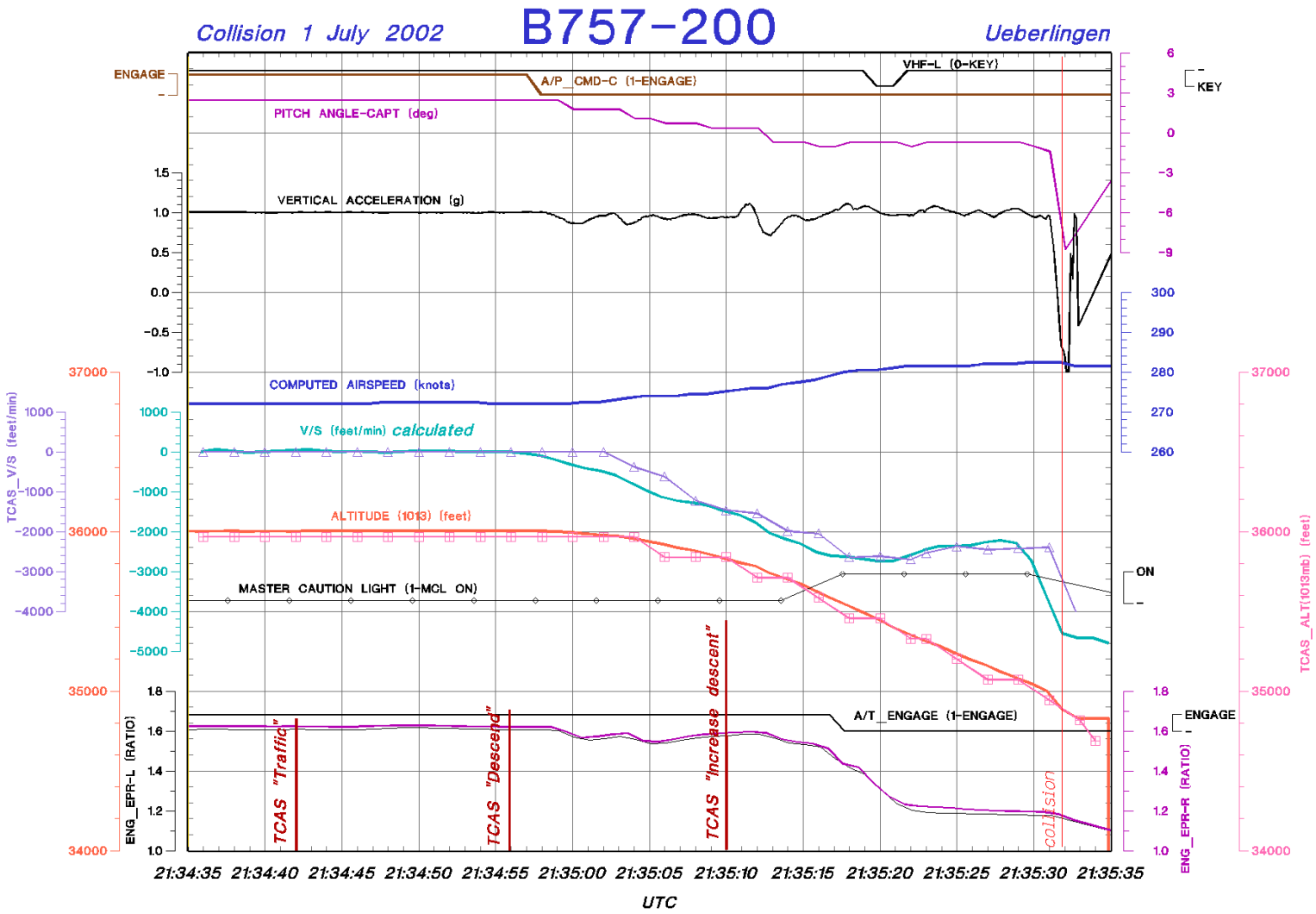
## Events in both Cockpits

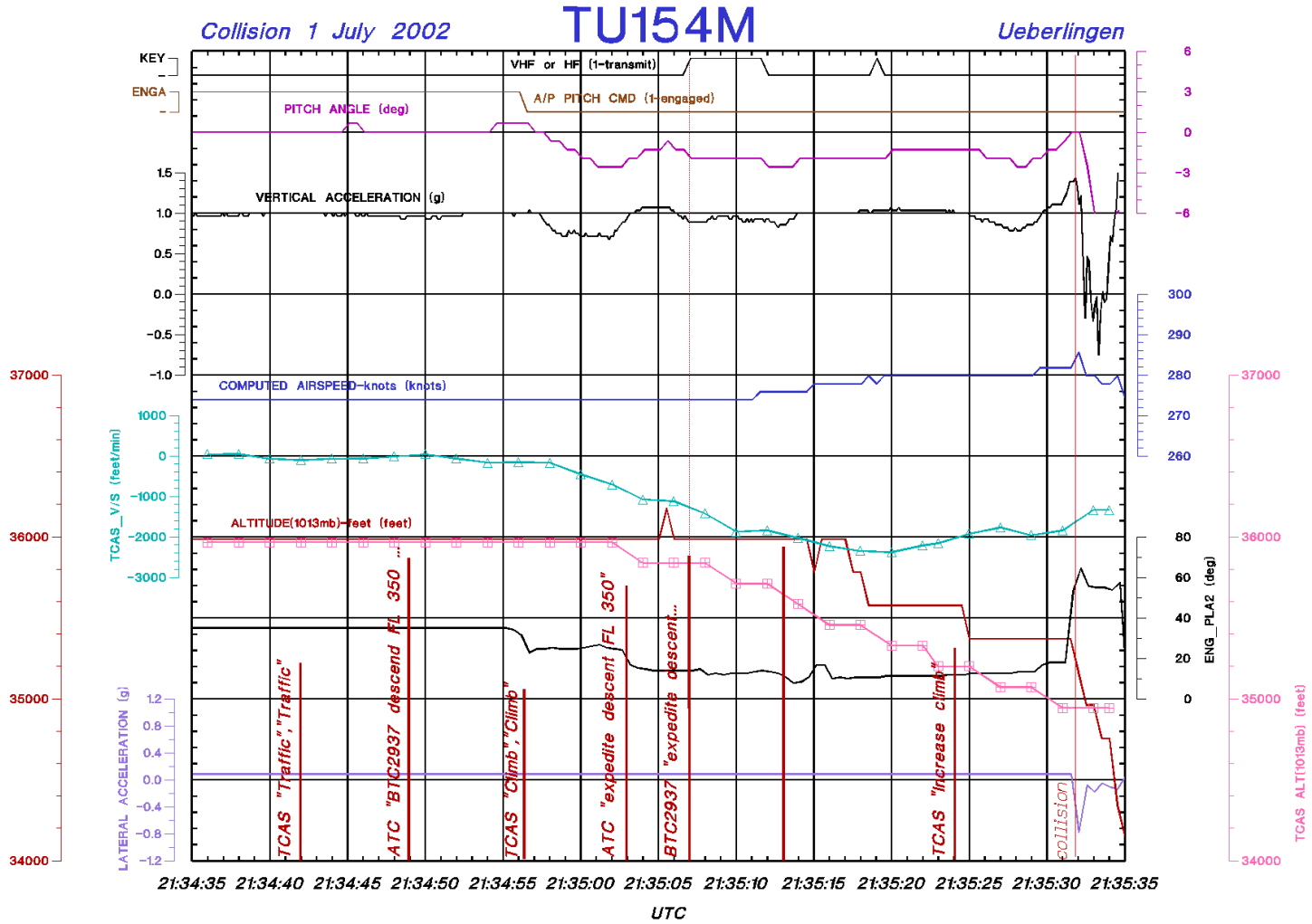
| Zeit UTC | Min Sek | Boeing B757-200 Flug DHX 611 | Tupolew TU154 M Flug BTC 2937 |
|---|---|---|---|
| 21:21:50 | 13:42 | Initial call to ACC Zurich on 128.050 MHz at FL 260.<br>The crew is instructed to switch the transponder to 7524, to climb to FL 320 and is cleared direct to Tango VOR. The crew requests a climb to FL 360. ACC Zurich announces the clearance in 4 to 5 minutes later. | |
| 21:26:36 | 8:56 | The crew receives the instruction to climb to FL 360. | |
| 21:29:50 | 5:42 | The aircraft reaches FL 360. | |
| 21:30:11 | 5:21 | | Initial call to ACC Zurich on 128.050 MHz at flight level FL 360. The crew is instructed to switch the transponder to 7520. |
| 21:33:03 | 2:29 | | Start of a conversation within the cockpit about a TCAS-indication, which shows another aircraft in the same altitude. |
| 21:34:24 | 1:08 | The First Officer indicates to leave his seat in the cockpit and hands over the controls to the PIC.<br>*„Excuse I`ll use the facilities".* | |
| 21:34:42 | 0:50 | TCAS informs the crew of conflicting traffic (TA)<br>*("Traffic, Traffic").* | TCAS informs the crew of conflicting traffic (TA)<br>*("Traffic, Traffic").* |
| 21:34:49 | 0:43 | | The radar controller instructs the crew to an expedite descent to FL 350. This instruction was given together with an information about conflicting traffic..<br>*"B-T-C 2937, ..descend flight level 3-5-0, expedite, I have crossing traffic"* |
| 21:34:54 | 0:38 | | The crew initiates a descent. |
| 21:34:56 | 0:36 | The TCAS issues a RA to descend. The crew follows that command.<br>The radar separation falls below 7 NM. | The TCAS issues a RA to climb. The crew continues in following ATC.<br>The radar separation falls below 7 NM. |
| 21:35:03 | 0:29 | | The radar controller of ACC Zurich repeats the instruction to an expedite descent to FL 350, because the first instruction had not been acknowledged.<br>"B-T-C 2937, ..descend level 3-5-0, expedite descent".<br>*The crew now immediately acknowledges.*<br>„Expedite descent level 3-5-0, BTC 2-9-3-7".<br>After that the radar controller informs the crew of other traffic at FL 360 in the "2 o'clock position".<br>"*Ja, … we have traffic at your 2 o´clock position now at 3-6-0".* |
| 21:35:10 | 0:22 | The crew receives the TCAS command to increase the descent ("increase descent").<br>The First Officer is back to his seat. | |
| 21:35:19 | 0:13 | The crew reports to ACC Zurich that following a TCAS command they have initiated a descent ("TCAS descent").<br>*"Dilmun six hundred... TCAS-descent".* | |
| 21:35:24 | 0:08 | | The crew receives the TCAS command to increase the climb *("increase climb").* |
| 21:35:32 | 0:00 | Collision with the Tupolev TU154M at 34 890 ft | Collision with the Boeing B757-200 at 34 890 ft |

# FDR data (extracts) of the B757-200 (last minute)




File: B757_coll_ALL1
Created: 21 AUG 2002

# FDR data (extracts) of the TU154M (last minute)




File: TU154_coll_ALL1
Created: 21 AUG 2002

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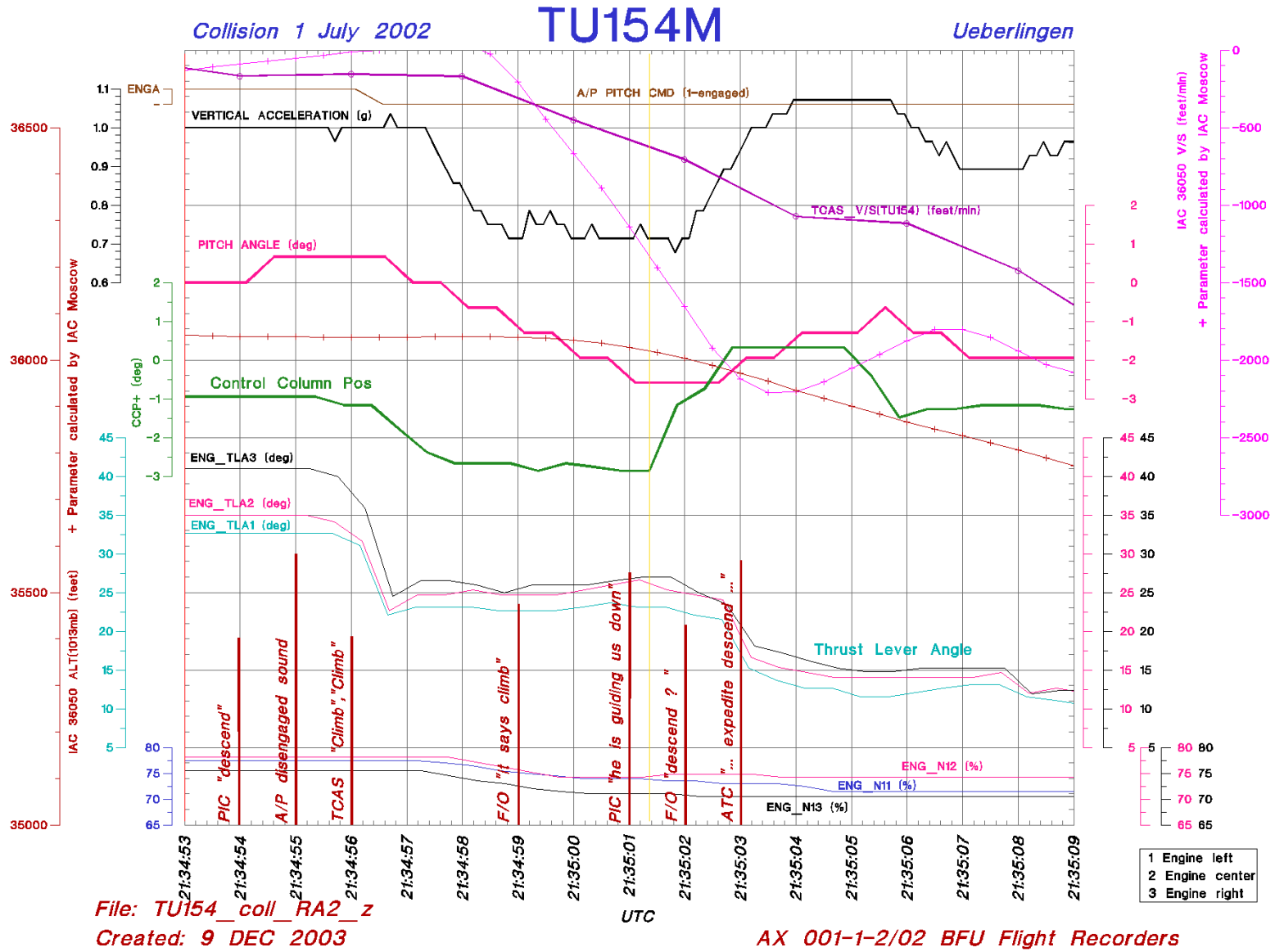
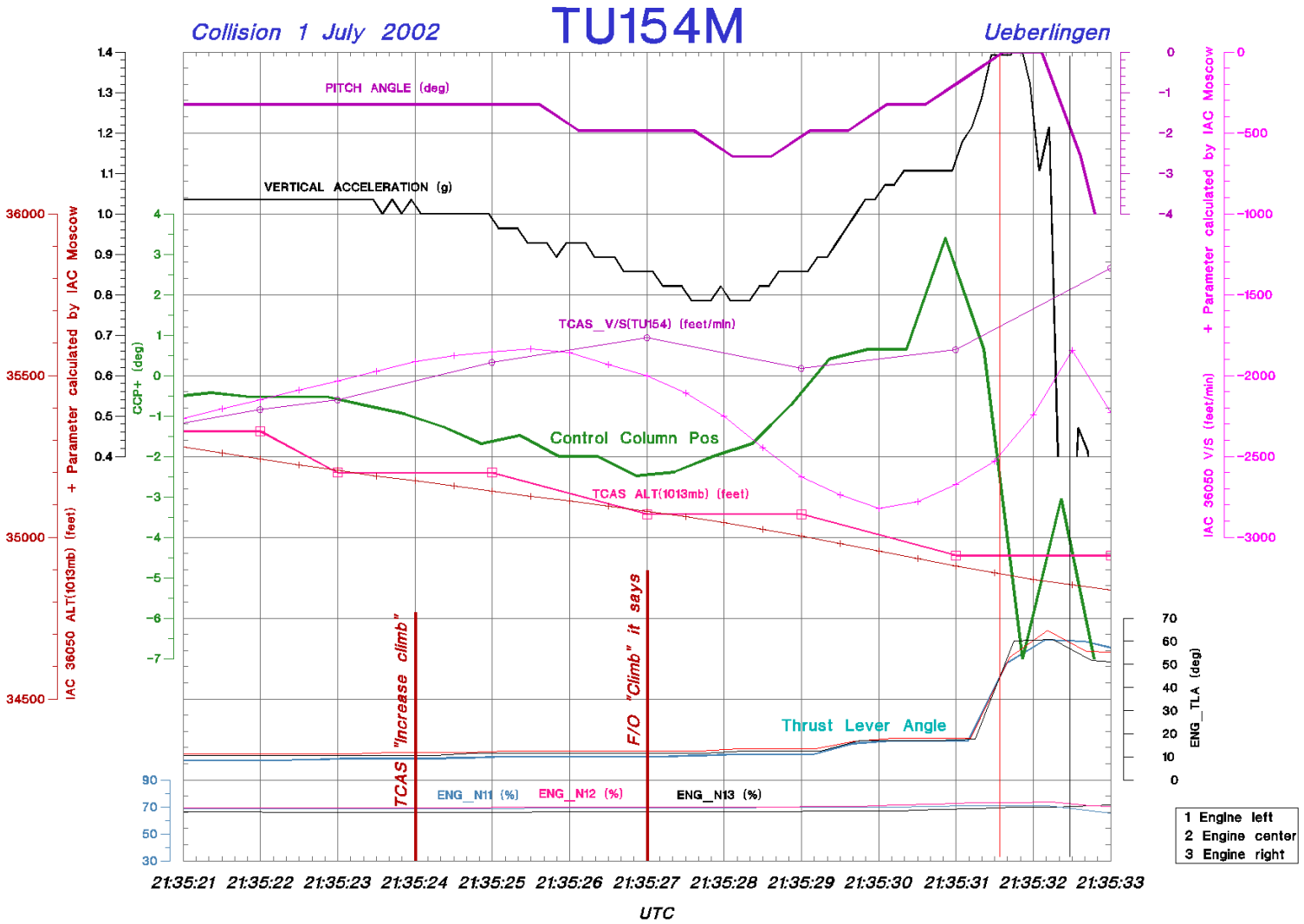
# FDR data (extracts) of the TU154M (response to TCAS RA)



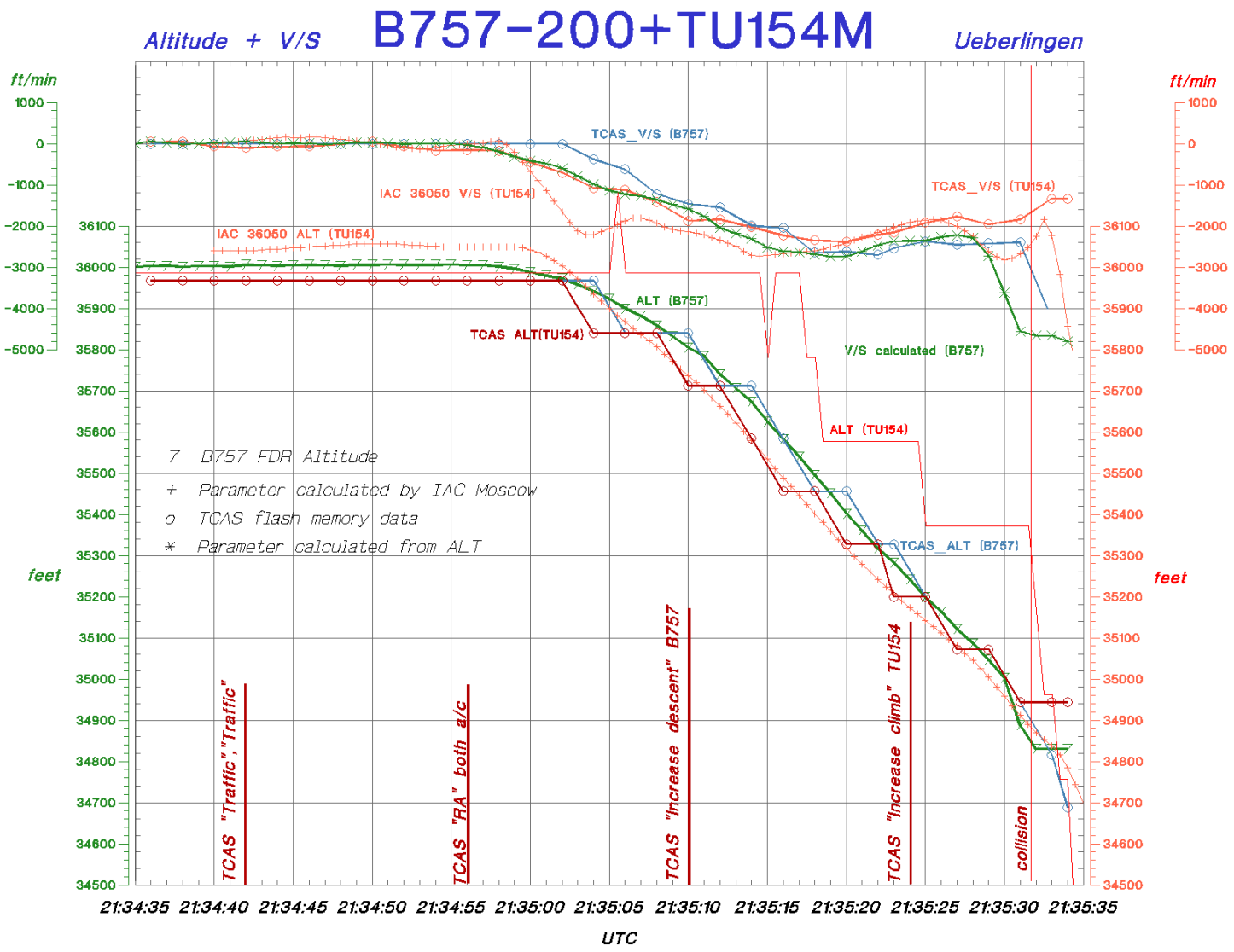
# FDR data (extracts) of the TU154M (descent and approach to FL 350)




File: TU154_coll_LVL350
Created: 9 DEC 2003

AX 001-1-2/02 BFU Flight Recorders

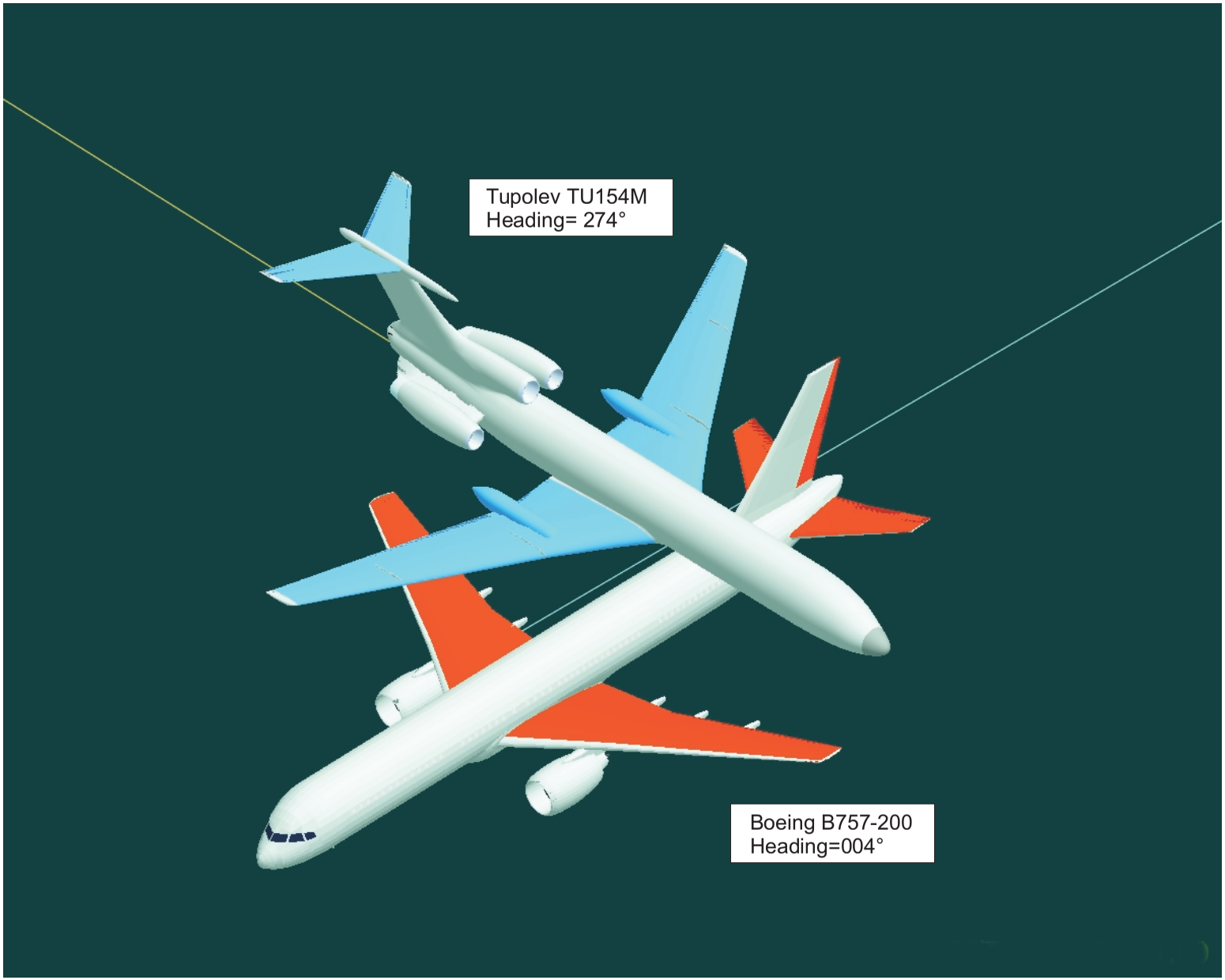
# TCAS- and FDR- parameters (extracts) of B757-200 and TU154M



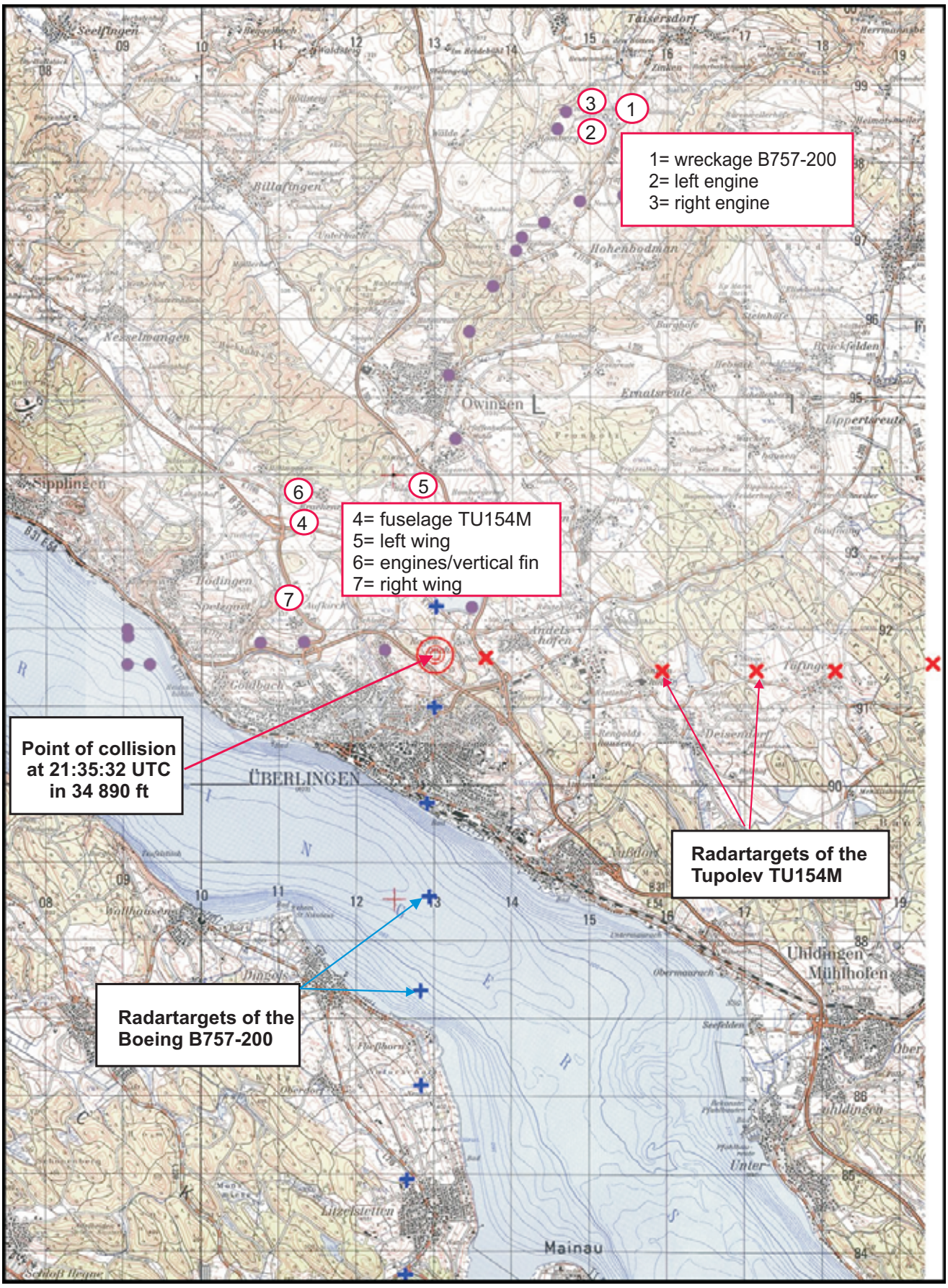

File: B757_vertical_TU154
Created: 28 MAR 2003

AX 001-1-2/02 BFU Flight Recorders

# Reconstruction of Collision



# Distribution of main wreckage-parts



**Regulations within ACC Zurich for „Single Manned Operation Procedures (SMOP)"**

Single Manned Operation Procedures (SMOP) at enroute sectors in a skyguide Control Centre may be approved for application by the local operational management under the following defined circumstances:

General:

- During time period with low traffic demand and at sectors with low traffic load only.
- Preferably enroute sectors in lower airspace should be operated by SMOP.
- If necessary, the traffic amount shall be limited by capacity regulations imposed by the supervisor via the CFMU.
- Two co-located sectors shall normally not be operated by SMOP at the same time.
- Special acceptance rates for SMOP operated sectors shall be defined by the local operational management.

Conditions:

- The Radar-, Communication-, Navigation- and FPL-Systems are working properly.
- The optical STCA is operational and the acoustic STCA is available upon request by the ATCo.
- No adverse weather forecast in the area of responsibility or at relevant airports (defined by the local ops management).
- In Centres with Controller Assistant Positions a Controller Assistant is on duty at the sector.
- No visitors at SMOP-sectors.

Supervisor Duties:

- If the traffic demand is higher than a defined value, the supervisor has to request a monitoring value from the CFMU.
- The supervisor is committed to watch the traffic demand according CFMU terminal frequently.
- The supervisor is committed to watch the actual traffic load at the SMOP operated sectors frequently.

ATCo's duties:

- In centres with Controller Assistant Positions the ATCo shall delegate certain defined tasks to the Controller Assistant.
- If necessary, the ATCo shall request in due time support from the second ATCo of the co-located sector or from the supervisor.
- The headset should be available at the sector and used in due time.

**Publication of deviating statements**

According to ICAO Annex 13 chapter 6 in connection with DOC 9756 chapter 1.4.2 and § 17 "German Law relating to the Investigation of Accidents and Incidents associated with the Operation of Civil Aircraft" (FlUUG), the BFU publishes the following statements of states involved in the investigation.

These statements concern facts and conclusions which were important for the determination of causes and deviate from the BFU's opinion which is published in the investigation report. The respective states requested their publication.

**Kingdom of Bahrain**

The Kingdom of Bahrain has revealed their deviating positions. These essentially concern the significance the investigation of the Human Factors group has within the report. The Kingdom of Bahrain is of the opinion that the results of the Human Factors group shall have been made the sole basis for the analysis.
The following arguments are verbatim excerpts of the statement of the Kingdom of Bahrain. According to the prefacing principles of this appendix, they relate to chapter 3 of the investigation report and will not be commented by the BFU:

*"Most of the findings of Section 3 are generally correct and consistent with the body of the report and other available information. However, some are not totally accurate or complete. The resultant inference can be that individuals failed to understand and cope with the situation due to fault on their part. Yet it is not identified that the environment in which they were placed conspired against them and the system did not provide them with the support and training they should have had.*

*Some findings significant to the systemic nature of the accident and that are in the body of the report or in the Human Factors report are not carried through to Section 3.*

- *The Human Factors report considers at length the Crew Resource Management observed on the Tupolev and the CRM training that was provided. Prior to the TCAS TA the information was available that a conflict existed, but the crew did not develop a team understanding of the situation and project the need to take action. The issue is the use of the available information and the CRM qualities displayed before the TCAS TA. It is understood that the TCAS event itself is a different issue. The CRM of the Tupolev crew is not considered in the Conclusions.*
- *Numerous shortcomings in the Air Navigation Service Provider are exposed throughout the body of the report. In association with various events, these systemic inadequacies help explain the behaviour of individuals involved. When viewed in combination, the exposed deficiencies indicate the ANSP Safety Management System was not effective.*
- *The systemic weaknesses of the ANSP are not categorically identified in the Conclusions.*
- *The second point on the ASMS/Safety Policy needs to be stronger. ASMS and the Safety Policy are interdependent, and do evolve rapidly, if the management have the commitment and resolve to implement them effectively. The HF Group report brings this aspect clearly that the ATS Service Provider lacked the commitment, convictions and the resources to match their perceived safety issues with appropriate actions.*
- *The fifth, ninth and tenth points on Briefing/Directives need to be stronger. To say the ATCOs did not read the Bulletin Board or the Directives were inadequate, focuses the attention on the ATCOs and the Directives alone. The emphasis must be on: Why the management, knowing fully well the consequences of the night work, did not co-ordinate with and brief all staff involved? The management had to make the simplest of 'risk assessment/mitigation analysis', compare it with the SMOP's and realise the ATCO, working on his own was lwft with very little in the way of 'defences'. At the very least the management could have insisted the ATCOs work as a two-man operation on the particular night.*
- *The sixteenth point on Strip Presentation is inappropriately worded. It did not highlight the conflict, which then has serious implications for ATCOs, when radar fails (note RP's duty statement for radar-failure), another systemic failure.*

*Causes*

- *The second systemic cause should be expanded incorporating the findings from the HF Group report on the failure to assess the risks on the particular night, mitigate against them by manning both positions the whole night, briefing all staff appropriately, delegating responsibilities and effective training. Training does not necessarily mean TRM/CCC Training, but rather ensuring that the ATCOs*

*understand and practice (simulate) operations in "radar fall-back mode". This should have been an essential element of their emergency/refresher training.*

- *The third systemic cause should also be expanded. How could management possibly tolerate a single controller working at night at 'low' traffic level, when such operation did not conform to SMOP's criteria? It also raises a question on how does one define 'low' traffic – three aircrafts on 01 July 2002 demanded a great deal of attention even notwithstanding the temporary radar and telephone shortcomings?"*

**Russische Föderation**

The Russian Federation has revealed their deviating positions. These essentially concern the following points:

- The significance of the incorrect traffic information the controller gave the TU154M crew at 21:35:12 hrs
- Deviating evaluation of the B757-200 crew's course of action in regard to TCAS

The following deviating positions concern the causes, are verbatim excerpts of the statement of the Russian Federation and will not be commented:

- *The imminent infringement of the separation between the TU154M and the B757-200 in the airspace of Class A was tolerated and not noticed by the ATC. The instruction for the TU154M was given at a time when the prescribed separation to the B757-200 could not be ensured anymore. No instructions were issued by the ATC to the crew of the B757-200.*
- *The TU154M crew followed the ATC instruction to descend and continued to do so even after TCAS advised them to climb. This manoeuvre was performed contradictory to the generated TCAS RA. The crew was unable to follow TCAS RA as by that time they were at 35 500 feet and the controller informed them about conflicting traffic above, at FL 360. The false ATCO's information on the direction towards the conflicting traffic (2 o'clock instead of actual 10 o'clock) and contradictory ATCO and TCAS instructions did not contribute to the correct decision of the crew as well.*

  *The B757-200 crew who were at the same frequency and heard three ATC instructions to descend, as well as the readback of the TU154M crew about leaving FL 360, had a real possibility to avoid collision.*

**Schweiz**

Switzerland has revealed their deviating positions. These essentially concern the significance of the descent through FL 350 by the TU154M as they followed the ACC Zurich instruction as cause of the accident and the incorporation of two additional findings in chapter 3.1 of the investigation report.

Switzerland has requested that the two additional findings and the additional cause are published. They will not be commented by the BFU:

*3.1 Findings*

*Accident:*

- *When the TU154M, contrary to the instruction of the ATC, was descending through flight level 350, the airplane's rate of descent was approximately 1900 ft/min.*

*ACAS/TCAS:*

- *The simulation and the analysis of the alert sequence showed that the initial RA's would have ensured a safe vertical separation of both airplanes if both crews had followed the instructions accurately*.

*3.2 Causes (3. immediate cause)*

- *When reaching flight level 350, the rate of descent of the TU154M was still approximately 1900 ft/min. Subsequently the crew of the TU154M descended below the flight level assigned by the air traffic control unit.*

**United States of America**

The United States of America have not submitted deviating positions. They made aware of some editorial mistakes. The BFU has corrected them.