containing the airport codes.

When the radar coordinator resumed monitoring of his radar screen, he noticed that the cleared flight level displayed on the radar label for flight BEC 016 was flight level FL 260. He realised there was a conflict situation between flight BEC 016 and aircraft 7T-WHB and called out to the trainee in these terms: '*What about 7-HB?'*

The trainee then realised that a conflict was imminent.

At 18:36:37 UTC, the STCA alert was triggered in the Marseille control centre, indicating a conflict between flights BEC 016 and 7T-WHB. Flight BEC 016 was passing flight level FL 238; its rate of climb was approximately 2500ft/min. The distance between the two aircraft flying in opposite directions was 13 NM, according to the radar plots.

At 18:36:50 UTC, the STCA alert was triggered in the Geneva control centre when the two aircraft were 11.4 NM apart flying in opposite directions. Flight BEC 016 was passing flight level FL 243 and climbing, whilst aircraft 7T-WHB was maintaining flight level FL 250.

At 18:36:54 UTC, the trainee cleared BEC 016 to flight level FL 250, i.e. the same level as that of aircraft 7T-WHB. Five seconds later, the flight crew of BEC 016 replied: *'We reach two five zero, Bravo Echo Charlie zero one six.'*

At the same moment, Marseille control was giving traffic information to aircraft 7T-WHB and suggesting avoiding action: '*7 Tango Whisky Hotel Bravo, traffic information at your twelve o'clock, traffic not on my frequency, climbing, if you wish you can turn right heading 270*.' The crew of aircraft 7T-WHB read back this information and the aircraft changed heading approximately 20° to the right.

When the trainee cleared flight BEC 016 to flight level FL 250, the radar coordinator insistently intervened, verbally and by gestures, to force the continuation of the climb. The coach immediately took over control of the traffic and at 18:37:03 UTC transmitted the following message to flight BEC 016: '*Correction, zero one six, continue climb flight level three hundred, maximum rate, opposite traffic.'* The crew of BEC 016 replied: '*Continue climb, er... zero one six.'* The distance between the two conflicting aircraft was 9.9 NM in opposite directions; the relative converging speed was approximately 700 kt according to the radar plots. Flight BEC 016 was at flight level FL 247. The routes would cross 48 seconds later.

At this instant, the radar plots indicate that flight BEC 016 was in the process of levelling off at flight level FL 250. This flight then descended at a high rate to flight level FL 243, and then resumed its climb at a similarly high rate.

At 18:37:10 UTC, during a telephone coordination with Geneva, the Marseille controller made known his concern about the crossing of the level assigned to flight BEC 016. Geneva acknowledged that they had made a mistake.

At 18:37:18 UTC, the Marseille centre STCA alert ceased. The Marseille controller informed the crew of aircraft 7T-WHB that the conflicting traffic was now descending to flight level FL 240.

At 18:37:24 UTC, according to the information transmitted by the Mode S (downlink) transponders, the flight crews of the two aircraft received the first coordinated TCAS resolution advisories. The crew of flight BEC 016, which was climbing, received a "Descend" resolution advisory. The crew of aircraft 7T-WHB, which was maintaining flight level FL 250, received a "Climb" RA advisory (see Annexe 2).

At 18:37:30 UTC, the STCA was again triggered in the Marseille control centre. The controller transmitted the following information to the flight crew of flight 7T-WHB: *"Er, traffic information now flight level.... at your same flight level the traffic is at your one o'clock"*. The radar plots indicate that flight BEC 016 was at flight level FL 251, at a distance of 4 NM from aircraft 7T-WHB.

The coach twice requested the crew of flight BEC 016 to report the flight level through which their aircraft was passing. To the first question, transmitted at 18:37:31 UTC, the pilot replied: "*Two five zero, reaching.*" To the second request, sixteen seconds later, the pilot replied: "*two, two four... two five zero*".

At 18:37:33 UTC, the flight crew of flight BEC 016 received a resolution advisory with a reversed sense, to climb, when according to the radar plots the aircraft was climbing through flight level FL 249.

At 18:37:37 UTC, the crew of aircraft 7T-WHB received a "Descend" resolution advisory. No difference in flight level was recorded on the radar plots.

The routes of the two aircraft crossed at 18:37:51 UTC, 8 NM west-south-west of waypoint KOGAS. The lateral distance was 0.4 NM and the altitude difference was 100 ft.

The coach and the trainee estimated that the workload and traffic complexity was medium to high during the sector occupation period. At the time of the incident the workload was high, with 18 aircraft on the frequency of sector KL12.

1.3 Extracts from the ATMM TCG – Section ATC, General Working Methods and Working Methods

1.3.1 Tasks and responsibilities – radar controller (Radar Executive - RE) and radar coordinator (Radar Planner – RP)

The collective tasks (.....) are performed in close co-operation between the RE and RP controllers. However, RE primarily ensures the monitoring of the frequency (ies). RP primarily ensures co-ordination with other sectors or adjacent centres, and ensures the monitoring of any additional frequencies such as the emergency or UHF frequencies.

1.3.2 Transfer of communication

The transfer of communication shall take place not later than the transfer of control (....), unless otherwise coordinated (LoA UAC CH/TCG-Marseille ACC/UAC)

1.3.3 Emergency separation

In case of imminent conflict and when there is insufficient time for coordination to avoid a collision, the avoiding actions shall be executed as follows:

UAC CH/TCG: Vertical avoidance manoeuvre

In no circumstances this vertical avoidance shall interfere with the TCAS RA

Marseille ACC/UAC: Horizontal avoidance manoeuvre (LoA UAC CH/TCG-Marseille ACC/UAC)

1.4 Working without paper flight progress strips – the stripless system

1.4.1 General

The stripless control system was brought into service in the Geneva UAC West upper control centre in its final configuration on 22 December 2005. This system was introduced to increase the volume of traffic and improve safety levels.

The stripless system replaces the flight progress strip – a paper information medium including flight plan data (aircraft type, departure point, destination, scheduled route...) and on which the controller used handwritten annotations to enter updates relating to the evolution of the traffic in his sector (cleared flight levels, radar heading, etc.). Arranged in a specific order, the strips allowed controllers to monitor current and expected traffic and detect potential conflicts.

The stripless system displays the essential flight plan data directly on the electronic label, termed a radar label, which accompanies the aircraft symbol on the radar screen and in information windows.

All updates to an aircraft's flight plan (new cleared or coordinated flight level, radar heading, direct route assigned to a crew, etc.) are entered directly on the radar label and are displayed in all control sectors concerned, thereby reducing telephone coordinations.

When a new flight level is assigned, the controller enters this level in the CFL field of the radar label. The new cleared flight level is then displayed on the radar label of the aircraft concerned.

The working tool which was relevant in this incident is the DST. It enables medium-term conflicts in the vertical plane to be detected. This tool warns the controller, when he enters a cleared flight level in the system, if there is a conflict with one or more other aircraft. If so, a DST window opens on the radar screen and, in addition to displaying the data of the conflicting traffic, a text warns “caution conflict, verify clearance”. Two option buttons are proposed: VALID or CANCEL.

The DST does not take the controller’s action plan into account. For example, if the controller enters a climb clearance which intentionally crosses the flight level of another potentially conflicting aircraft, the DST window opens. It is then possible to resolve the problem at the tactical level, for example by imposing a high rate of climb well before there is an actual conflict. The controller then validates the information and the DST conflict window closes.

When the controller accepts this information by clicking on the VALID button, the window closes and the visual alert symbols of the aircraft concerned disappear.

It is not possible to force an alert window to reappear following a validation.

The DST alert appears only on the screen of the radar controller who has entered data in the radar label. For example, if the trainee enters a flight level on the radar label of the aircraft symbol and the DST detects a potential conflict, the alert will appear only on the trainee’s radar screen, not on the coordinator’s or coach’s screen.

When individually setting up the radar screen, the controller is able to select the position at which the DST alert window opens. It always opens at the position defined by the controller if the latter has chosen the “fixed position” option. The controller can also select the “near the mouse" option, following which the DST alert window opens near the point where the mouse cursor is located. At the time of the incident, the DST alert window was set to the “fixed position”; at the time of the alert it opened on the extreme right of the radar screen. (Annex 1).

A service order issued by Skyguide for the use of the DST notes that conflict detection must be based on monitoring of the radar screen (radar scanning) and on an analysis of the content of the information windows.

“DST shall not be used as the only means of conflict detection” (SO G 30.06.2005).

1.4.2 Working methods for conflict detection

The working methods were taught to the controllers by means of theoretical courses as well as practical simulation sessions at the radar.

Before issuing a clearance to climb or descend to the crew of an aircraft, a radar controller must, among other things:

Ref.: Skyguide teaching aid.

- *Check for conflicting traffic in the vicinity of the aircraft concerned,*
- *Check for traffic on standard routing interfering with the flight profile of the aircraft concerned,*
- *Check for traffic on non standard routes,*
- *If needed, check and acknowledge DST.*

1.4.3 The alerts generated by the DST and the STCA

Throughout the 62 minutes preceding the incident, six medium term conflict alerts had been generated, including that for the conflict between the two aircraft involved in the incident and, according to the radar data, two STCA alerts.

According to their statements, the coach and the trainee consider that the stripless system does not generate too many alerts which conflict with the controller’s intentions.

1.4.4 Use of the electronic working tools by controllers

When an aircraft approaches a control transfer point or a limit of action towards an adjacent control centre, the radiotelephony frequency of the sector to which the aircraft is to be transferred is displayed on the radar label. At the moment of transfer of communication, the controller clicks on the displayed frequency; the position symbol of this aircraft switches from AoC to non-AoC, indicating to the controller that the aircraft is no longer on his sector’s frequency. The colour of the radar label does not change.

Fig. 5

Fig. 6

Figure 5 shows the position symbol of aircraft 7T-WHB in AoC (diamond) and figure 6 in non-AoC (half-diamond).

1.4.5 Training on the stripless system

The theoretical and practical training on the stripless system was judged adequate by all the controllers involved in the incident. Introduction of the system took place over 15 months and in 8 stages.

1.5 Practical training of trainee controllers

1.5.1 Responsibilities of the coach

The ATMM Switzerland manual – Section 2 / Administration – as well as the European Manual of Personnel Licensing – Air Traffic Controllers describe the following procedures concerning supervision at the working position:

As an OJTI, you are responsible for the safety and efficiency of ATM services provided by a trainee under your supervision to the same extent as if you were providing the services yourself, except that you will not be held responsible for the consequences of any action taken by the trainee in disobedience to your instructions.

Do not leave the trainee for whom you are responsible without direct supervision, unless he has been formally qualified to operate the working position concerned alone.

Advise or instruct the trainee, as required by the circumstances, to have him make appropriate decisions by himself. He should be given as much autonomy as possible, taking into account:

a) your own evaluation of the trainee's performance and aptitude;

b) his level of training and practical experience;

c) any instruction given by the person or service responsible for training.

Do not allow the trainee under your responsibility to lose control of the operational situation to such an extent that safety is impaired.

At least once during or at the end of the daily shift, give a complete debriefing of the trainee's performance and, when appropriate, provide him with advice on how to improve performance.

1.5.2 Organisation of supervision

In UAC West, the majority of controllers with more than two years' experience also perform the function of coach. They devote approximately 20% of their working time to supervision, i.e. four days rotation per month. In order to ensure adequate supervision and follow-up of a trainee controller, a group of six or seven controllers are assigned to one trainee. Instructions and objectives are set for each phase of training. In addition, a training record noting his progress is drawn up at the end of each rotation of the trainee controller; it is signed by the supervising controller and by the trainee. This training record is kept in the personnel file of each trainee controller. This method enables each supervising controller to acquaint himself with the training level of a trainee at the beginning of a new work rotation.

The position which the coach must occupy physically in relation to his trainee is not laid down in any Skyguide directive.

1.6 Equipment available at working positions

Each control sector consists of three identical, switchable control positions. In normal times, only two positions are used.

Each control position has individual settings for the presentation of information on the radar screen. For example, adjustment of the brightness and contrast of the displayed information as well as the character size and font. Thus each controller works with customised settings in any sector or at any control position within a sector, after identifying himself by logging in.

1.7 Assignment plan for controllers

1.7.1 The trainee and his coach

On the day of the incident, the trainee and his coach came on duty at 16:30 LT. The coach was aware of the trainee's training level. After a short briefing, they went to sector KL12 where they worked for about an hour. After a break, they resumed work in the same sector at 18:55 LT. The trainee occupied the radar controller's position, i.e. the position in the centre of the sector. The coach was to his left. A few minutes after the serious incident, the trainee was replaced by the radar coordinator and the coach by another controller.

1.7.2 The radar coordinator

On the day of the incident, the radar coordinator came on duty at about 17:00 LT. He occupied the control position to the right of the trainee. Following the serious incident, the radar coordinator replaced the trainee in the control position which he occupied. He was replaced in turn some 15 minutes later.

Following the serious incident and at the supervisor's request, a critical incident stress management session – CISM – took place with the three controllers involved.

1.8 Training phase

1.8.1 Supervision phase at the working position followed by the trainee controller OJT4

The OJT 4 phase is the final practical training phase and precedes the final examination. It involves 40 days of work.

Extracts from the document Stratus Syllabus V 0.5 Unit training UAC Switzerland

Objectives

Consolidation of safety and efficiency of work at all the positions of Endorsement 2 - E2 sectors (West or East).

Content

- *On moderate to heavy traffic, manage a safe, efficient and autonomous traffic.*
- *Initiate and carry out co-ordination/ E-coordination.*
- *Use Standard English phraseology.*
- *Use clear diction and good radio technique.*
- *Use the available technical facilities.*
- *Apply correct IFREG procedures.*
- *Make appropriate decisions.*
- *Apply standard separation techniques.*
- *Provide advice and information useful for the safe and efficient conduct of flights.*
- *Apply Team-work techniques and procedures.*
- *Have an appropriate behaviour at all times.*

1.9 Information on the trainee controller

The trainee controller began his activity under supervision at UAC West in mid-July 2006. His progress during training was in accordance with the objectives. He passed an intermediate practical examination at the beginning of December the same year.

1.10 TCAS aspect

1.10.1 Pilots' response to the TCAS alerts

Action by the flight crew

*The flight crew **shall not** deviate from an ATC clearance on the basis of a traffic advisory only.*

*In the event of an RA the flight crew **shall:***

- *respond immediately by following the RA as indicated, unless doing so would jeopardize the safety of the aircraft;*

- *follow the RA even if there is a conflict between the RA and an ATC instruction to manoeuvre;*
- *not manoeuvre in the opposite sense to an RA;*
- *as soon as possible, as permitted by workload, notify the ATS unit of the RA, including the direction of any deviation from the current air traffic control instruction or clearance.*

Ref.: ICAO Doc 8168 Pans Ops Volume 1, Part III, Section 3, § 3.2.

1.10.2 InCAS simulation

Following the incident, a Eurocontrol InCAS simulation was carried out to reconstruct the trajectories of the two aircraft and to recreate the alerts issued by the onboard collision-avoidance systems.

According to this simulation, the crews of both aircraft received a traffic advisory TA at 18:37:02 UTC.

At 18:37:56 UTC, the TCAS reported clear of conflict to them.

The information relating to the RA originating from the downlink Mode S and the simulations coincides.

1.11 Statements by the flight crews

1.11.1 The crew of 7T-WHB

The flight crew consisted of four persons, all present in the cockpit at the time of the incident:

1. An aircraft commander pilot with the rank of captain occupying the left-hand seat and fulfilling the function of pilot in command PIC and pilot flying PF.
2. An aircraft commander pilot with the rank of lieutenant, occupying the right-hand seat, acting as pilot non flying PNF.
3. A flight engineer with the rank of captain occupying the central position, between the two pilots.
4. The commander (in charge of mission), an aircraft commander and instructor, with the rank of colonel, occupying the rear bench seat.

The commander (in charge of mission) admitted that the various RA resolution advisories issued during the conflict caused consternation in the cockpit. He stated that no RA resolution advisory was followed by the flight crew and justified this behaviour by the confidence placed in the ATC controller who had suggested a right turn onto heading 270°.

In reply to the question of whether the pilots have TCAS procedures issued by the Air Force the commander (in charge of mission) stated to the effect that flight crews refer to the TCAS user manual specific to the unit fitted to their aircraft.

The commander (in charge of mission) concluded by stating that the simulators used for training their pilots do not have TCAS equipment and that consequently the training relating to its use is purely theoretical.

1.11.2 The crew of BEC 016

The flight crew of the Kazakh aircraft consisted of four persons, all present in the cockpit at the time of the incident:

1. An aircraft commander pilot occupying the left-hand seat and fulfilling the function of pilot in command PIC and pilot flying PF.
2. An aircraft commander pilot-instructor, occupying the right-hand seat and fulfilling the function of pilot non flying PNF.
3. A navigator.
4. A flight engineer.

The chief pilot stated that the Berkut State Air Company has not defined an avoiding procedure in the event of TCAS alerts for this type of aircraft. He added that in the event of TCAS alerts, the responsibility for reacting rests with the two pilots.

He stated that RA resolution advisories have priority over ATC instructions.

Again according to his statement, crews have not had the possibilities of training on TCAS alert situations and only the commander had experienced an actual RA resolution advisory in January 2003 when he was in the airport approach phase.

No explanation was provided concerning the manoeuvres carried out at the time of the resolution advisory RA issued by the TCAS.

1.12 Meteorological conditions

(according to MétéoSuisse; original version in German)

General situation

A marked low pressure area extended from Ireland to Holland. The unsettled weather which accompanied it crossed Switzerland during the course of the day. The cold front approached Switzerland towards the evening.

Forecasts and hazards

AIRMET

At the time of the incident the following Airmet was active:

LSAS AIRMET 4 VALID 081700/082100
LSZH- LSAS SWITZERLAND FIR MOD TURB FCST N OF ALPS BLW FL130 MOV NE NC AND SWITZERLAND FIR MOD ICE FCST ALPS ABV FL050 MOV NE NC –

Geneva TAF (LSGG)

LSGG 081500Z 081601 23012KT 9999 FEW010 BKN040 TEMPO 1618 –SHRA
BECMG 2301 VRB03KT FEW040 BKN100=

SWC, Windcharts

SWC, Windcharts valid 18 UTC
No longer in existence

Measured and observed values

Geneva METAR

LSGG 081720 24012KT 9999 FEW010 SCT030 BKN050 07/04 Q1001 NOSIG=
LSGG 081750 24010KT 9999 FEW010 SCT030 BKN040 07/04 Q1001 NOSIG=
LSGG 081820 24012KT 200V280 9999 FEW015 SCT030 BKN100 07/04 Q1001 NOSIG=
LSGG 081850 22013KT 190V250 9999 FEW020 BKN090 08/04 Q1002 NOSIG=
LSGG 081920 22013KT 170V240 9999 FEW020 SCT035 BKN080 08/04 Q1002 NOSIG=

Radar image

The precipitation zone of the cold front which was approaching was already visible; however, it had not yet reached the region in which the airprox occurred.

Forecasts of winds at altitude

QAO-A1: 15h21Z FL180 260/050 FL240 250/060 FL300 250/075

Day/night limit: 17:13 UTC

2 Analysis

2.1 Technical aspects

It should be noted that the safety systems and the STCAs were functioning. In particular, these were the DST, the STCA systems in the Geneva and Marseille control centres and the onboard TCAS systems.

No defect was found in either the ground or onboard systems.

2.2 Operational air traffic control aspects

2.2.1 Tools available to controllers

The stripless system was commissioned in its final configuration some 13 months prior to the incident. Its use was assimilated well by controllers.

The redundant verification procedure – closing the loop – specific to the stripless system enabled the coordinating controller to detect immediately the inappropriate clearance given by the trainee.

When carrying out the individual settings for the radar screen, the trainee chose the “fixed position” mode for the opening of the DST window. Consequently, when the conflict between BEC 016 and 7T-WHB was reported, the window opened on the extreme right of the screen, whilst the conflict was occurring on the left. This decentring of the information may have caused the trainee to make an error, attributing this alert to the conflict which was occurring in the Aosta region and which he had already resolved. This may explain the fact that the trainee validated the alert without being fully aware of the content.

Furthermore, it is possible for a controller to validate a DST window inadvertently. It is unacceptable for the alert to disappear if a conflict has not been resolved. The system does not repeat the alert if the controller validates the information.

The stripless system is a valuable tool which facilitates traffic management but which requires self-discipline on the part of the controller.

2.2.2 Working methods

At the time of this incident visual scanning was not being applied methodically. In actual fact, in order to detect and resolve conflicts, methodical scanning of the radar image is imperative before issuing a clearance to climb or descend.

2.2.3 Management of DST alerts

Since the DST medium term conflict detection tool does not take the controller's action plan into account, it therefore generates alerts for all potential conflict situations which the controller has to analyse. Moreover, controllers have the option of choosing certain detection criteria..

2.2.4 The role of the coach and coaching

The task of a coach is complex, as he is obliged to pay constant attention to the trainee's actions. The coach must anticipate a potentially critical situation. In case of doubt, he may ask the trainee what is his plan of action to resolve a specific problem. In addition, the coach must be ready at all times to intervene, for example by helping the trainee to ensure separation between two or more aircraft, to increase traffic fluidity and, in a critical case, to intervene on the frequency to take over control of the sector in order to prevent a situation from becoming dangerous. A coach must have the ability to anticipate the trainee's action plan whilst leaving him the maximum amount of autonomy. He must intervene at the appropriate time, before a situation worsens. At the time of the incident, the trainee was in the final training phase and therefore enjoyed a high degree of autonomy.

The coach was supervising his trainee's work from the control position on the trainee's left, in accordance with practice. Supervising a trainee's work from an adjacent control position is, according to the coach's statements, more appropriate for this function than positioning oneself directly behind the trainee. The AAIB shares this view, to the extent that the coach has the same information on his screen as the trainee, including, among other things, the DST alerts.

When the trainee gave flight BEC 016 the clearance to climb, the coach did not realise the risk of a loss of separation between the two aircraft. His attention was on verifying of a separation between two aircraft in the Aosta region and this momentarily caused him to lose his overview of the traffic.

The trainee cleared the crew of flight BEC 016 to climb to flight level FL 250. At this moment, the coached reacted immediately: He took over control and instructed the crew of flight BEC 016 to climb to flight level FL 300 at the maximum rate of climb.

Noting subsequently that flight BEC 016, instead of climbing, was initiating a descent and that convergence with aircraft 7T-WHB was becoming critical, the coach thought that the conflict would generate TCAS alerts. Not wishing to add to the confusion, he stated that he did not intervene any further in order to avoid giving instructions contradictory to the resolution advisories of the TCAS, which he believed to be active at this time, on the basis of what he was observing on the radar. It should be stressed that between the time BEC 016 reported that it was approaching flight level FL 250 and the time of the descent only 10 seconds elapsed.

It would be opportune for the coach to be able to access the history of unresolved alerts.

2.2.5 The trainee

When the trainee transferred aircraft 7T-WHB to the Marseille control frequency, the aircraft was 19 NM from the limit of responsibility between the Geneva UAC West control centre and Marseille control.

In fact, he transferred the aircraft early in order to reduce congestion on the control frequency, though this eliminated the option of intervening at a later time and entails the risk of forgetting about the aircraft. In view of the high density of radiotelephony exchanges, this procedure is usual in a context in which there is no potential conflict within the control sector; however, this was not the case.

At the time of the first call from flight BEC 016 and the clearance given by the trainee, the latter had forgotten about the presence of aircraft 7T-WHB, which was opposing the Tu-154 aircraft and flying in the opposite direction. Hence 7T-WHB was no longer being included in his separation concept.

On the other hand, by clearing flight BEC 016 to flight level FL 260, the trainee ensured separation from another aircraft which was maintaining flight level FL 270.

Before giving this clearance, the trainee should have detected the conflict by scanning the airspace ahead of and close to the Tu 154.

The trainee was in the final practical training phase, phase 4. His progress in the course of his training was good; the training managers had decided to bring forward the date of his final examination. His qualifications were good. It is possible that this fact inspired a degree of excessive confidence in him. Wishing to demonstrate his very good work, the trainee favoured working methods which he believed to be efficient in order to expedite traffic flow, without realising that in this case safety might be compromised. His level of experience did not permit him to apply these working methods.

2.2.6 The radar coordinator

Before flight BEC 016 made contact with sector KL12, the radar coordinator consulted his flight plan data. At the time of the first call and when the trainee gave the clearance to flight level FL 260, the radar coordinator was in the process of consulting an ICAO document and, according to his statements, he therefore did not hear the content of this clearance.

When the radar coordinator resumed monitoring his radar screen, he immediately detected the conflict and intervened accordingly with the trainee.

2.2.7 The controller of Marseille sector Y1

The Marseille sector Y1 controller was aware of flight BEC 016 as a result of a telephone coordination initiated by Geneva sector INI South.

When the STCA was first activated, the controller noted that flight BEC 016, which was on an opposing trajectory to aircraft 7T-WHB, had passed the flight level which had been coordinated with sector INI South, FL 240. He issued traffic information to the crew of aircraft 7T-WHB and wisely suggested an avoiding manoeuvre in the horizontal plane.

Thus he acted on the basis of the emergency procedure provided for in the Letter of Agreement between Geneva and Marseille.

2.3 Flight management aspects

2.3.1 Flight BEC 016

When the crew of BEC 016 made contact with Swiss Radar on the 134.850 MHz frequency, they reported that they were climbing towards flight level FL 240 with a route direction KORED. The controller immediately assigned them flight level FL 260, an instruction which was read back correctly by the crew. Almost 35 seconds later, the controller re-cleared them to flight level FL 250. At this instant, BEC 016 was passing flight level FL 245 and climbing at a rate close to 3000 ft/min. The crew had hardly replied that they were reaching flight level FL 250 before they received a new clearance to climb to flight level FL 300.

On the graphic produced using Mode S information (Annexe 2) for reconstructing the flight profile of BEC 016, one can observe that the flight crew had already initiated acquisition of flight level FL 250 when they were re-cleared to flight level FL 300.

With regard to the flight phase described above, the AAIB sent written questions to the flight crew, though no reply was forthcoming.

Flight BEC 016 initiated a descent at a rate close to 4200 ft/min towards flight level FL 242 before resuming its climb at a similarly pronounced rate. It was at this moment that the first “Descent, Descent” type RA occurred, when the cleared level was still FL 300 and BEC 016 was at flight level FL 243 and climbing. The aircraft nevertheless continued its climb and continued to register “Descent, Descent” type RAs followed by “Increase Descent Increase Descent” whilst it was below flight level FL 250, the level occupied by the converging conflicting aircraft. Once it had passed this level, BEC 016 initiated a descent, seeming to wish to re-acquire flight level FL 250, despite a new “Climb, Climb” type RA, before continuing its climb beyond flight level FL 260.

It should be noted that in the space of 50 seconds the crew of BEC 016 received no less than three level clearances, to levels FL 260, FL 250 and FL 300. Moreover, during this phase which was to say the least confused, radiotelephone exchanges between Swiss Radar and the crew of BEC 016 ensued at a sustained rate.

The explanation of the fact that flight BEC 016 initiated a very pronounced descent after being re-cleared to flight level FL 250 when it had been previously cleared to flight level FL 260 indicates that the manoeuvre involving reaching the level was carried out under manual control, i.e. without use of the autopilot. The recorded high rates of climb and descent respectively in no way facilitated flight level acquisition. The indicated rates of climb and descent oscillated between 3000 and 4200 ft/min. The combination of these two factors accentuated the already aggressive corrections made to the flight profile and, in conjunction with the reaction time, contributed to the worsening of the situation.

Less than a minute elapsed between the time the Swiss Radar controller cleared BEC 016 to flight level FL 250 and the time the two conflicting aircraft crossed. During this time, radiotelephone communications were intensive, the flight profile changes of BEC 016 alternated between climbing and descending and resolution advisories followed one after another for almost 30 seconds. It is understandable that the crew of BEC 016 had some difficulty in following these different instructions.

2.3.2 Aircraft 7T-WHB

The Algerian crew received initial traffic information from Marseille Radar, accompanied by a suggested heading change to the right, i.e. heading 270°. As the aircraft was on a route of approximately 200°, the proposed change in trajectory was equivalent to a 70° change in relation to the route being followed. The crew read back this information, without at first detailing their intentions.

Then, when the controller reported that the opposing traffic was descending to flight level FL 240, the crew of 7T-WHB replied that they were maintaining their heading which, in the meantime, according to the radar plots, had changed by 20° to the right, corresponding to a route of 220°. A few seconds later, the Marseille controller reported to the Algerian crew that the conflicting traffic was at the same level, at their one o'clock, then at their twelve o'clock. The crew expressed their surprise and initiated an avoiding right turn as suggested previously by the Marseille controller. This manoeuvre is visible on the radar plots and corroborates the Algerian crew's statement. If this turn had not been made, the situation would have worsened.

In order to make the turn, the pilot disengaged his automatic pilot. At the time of this manoeuvre, the radar plots indicated a loss of altitude of 100 ft by the Algerian aircraft.

The investigation showed that the TCAS issued a series of RA of the type "*Climb Climb, Increase Climb Increase Climb, Descent Descent Now, Descent Descent Now*", without the crew following them. This may be explained by the fact that according to their statements no crew member had received adequate training on the functioning and operational use of the TCAS system.

3 Conclusions

3.1 Findings

- The sector KL12 team consisted of a coach radar controller, a trainee and a radar coordinator.
- The two Geneva sector KL12 controllers were each in possession of an appropriate licence.
- The trainee was in the final training phase (phase 4) and did not hold a controller's licence.
- At the time of the incident, control sectors K1 (133.690 MHz), K2 (132.315 MHz), L1 (134.850 MHz) and L2 (126.050 MHz) were combined into one sector, KL12.
- The radar coordinator occupied the sector KL12 right-hand position, the trainee the centre position and the coach the left-hand position.
- The trainee's DST window display is not available on the screens of the coach or the radar coordinator.
- The DST window was in fixed position mode.
- When FL 260 was entered in the CFL window for flight BEC 016, the DST alert window opened on the trainee's screen. He validated this alert.
- The crew members of the two aircraft involved in the incident were in possession of an appropriate licence.
- Flight BEC 016 was on the frequency, and under the control, of Geneva sector KL12.
- Aircraft 7T-WHB was in Geneva-controlled airspace but was on the Marseille sector Y1 frequency.
- The aircraft on flight BEC 016 was equipped with a TCAS V7.
- Aircraft 7T-WHB was equipped with a TCAS V6.04A.
- Aircraft 7T-WHB initially made a 20° right turn, following the suggestion by the Marseille controller.
- Flight BEC 016 received the instruction to interrupt its climb to FL 250 about 500 ft before reaching this flight level, at a rate of climb of approximately 3000 ft/min (approximately 50 ft/sec).
- Shortly after receiving the instruction to interrupt its climb to FL 250, flight BEC 016 was immediately instructed by the coach to continue its climb to FL 300 at the maximum rate of climb.
- 10 seconds after the instruction to interrupt its climb, the flight profile of BEC 016 was reversed with a descent below flight level FL 250. After 15 seconds, the profile was again reversed, with a climb.
- The crew of flight BEC 016 received a descent resolution advisory RA, followed by a climb resolution advisory RA.
- The crew of aircraft 7T-WHB received a climb resolution advisory RA, followed by a descent resolution advisory RA which were not followed.

- The incident took place 8 NM west-south-west of waypoint KOGAS, at flight level FL 250, in class A controlled airspace.
- At 18:37:51 UTC, according to the radar plots, the two aircraft crossed with a lateral distance of 0.4 NM and an altitude difference of 100 ft.
- The meteorological situation played no part in this incident.

3.2 Cause

The serious incident is due to the fact that ATC forgot about the presence of an aircraft in his traffic management.

Factors which played a part:

- Absence of harmonised information on the screens of the trainee and the coach
- Absence of reaction to the TCAS resolution advisories on the part of the crew of aircraft 7T-WHB

4 Safety recommendations

4.1 Safety deficit

A Lockheed C-130 Hercules type aircraft was cruising at flight level FL 250. Its crew contacted sector KL12 of the Geneva upper control centre.

Control cleared the crew to proceed direct to waypoint BALSI and to maintain flight level FL 250. About twenty minutes later, the C-130 was transferred to the Marseille control frequency.

A Tu-154 was on a route opposed to that of the C-130. The crossing point of the routes of the two aircraft was near waypoint KOGAS, in the airspace controlled by the Geneva control centre. The sector which controls the airspace below section KL12 cleared the crew of the Tu-154 to climb to FL 240 and transferred it to sector KL12, the floor flight level of which is FL 250.

At the time of the first call by the crew of the Tu-154 on the sector KL12 frequency, manned by three controllers including one trainee controller, the trainee cleared them to climb to flight level FL 260, without taking into account the C-130, which was on an opposing heading. The C-130 was still in the airspace controlled by Geneva at flight level FL 250.

At the time the cleared flight level FL 260 was entered in the system, a dynamic scanning tool (DST) alert window opened on the trainee's radar screen and warned him of the conflict between the two aircraft.

At the time of the incident, the DST alert was set to the “fixed position”; the alert was displayed on the extreme right of the radar screen and away from the screen position where the conflict would take place.

When customising the radar screen settings, the controller is able to select the position at which the DST alert window opens. It always opens at the defined position if he has chosen the “fixed position” option. He can also choose the “near the mouse" option; then the alert window opens near the point where the mouse cursor is located.

The trainee validated the information without being aware of it, the window closed and the visual alerts near the relevant aircraft symbols disappeared.

The design of the system does not allow for the DST alert window to be brought up on the display again after it has been validated.

This DST alert appears only on the radar screen of the controller who has entered data into the system – in this case that of the trainee.

The two aircraft crossed at lateral distance of 0.4 NM and an altitude difference of 100 ft.

4.2 Safety recommendations

Safety recommendation No. 410

The Federal Office of Civil Aviation must demand the following modifications concerning the DST system:

- Identical presentation of traffic situation information on the screens of a trainee and his coach
- Appearance of the DST alert windows close to the location of the conflict on the radar screen
- Unresolved DST alerts must remain displayed on the radar screens.

Berne, 11 July 2012

Federal Aircraft Accident Board

André Piller, President

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DEFINITIONS

ACAS – Airborne Collision Avoidance System. Also called **TCAS** - Traffic Alert and Collision Avoidance System. An aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground-based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR transponders.

ACC – Area Control Centre. A unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction.

AoC – Assume of control. Acceptance of a transfer of control.

ATC – Air Traffic Control.

ATFM – Air Traffic Flow Management. A service established with the objective of contributing to a safe, orderly and expeditious flow of air traffic by ensuring that ATC capacity is utilized to the maximum extent possible, and that the traffic volume is compatible with the capacities declared by the appropriate ATS authority.

ATIS – Automatic Terminal Information Service. The automatic provision of current, routine information to arriving and departing aircraft throughout 24 hours or a specified portion thereof.

ATM – Air Traffic Management. ATM-GE Air traffic management Geneva. The aggregation of the airborne functions and ground-based functions (air traffic services, airspace management and air traffic flow management) required to ensure the safe and efficient movement of aircraft during all phases of operations.

ATMM – Air Traffic Management Manual.

ATS – Air Traffic Service. A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).

Capacity. Ability of the ATC system or any of its sub-systems or an operating position to provide service to aircraft during normal activities. It is expressed in numbers of aircraft entering a specified portion of the airspace in a given period of time. The maximum peak capacity which may be achieved for short periods may be appreciably higher than the sustainable value.

Declared capacity. A measure of the ability of the ATC system or any of its sub-systems or operating positions to provide service to aircraft during normal activities. It is expressed as the number of aircraft entering a specified portion of airspace in a given period of time, taking due account of weather, ATC unit configuration, staff and equipment available, and any other factors which may affect the workload of the controller responsible for the airspace.

CFL - Cleared flight level.

CFMU - Central Flow Management Unit (Eurocontrol)

Correlation. Mechanism of the control system which established a biunique link between a radar track and a flight plan.

CTA – Control Area. A controlled airspace extending upwards from a specified limit above the earth.

Downlink Mode S. Datalink in the air-to-ground direction. Mode S air-to-ground signals are transmitted on the response frequency at 1090 MHz.

DST – Dynamic Scanning Tool. Dynamic conflict detection system.

FIR - Flight Information Region. An airspace of defined dimensions within which flight information and alerting services are provided.

FL – Flight Level. A surface of constant atmospheric pressure which is related to a specific pressure datum, 1,013.2 hectopascals (hPa), and is separated from other such surfaces by specific pressure intervals.

Flight Plan - PLN. Specified information provided to air traffic services units, relative to an intended flight or portion of a flight of an aircraft.

Flow Control. Measures designed to adjust the flow of traffic into a given airspace, along a given route, or bound for a given aerodrome, so as to ensure the most effective utilization of the airspace.

FMP – Air Traffic Flow Management Position. Working position established within an ACC to ensure the necessary interface with the CEU on matters concerning the provision of the ATFM service.

InCAS. Interactive Collision Avoidance Simulator.

OJT – On the job training. Practical training at a control position.

OJTI – On the job training instructor.

ORCAM - Originating Region Code Assignment Method. The objective of the ORCAM User Group (OUG) is to administer the allocation of SSR codes and monitor their use on behalf of the ICAO European and North Atlantic Regional Office.

PF - Pilot Flying. Pilot at the controls of the aircraft, in a crew consisting of several members.

PNF – **Pilot Not Flying.** Pilot assisting the pilot at the controls of the aircraft, in a crew consisting of several members.

Primary radar. A radar system which uses reflected radio signals.

Radar blip (primary or secondary). A generic term for the visual indication, in non-symbolic form, on a radar display of the position of an aircraft obtained by primary or secondary radar.

Radar Label. Information appearing alongside the symbol of an aircraft on the radar screen. A radar label will include at least the SSR code transmitted by the aircraft or, after carrying out the code/callsign correlation, the identification of the aircraft and the level information obtained by means of the mode C SSR. All the label information will be presented clearly and concisely.

Radar scanning. Visual scanning of the radar screen.

Radar track. “Unique” information created by software using complex mathematical algorithms on the basis of plots originating from multiple radar stations.

RA – Resolution Advisory. An indication given to the flight crew recommending:

a) a manoeuvre intended to provide separation from all threats; or
b) a manoeuvre restriction intended to maintain existing separation.

Corrective RA. A resolution advisory that advises the pilot to deviate from the current flight path.

Positive RA. A resolution advisory that advises the pilot either to climb or to descend .

Preventive RA. A resolution advisory that advises the pilot to avoid certain deviations from the current flight path but does not require any change in the current flight path.

Descend RA. A positive RA recommending a descent but not an increased descent.

Climb RA. A positive RA recommending a climb but not an increased climb.

RA sense. The sense of an ACAS II RA is "upward" if it requires climb or limitation of descent rate and "downward" if it requires descent or limitation of climb rate. It can be both upward and downward simultaneously if it requires limitation of the vertical rate to a specified range.

RPS – Radar Position Symbol. The visual indication, in symbolic form, on a radar display, of the position of an aircraft obtained after automatic processing of positional data derived from primary and/or secondary surveillance radar.

SSR response. The visual indication, in non-symbolic form, on a radar display, of a response from an SSR transponder in reply to an interrogation.

STCA - Short Term Conflict Alert. The generation of short term conflict alerts is a function of an ATC radar data processing system. The objective of the STCA function is to assist the controller in maintaining separation between controlled flights by generating, in a timely manner, an alert of a potential infringement of separation minima.

Threat. An intruder deserving special attention either because of its close proximity to own aircraft or because successive range and altitude measurements indicate that it could be on a collision or near-collision course with own aircraft. The warning time provided against a threat is sufficiently small that an RA is justified.

TMA - terminal control area. A control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes.

SSR – Secondary Surveillance Radar. A surveillance radar system which uses transmitters/receivers (interrogators) and transponders.

Strip. Paper flight progress strip, i.e. the physical representation of the flight plan elements of an aircraft on a strip of paper.

Stripless. Traffic management without paper strips.

TA – Traffic Advisory. An indication given to the flight crew that a certain intruder is a potential threat.

TCAS. See ACAS

TCG. Terminal Control Geneva.

TMA. Terminal Control Area. A control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes.

UAC-CH. Upper Area Control Centre Switzerland.

UTC – Coordinated Universal Time (Z). The relation between LT, CET and UTC is: LT = CET = UTC + 1 hour.

VOR - VHF omnidirectional radio range; very high frequency omnidirectional radio range.

Waypoint. Specified geographical point used to define a surface navigation route or the trajectory of an aircraft using surface navigation.