Investigation report

B 1/2005L

Serious incident at Kittilä airport on 4 January 2005

Translation of the original report

Registration RA 85794

Tupolev Tu-154M

Accident Investigation Board Finland

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SUMMARY

Serious incident at Kittilä airport on 4 January 2005

On Tuesday, 4 January 2005, a Tupolev Tu-154 commercial aircraft, registration RA85794 and callsign SYL9923, landed at its destination in Kittilä at 07:31:53 UTC. The aircraft, chartered by Yakutia Airlines, had departed from Vnukovo airport in Moscow. The aircraft landed short, touching the paved section of runway 34 thirty (30) metres before the threshold. The tail section of the fuselage was the first section to make contact with the ground and sustained major damage. None of the passengers or aircrew members were injured. On 10 January 2005, Accident Investigation Board Finland (AIB) decided to appoint an investigation commission, B 1/2005 L, for this accident. Air Accident Investigator Hannu Melaranta was named investigator-in-charge with investigators Jussi Haila and Heikki Isomaa as members of the commission. The Federal Aviation Authority of Russia designated Yury Fedyshin as their authorized representative.

Once Rovaniemi Area Control Centre (ACC) first cleared the airliner to descend to Flight Level (FL) 150 (4,575 m) and later to FL 100 (3,050 m), the airliner left its cruising altitude at the normal position. At 07:19 Rovaniemi ACC recleared the aircraft to continue its descent and a moment later cleared it to leave controlled airspace. The ACC also informed it that radar service was terminated and instructed the aircraft to contact Kittilä Aerodrome Flight Information Service (AFIS). The aircraft contacted Kittilä but the flight crew did not understand that the Air Traffic Service (ATS) in Kittilä was AFIS service. The aircraft maintained FL 100 (3,050 m), even though under the AFIS procedure it should have continued to descend on own navigation for the approach. The aircraft finally left FL 100 (3,050 m) 11.5 NM (21 km) from Kittilä runway. This distance represents approximately one third of the normal distance from where descents commence. The aircraft did not intercept the ILS precision approach as per published procedure nor in accordance with regulated company procedures at any phase of the approach. Nor did it follow and maintain the ILS glidepath at any time during the approach. Kittilä aerodrome has a published racetrack procedure and had the aircraft followed it, it could have descended and intercepted the glidepath from the position at which it was when it passed locator KIT. The subsequent descent angle was approximately three times greater than the normal 3.4° path angle, established for the approach. During final approach the engine RPMs were at idle, running at ca. 30%. As per regulations, the engines should have been running at the minimum RPM of 61% and at 75% below 200 m. All engine RPMs began to spool up 6 seconds before touchdown. The aircraft touched down at an abnormal attitude; nose high with the tail section of the fuselage touching the ground first. The Flight Data Recorder (FDR) recorded a +3.5 g vertical acceleration at touchdown.

The investigation revealed that the flight crew were unaware of how the AFIS service worked, of the temporarily changed airspace structure in Kittilä as well as of the type of ATS service provided in Kittilä at any given time. Some of the crew members had flown

to Kittilä the previous week, at which time Air Traffic Control (ATC) services had been available. The crew used the *Jeppesen Licensed to Russia* airway manual. However, the description of AFIS procedures in Finland contained therein was both inadequate and erroneous. Regulations on Finnish AFIS procedures as well as AFIS standard phrases were published in aeronautical information circulars (AIC) disseminated in Finland.

Multi Crew Cooperation during the approach did not function as intended, nor did the crew fully comply with the regulations in the company's manuals. The crew did not have sufficient command of the English language.

The direct causal factors of the incident were:

The crew were unaware of the fact that they were flying in an AFIS environment. Nor were they familiar with the principles of AFIS procedures.

The crew commenced the descent too late at a distance which was approximately three times shorter than normal procedure.

The pilot-in-command decided to execute a straight-in approach even though the aircraft was approximately three times higher than that required at the time.

Even though the parameters for a safe landing were not fulfilled, the pilot-in-command decided to land.

Contributing causal factors were:

Finnish ATS arrangements with regard to AFIS service differ from ICAO definitions. No descriptions on Finnish AFIS service characteristics existed which could appropriately reach all airlines that fly to Finnish AFIS aerodromes. This, especially, applies to foreign airlines. When the flight crew briefed for the flight, they did not have full access to information regarding the type of ATS service that is available in Kittilä at any given time. This information is included in NOTAMs meant for pilots.

The present ATS provider practice of only publishing AFIS procedures domestically does not facilitate the dissemination of complete information to operators or flight crews. This, for its part, shows that the risks inherent in this type of air traffic service have not been analysed. Whilst AFIS service has been considered appropriate even at aerodromes where scheduled and chartered commercial aviation takes place, neither AFIS procedures nor information on them are adequately tailored to correspond to traffic volume requirements. Individual aerodromes have tried to manage air traffic volumes by instituting various temporary arrangements. However, no uniform practice among Finnish aerodromes exists.

There are no explicit requirements concerning AFIS training in international or JAR flight crew certifications.

Multi Crew Cooperation did not work as intended. The co-pilot's and the flight engineer's remarks on abnormal flight parameters did not carry sufficient weight and the pilot-in-command, who was the Pilot Flying (PF), disregarded them.

The flight crew's proficiency in the English language was inadequate. Communication with air traffic control during the phases of flight preceding the approach did not fully comply with standard phraseology. The air traffic controller and the AFIS officer had little possibility of steering the operation of the flight crew in the desired direction. No international standard AFIS phraseology exists. Examples of standard AFIS phrases are published in domestic regulations; however, no one has seen to it that this information reaches operators or pilots.

The investigation commission made three recommendations:

It is recommended that the Ministry of Transport and Communications see to it that the Civil Aviation Administration and the Finnish Civil Aviation Authority ensure that that the user of air traffic services be at all times aware of the content of service provided or that the service provided comply with international standards.

The investigation commission recommends that the Federal Aviation Authority of Russia inspect the airline's operating practices and procedures as well as aircrew training in order to ensure that they are in full compliance with the requirements established for safe international aviation and the rules of the air.

The investigation commission recommends that the Ministry of Transport and Communications see to it that the appropriate authority promulgate all ICAO Annex notifications pursuant to the obligations of ICAO's contracting states.

The final draft of the investigation report was disseminated for statement and comments on 21.9.2006 Responses received by the due date are taken into consideration in the final version of the investigation report.

During the investigation, the Civil Aviation Administration has defined the documentation concerning AFIS-operations to make it more available to the international operators.

The Finnish Civil Aviation Authority has expressed its interpretation concerning the AFIS-service in Finland. This interpretation differs from the Investigation Commission's view, which is based on the ICAO:n circular 211-AN/128, paragraphs ”Foreword”, 5. c) and ”General”, 1.

The Investigation Commission also notes, that contrary to the view of the Finnish Civil Aviation Authority, the state's obligation to notify about the differences to all ICAO Annexes is unambiguous.

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ABBREVIATIONS

ACC	Area control centre
ADF	Automatic direction-finding equipment
AFIS	Aerodrome flight information service
AIP	Aeronautical information publication
APU	Auxiliary power unit
BFU	Bundesstelle für Flugunfalluntersuchung (German aviation accident investigation authority)
CAT7	Category 7
COP	Co-pilot
CTA	Control area
CTR	Control zone
CVR	Cockpit Voice Recorder
DME	Distance measuring equipment
EASA	European Aviation Safety Agency
ECAC	European Civil Aviation Conference
FAA	Federal Aviation Administration
FDR	Flight Data Recorder
F/E	Flight engineer
FIZ	Flight information zone
FT	Feet
GP	Glidepath
GPS	Global Positioning System
GPWS	Ground proximity warning system
ICAO	International Civil Aviation Organization
ILL	Finnish Civil Aviation Administration
ILS	Instrument landing system
JAA	Joint Aviation Authorities
JAR-FCL	Joint Aviation Requirements – Flight Crew Licensing
KT	Knot(s)
LLZ	Localizer
METAR	Aviation routine weather report
MHz	Megahertz
MSL	Mean sea level
N_1 RPM	Engine Low Pressure Rotor speed (%)
NDB	Non-directional radio beacon
NOTAM	A notice which is essential to personnel concerned with flight operations
NM	Nautical mile(s)
PAPI	Precision approach path indicator
PF	Pilot Flying
PIC	Pilot-in-command
PNF	Pilot Not Flying

QNH	Altimeter setting to obtain elevation
RWY	Runway
SFC	Surface
SOP	Standard operation procedure(s)
TAF	Aerodrome forecast
TMA	Terminal control area
TWR	Aerodrome control tower
UTC	Coordinated universal time
VOR	VHF omnidirectional radio range

SYNOPSIS

All times in the report are Coordinated Universal Time (UTC).

A serious incident with the potential for being a major accident occurred at Kittilä airport on 4 January 2005. A Russian Tupolev 154M operated by Yakutia Airlines, registration RA85794, landed approximately 30 m short of the threshold at a high sink rate. As a consequence, the tail section of the fuselage and the inboard tips of the trailing edge flaps made contact with the ground, sustaining major structural damage. No persons were injured.

Accident Investigation Board Finland (AIB) was notified of the incident right away and it immediately launched an on-site investigation, assisted by Kittilä police. AIB investigators arrived on the scene approximately three hours after the event. Accident Investigation Board Finland (AIB) decided to appoint an investigation commission, B 1/2005 L, for this accident. Air Accident Investigator Hannu Melaranta was named investigator-in-charge with investigators Jussi Haila and Heikki Isomaa as members of the commission. Yakutia Airlines and the Federal Aviation Authority of Russia were informed of the incident and of the investigation. The Federal Aviation Authority of Russia designated Yury Fedyshin as their authorized representative.

At the request of AIB, the police carried out an on-site investigation as executive assistance. They photographed the damage to the aircraft, interviewed the flight crew and performed a breathalyser test on them. No rescue service alarms were made. However, the AFIS officer reported the incident to ACC, which in turn notified AIB, whose investigators arrived at 10:30. The investigation focused on flight crew operations, the air traffic service provided as well as its special features. The Finnish Meteorological Institute provided an analysis of prevailing weather conditions at the time. The German Federal Bureau of Aircraft Accidents Investigation *BFU* assisted in analysing the information on the Flight Data Recorder and the Cockpit Voice Recorder.

While the investigation was ongoing, the commission sent out a notification pursuant to section 10 of the Accident Investigation Decree (79/1996). The notification called the attention of the Civil Aviation Administration and the Flight Safety Authority to the fact that Finland has not formally informed of compliance or of non-compliance to ICAO Annex 11 provisions, concerning the standards and recommended practices (SARPS) of ATS services. The notification noted that this being the case, the information published in Finland's aeronautical information publication (AIP), concerning the principles of AFIS operations, does not necessarily reach all aviators. Moreover, domestic AFIS standard phrases are only published in Finland. The full notification and the response to it are appended to the investigation report.

The investigation was completed on January 10th 2007.

1 FACTUAL INFORMATION

1.1 History of the flight

1.1.1 Descent and initial approach

The aircraft entered Finnish airspace at 06:41 at Reporting Point KOMEK, east of Joensuu, on FL 350 (10,600 m). The cruise was uneventful. When the aircraft was on the Rovaniemi Area Control Centre (ACC) frequency, the ACC asked – requested by Kittilä – whether they required refuelling in Kittilä. The crew responded that they required approximately 6,000 kg of fuel.

At 07:05 the ACC cleared the aircraft to descend to FL 150 when ready *("Sierra yankee lima 9923, when ready, descend to flight level 150")*. The crew read the clearance back: *"Descending to level 150, 9923".*

At 07:10 the ACC cleared the aircraft to head directly towards the Initial Approach Fix (IAF) for runway 34 in Kittilä *("Rovaniemi radar, Yakutian 9923 direct for initial approach fix for runway 34").* The crew read the clearance back: : *"Sierra yankee lima 9923, set heading direct for initial approach fix for runway 34… to initial approach fix for runway 34".*

At 07:14 the ACC recleared the aircraft to descend to FL 100 (3,050 m) *("Sierra yankee lima 9923, continue descend to flight level 100").* The crew responded*: "One hundred 9932…23, sorry".* The ACC acknowledged*: "Rovaniemi".*

At 07:19 Rovaniemi ACC cleared the aircraft to descend on Kittilä QNH 991 and informed them of the transition level, FL 60 (1850 m) *("Sierra yankee lima 9923, cleared for descend Kittilä QNH 991, transition level 60").* The crew read back: *"QNH 991, descend level 60, 9923".* The ACC did not correct the erroneous readback. Instead, it cleared the aircraft to leave controlled airspace in descent and gave the QNH 991: *"9923, and you are cleared to leave controlled airspace by descent, QNH 991".* The crew replied: *"QNH 991".* The ACC went on by informing of radar service termination and instructed the aircraft to contact Kittilä AFIS at 118.95 MHz: *"9923 radar service terminated, contact Kittilä AFIS frequency 118.95, terve"*. SYL9923 replied: *"118.95 good day".*

At 07:20 the crew called Kittilä on the AFIS frequency: *"Kittilä AFIS, Yakutian 9923 good morning, QNH, information Whiskey, descend level 100".* Kittilä AFIS advised that there was no reported traffic, reported that surface wind was 020 degrees two knots, QNH was 991 and added that information Yankee was valid: *"Good morning sierra yankee lima 9923, roger, this is Kittilä Information. No reported traffic. Wind 020 degrees, two knots, QNH 991, and information Yankee".* The crew replied: *"Information Yankee, the weather is copied, 9923".*

At 07:23 the crew reported: "*9923 approaching flight level 100".* AFIS replied: *"9923 roger. No reported traffic. Report 15 miles, runway 34".* The crew acknowledged: *"9923 report 15 miles, runway 34".* AFIS replied: *"Kittilä"*. Based on Flight Data Recorder (FDR) information the aircraft reached FL 100 at 07:24. According to the written statements of the pilot-in-command (PIC) and the co-pilot (COP), their clearance was to maintain FL 100 (3,050 m) until 15 NM (28 km) from Kittilä

At 07:24:30 the crew reported: *"9923, 26 miles before Kittilä, request further descend".* AFIS advised that the aircraft was permitted to descend and that there was no reported traffic *("9923, You can descending, no reported traffic").* The crew replied to this: *"Continue prensent level".* AFIS replied: *"Kittilä"*. The aircraft continued to maintain level flight.

At 07:26:40 AFIS advised: *"9923, you can descending, this is no controlled airspace, continue approach runway 34".* The crew replied: *"Continue approach runway 34, 9923. Runway heading now, 15 miles before Kittilä. Confirm further descend. Request further descend"*. AFIS replied to this: *"Okay, confirm. Do you need…Correction, do you can straight ahead approach runway 34?".* The crew responded: *"Cleared straight approach runway 34, 14 miles before Kittilä, request further descend".* AFIS replied: *"Okay 9923. Check QNH 991 and report Kilo India Tango inbound".* The crew replied: *"Kittilä inbound, 9923. By QNH 991 descend 2,500 feet".*

At 07:27:56 AFIS replied: *"Roger"*. Based on FDR information, the aircraft left FL 100 (3,050 m) at 07:28:15. Radar plots place it 11.5 NM (21 km) from the threshold of runway 34 at that time.

The FDR showed that at 07:28 airspeed bled off from 280 knots (520 km/h) to 220 kt (407 km/h) during the descent. During the approach the thrust lever angles of engines number one and three were 20° and engine number two 18° until they were set at the zerp degree position at 07:28:05. N_1 RPM was 55–58%. However, once the thrust levers were reset, engine RPM decreased to 40% whereafter it continued to gradually decrease, finally reaching 30% at 07:31:40.

At 07:28:20 the middle spoilers on the upper surface of the wing were deployed and the trailing edge flaps were set at 15°. At this time the aircraft was flying at 9,500 ft. Flaps were further extended to 28° at 07:29:00. Thirty seconds later the undercarriage was lowered at approximately 8,000 ft (2440 m) and at the airspeed of 180 kt (333 km/h).

1.1.2 Final approach and landing

At 07:30:15 the crew reported passing locator KIT: *"9923 Kittilä inbound"*. AFIS replied: *"Sierra yankee lima 9923, wind 16…correction 060 degrees four knots, runway 34 is free"*. The crew acknowledged: *"Ready to land, 9923, for runway 34"*. AFIS replied: *"Roger".*

According to the FDR, at 07:30:15 the aircraft was flying at 5,800 ft (1,770 m) on the altimeter setting of 1013 hPa. On Kittilä QNH 991 this altitude corresponded to 5,200 ft (1,590 m) MSL. Kittilä runway 34 threshold elevation is 644 ft (196 m). Radar plots indi-

cate that the aircraft was 5 NM (9.3 km) from the threshold at that time. According to the Jeppesen Licensed to Russia ILS instrument approach chart the aircraft should have descended to 2,500 ft (760 m) on QNH 991 before intercepting runway 34 ILS glidepath at approximately 5 NM (9.3 km) Kittilä DME (Distance Measuring Equipment) and passed 2,086 ft QNH (636 m) at 4.0 NM (7.4 km). The DME transmitter was located at runway 34 touchdown point, 300 m past the threshold. Locator KIT was the Initial Approach Fix 4.2 NM (7.8 km) from the threshold, which was the entry point to the racetrack procedure and also published in the instrument approach chart.

At 07:30:52 the crew reported: *"Runway in sight, ready to des…ready to land"*. AFIS replied by the callsign: *"9923".* According to FDR information the aircraft was flying at 3,700 ft standard, which corresponds to 3,100 ft (945 m) on QNH 991.

At 07:31:15 the flaps were further extended to 45° at approximately 2,000 ft QNH (610 m), whereafter airspeed began to decrease from 180 kt (333 km/h).

At 07:31:23 the crew asked AFIS to confirm the landing clearance: *"9923 cleared to land, confirm".* AFIS replied*: "Runway is free"*. The crew replied to this: *"Cleared to land, 9923 on 34"*. AFIS acknowledged: *"Kittilä".* According to FDR information the aircraft was at 2,300 ft (700 m) standard, corresponding to 1,700 ft (520 m) on QNH 991. Radar plots place the aircraft at 1.2 NM (2.2 km) from the runway 34 threshold at this point. As per the approach chart the altitude should have been 1,354 ft (413 m) QNH at 2 NM (3.7 km) DME, which corresponds to 1.8 NM (3.3 km) from the threshold.

During the interview the flight crew told the investigators that as they passed locator KIT, they were established on ILS localizer and slightly above the glidepath (GP) and that soon after this the approach stabilized, following the ILS GP indication as well as the approach path indicated by the PAPI-lights (Precision Approach Path Indicator), positioned on the left side of the runway at the touchdown point.

According to FDR information, the onboard GPWS (Ground Proximity Warning System) began to sound an alert at 07:31:32. The warning continued uninterrupted for 21 seconds all the way to touchdown at 07:31:54.

Section 4.5.2.4 in the Tu-154M aeroplane flight manual gives the following directive: *"Should the GPWS sound an alert, sink rate must immediately be reduced. If the flight occurs above rolling or hilly terrain or if the flight crew is not familiar with the contours of the underlying terrain, altitude must immediately be increased, albeit by not exceeding permitted acceleration or angle of attack limits and the thrust lever shall be moved to takeoff position and be kept there until the alert ceases"*.

During final approach the sink rate varied between 1,500–2,000 ft/min (7.6–12.7 m/s), and was 2,500 ft/min (12.7 m/s) at 07:31:52, i.e. right before touchdown. The nominal sink rate on the 3.4° ILS GP at 130 kt (240 km/h) is 780 ft/min (4 m/s).

The average pitch angle was -6° during final approach. However, at 07:31:45 it rapidly began to increase, peaking at +5° ten seconds later at 07:31:55. FDR information records touchdown at 07:31:53. Airspeed had decreased to 130 kt (240 km/h) two sec-

onds before touchdown. Airspeed remained constant for three seconds after touchdown, whereafter it began to decrease. At the time of touchdown, the FDR recorded the momentary vertical acceleration of +3.5 g and three seconds later another momentary peak of +2.1 g.

During the interview the flight crew explained to the investigators that the final approach was stabile except for the fact that at the height of 50–30 m the aircraft suddenly plummeted. The flight crew also explained that engine RPM during the final approach was 60–65%. When the aircraft suddenly sank, the pilot-in-command requested 85% RPM from the flight engineer, whose duty it was to control the thrust levers. However, as per the crew account, engine acceleration was slow and the increase in thrust could not prevent the aircraft from sinking.

Section 4.5.1.2 in the Tu-154M aeroplane flight manual states that in order to avert the risk of a flameout, it is not permissible to reduce engine RPM to under 61% during approach and landing.

According to FDR information, at 07:31:45 all thrust levers were pushed from the zero degree position to the 60° position within five seconds. The N_1 RPM of all engines was approximately 30% but it rapidly began to increase at 07:31:47. The engines gradually spooled up reaching maximum RPMs approximately three seconds after touchdown, at 07:31:56. The maximum RPM of engine number one was 65% and engines number two and three 69%. At 07:31:55 all thrust levers were retarded to the zero degree position. Five seconds later, to provide reverse thrust for about 10 seconds, the thrust lever of engine number one was set at -32° and engine number three at -28°. At this time the N_1 RPMs of these two engines were 75% and 80%.

The aircraft landed on a paved section 30 m before the runway 34 threshold. The mark left by the tail cone began at 30 m before the threshold, tyre marks began at 25 m and the marks left by the inner tips of the flap shrouds 19 m before the threshold. Approximately 20 m before these marks there was a military arrester net that was lowered on fifty-centimetres-deep snow. As the aircraft landed, it destroyed four lamps on the innermost fixture of the approach lighting system.

After touchdown the crew applied heavy braking. The AFIS officer said that the speed of the aircraft was already slow at mid-runway. The landing weight of the aircraft was 78,600 kg. The maximum allowable landing weight of the aircraft type is 79,600 kg. The aircraft taxied to the end of the runway, turned around and then taxied to the apron. The crew did not report of anything unusual to the AFIS officer. On the apron, the airport ground service crew noticed that the tail section was damaged and informed the AFIS officer of this. He, in turn, ordered the airport rescue vehicle to go and check the runway for anything unusual. The rescue crew noticed the landing marks, the broken approach lights, found pieces of the aircraft's broken light fixtures and subsequently notified the AFIS officer of their findings.

1.1.3 Flight crew regulations

Instructions on how to execute an approach and landing were included in Yakutian Airlines' Standard Operation Procedures (SOP) as well as in the Tupolev Tu-154M flight manual. The airline used the Jeppesen Sanderson, Inc. *Jeppesen Licensed to RUSSIA* airway manual which also included Kittilä approach charts.

The Tupolev Tu-154M flight manual provides operating instructions to the crew for the different phases of flight. The manual contains checklists which are designed for the co-operation of the following three flight crew members: The pilot-in-command (PIC), the co-pilot (COP) and the flight engineer (F/E).

The airline's Operations Manual provides instructions on how a four-member flight crew should operate. The flight crew comprise the PIC, the COP, the navigator (NAV) and the F/E. The manual contains specific instruction with regard to the pilot's role as the Pilot Flying (PF) or as the Pilot Not Flying (PNF).

The instructions contained in the airline's Operations Manual and the Tupolev Tu-154M flight manual did not contradict each other.

The following lists some of the instructions provided in the manuals regarding descent, approach and landing:

a) *Before commencing the descent the PIC and the COP must study and go through the airway manual's approach procedures for the aerodrome in question.*

b) *If necessary, middle spoilers can be used as speedbrakes at prescribed airspeeds during the descent.*

c) *At the distance of 35–20 km, the PIC must confirm that the spoilers are retracted, the spoiler lever is locked in the front position and that the warning light MID/INBOARD is not on.*

d) *From transition level to landing pattern altitude vertical speed must remain below 10 m/s.*

e) *In order to avert the danger of a flameout, engine RPM must not be allowed to decrease below 61% during descent, approach and landing. Should engine RPM decrease below 61%, thrust levers are to be immediately pushed towards higher engine RPM. If engine RPM decreases below 55 or if the turbine exhaust temperature suddenly rises, the engine must be shut down.*

f) *The ILS glidepath must be intercepted from below. The undercarriage is to be selected to the down position and the trailing edge flaps to the 28° position at least 6 km before intercepting the glidepath. PF requests 36° or 45° flap after intercepting the glideslope.*

g) The crew must inform the ATC of their readiness to land and they must receive a landing clearance before the outer marker while in IMC or prior to the turn to the final approach course during a visual approach.

h) *The ATC will issue a landing clearance after the PIC informs the ATC of his readiness to land.*

i) *The PNF monitors the localizer course and the glidepath. Should airspeed deviate more than ±10 km/h from the selected airspeed, he calls out "speed high / speed low". Should the localizer course indicator deviate one dot, he calls out "right of localizer / left of localizer". If the glidepath indicator deviates one dot, he calls out "above glideslope / below glideslope". Should vertical speed exceed 5 m/s, he calls out "sink rate".*

j) *The navigator monitors the distance to the runway, the altitude, which he weighs against the glidepath and vertical speed. He calls out the altitude every 100 m as well as possible deviations of the required parameters.*

k) *The F/E regulates engine thrust in accordance with PIC requests. When engine RPM decreases below 80%, the F/E calls out the engine RPM.*

l) *If the engine RPM requirement exceeds the nominal RPM or remains below 75% at the altitude of 200 m, a missed approach procedure must be executed.*

m) *The PIC calls the go-around and no-one shall question his decision.*

n) *The PIC must abort the approach and execute a missed approach procedure for, among other things, the following reasons:*

   a. *In order to maintain the correct glidepath, either engine RPM must be increased above the nominal RPM or reduced to below 75%.*

   b. *Decision altitude alert or ground proximity warning system alert is received before establishing the required visual reference to approach or landing lights to continue the approach.*

   c. *The position or the trajectory of the aircraft in relation to the runway at decision altitude does not permit a safe landing.*

   d. *A safe landing is not assured.*

o) *If the approach entails a non-standard descent angle (glideslope over 3° and vertical speed more than 4 m/s), vertical speed must be reduced to 3–4 m/s at the height of 20–15 m while maintaining the recommended airspeed.*

p) *At the height of 6–4 m thrust levers are retarded to idle and the flare is initiated while making certain that the angle of attack does not become excessively high*

q) *Touchdown in a correctly performed landing occurs at 300–600 m from threshold at an airspeed which is 5–10 km/h lower than the approach speed and at 0.5–1.0 m/s vertical speed.*

1.2 Injuries to persons

No persons were injured.

1.3 Damage to aircraft.

The aircraft was moderately damaged.

1.4 Other damage

Four approach lights, including their struts, were damaged.

1.5 Personnel information

SYL9923 Captain	Age 54
Licence:	Commercial pilot's licence, first class, valid until 15.6.2005
Medical certificate:	Commercial pilot, valid until 10.12.2005
Ratings:	All required ratings were valid.

The captain had a total flight experience of 16,000 hours, 5,400 of which as captain of Tu-154. He was a certified instructor captain.

SYL9923 Co-pilot:	Age 27
Licence:	Commercial pilot's licence, valid until 19.11.2005
Medical certificate:	Commercial pilot, valid until 19.11.2005
Ratings:	All required ratings were valid.

The co-pilot was on a training flight with the purpose of becoming certified to operate abroad, pursuant to Russian aviation authorities' requirements.

SYL9923 Navigator:	Age 44
Licence:	Navigator, first class, valid until 12.10.2005
Medical certificate:	Navigator, valid until 12.10.2005
Ratings:	All required ratings were valid.
SYL9923 Flight engineer:	Age 45
Licence:	Flight engineer, first class, valid until 17.11.2005
Medical certificate:	Flight engineer, valid until 17.11.2005
Ratings:	All required ratings were valid.
Kittilä AFIS officer:	Age 42
Licence:	AFIS officer, valid until 30.8.2005
Medical certificate:	ATC controller, valid until 30.8.2005
Ratings:	All required ratings were valid.

ACC controller:	Age 28
Licence:	ATC controller, valid until 30.6.2009
Medical certificate:	ATC controller, valid until 15.8.2006
Ratings:	All required ratings were valid.

1.6 Aircraft information

1.6.1 Basic information

Tupolev Tu-154M is a Russian made, 166 seat medium-range trijet passenger airliner.

Aircraft

Type and model:	Tupolev Tu-154M
Registration:	RA-85794
Serial number:	93A978
Operator:	Aircompany Yakutia

Engines

Number:	Three turbofans
Type:	Aviadvigatel D-30KU-154-II turbofan
Fuel:	Jet fuel (kerosene)

Airworthiness

Certificate of registration:	Issued on 11.4.2001
Certificate of airworthiness:	Valid until 26.3.2005

1.6.2 Weight and balance

The calculated takeoff weight at Vnukovo was 89,574 kg. According to the Tu-154 flight manual, the maximum takeoff weight is 100,000 kg. The centre of gravity was located in the permissible range, at 23.9% during takeoff and at 23.2% during landing. The landing weight of the aircraft was 78,600 kg, while the maximum landing weight is 79,600 kg. Kittilä runway conditions imposed no additional restrictions on the landing weight.

The aircraft zero fuel weight was 68,574 kg, while the maximum allowable zero fuel weight was 74,000 kg. Fuel load at takeoff was 21,000 kg and fuel load at landing was approximately 10,500 kg.

1.7 Meteorological information

1.7.1 General weather information

On the day of the occurrence there was a filling secondary depression in the Oulu province. Layer clouds were prevalent in Lapland. Snow showers mainly appeared in the eastern parts of Lapland province. Surface winds were light, blowing from the east and from the north. Upper winds at FL 50 and FL 100 were variable and light, blowing at approximately 5–15 KT.

1.7.2 Aeronautical weather in Kittilä

Kittilä METAR at 07:20:

Wind 020° two knots (1 m/s), visibility over 10 km, overcast at 1,700 ft (510 m), temperature -6° C, dew point -7° C, QNH 991 hPa, RWY 34 braking action 47/45/54.

Kittilä TAF for 06–15:

Wind 020° three knots (1.5 m/s), visibility over 10 km, scattered clouds at 1,000 ft (300 m), broken at 1,500 ft (450 m), temporarily between 06–15 visibility 4,000 m, snowfall, broken at 800 ft (240 m).

The temporary snowfall mentioned in the forecast did not occur.

1.7.3 Windshear probability estimate

Windshear is a phenomenon which almost always occurs close to the ground. Its intensity may vary by time and place and, therefore, windshear warnings are only issued at aerodromes where wind information can be obtained from high masts (Rovaniemi, Kuopio, Helsinki–Vantaa). A windshear warning is issued if its intensity equals or exceeds 6kt/100ft.

In this case, on the basis of Kittilä METAR information, surface wind at the landing time was 020°/02kt. According to numeric models wind at the height of approximately 100 m was ca. 050°/08kt and 060°/09kt at 250 m, respectively. However, the proximity of nearby fells may add ambiguity to the calculated lowest level winds. Furthermore, this method does not factor in any possible vertical air currents.

On the basis of these wind values windshear intensity for the final 100 m of the approach would have been ca. 2kt/100ft and approximately 1kt/100ft for the final 250 m. As the aircraft approached runway 34, the model calculates the wind at 200 m as an almost direct side wind. This would have had a negligible effect on airspeed. At lower altitude the wind turned into a slight headwind, although at a lower calculated intensity.

Wind directions presented by the model fit the synoptic observations well and wind intensities were at the same levels compared to those recorded at Sodankylä weather sta-

tion. In addition, windshear intensities calculated from Sodankylä wind data were roughly the same as the ones calculated for the Kittilä area from the model.

On the basis of the above, it seems that windshear played no significant role on the incident.

1.8 Aids to navigation

1.8.1 Onboard systems

The aircraft was equipped with all of the required aids to navigation as well as with onboard weather radar. The navigation equipment comprised of dual ADF VOR/ILS, GP and Marker receivers and radio altimeters. In addition, the equipment included a GPS navigation system and a GPWS (ground proximity warning system). GPWS is a system which alerts pilots of excessive terrain closure rate, excessive deviation below glideslope and excessive sink rate during final approach. There was no report that the aids to navigation or the onboard radar had malfunctioned.

1.8.2 Ground systems

The ILS system for RWY 34 in Kittilä was properly maintained and it had passed its previous calibration flight on 3.11.2004. The ILS system was recalibrated on 27.4.2005 at which time the equipment conformed to ICAO Annex 10 standards.

Rovaniemi ACC had access to information from six air traffic radars, shown on Eurocat V3.6 system displays. During the flight the Oulu MSSR radar was disconnected from the system due to maintenance. However, the aircraft was already beyond the range of that radar. All other radars were functioning properly at the time of the incident.

1.9 Communications

Radio communication between the aircraft and Rovaniemi ACC was conducted on the ACC frequency 124.200 MHz. Communications worked properly and both parties read each other well. Communication proceeded normally, including usual ATS radio traffic, until the time when the aircraft was cleared to descend into uncontrolled airspace. The ACC did not require the flight crew to correct their erroneous readback, nor did the ACC require a correct readback from the crew as it issued the clearance to the uncontrolled airspace.

Radio communication between the aircraft and Kittilä AFIS was conducted on the Kittilä AFIS frequency 118.950 MHz. Communications worked properly and both parties read each other well. Radio traffic was centred on leaving the altitude and establishing the permissibility of landing. The Kittilä AFIS officer spoke poor English when he used non-standard phraseology in the attempt to make the flight crew understand that they had the right to descend and land.

Rovaniemi ACC and Kittilä AFIS talked on the telephone regarding:

- Possible refuelling of the aircraft,
- Direct clearance to the Initial Approach Fix (IAF),
- Confirmation of the clearance to descend into uncontrolled airspace, at which time they also briefly spoke about the problem of how to make the flight crew understand the ATS system used in Kittilä,
- Notifying of the incident, discussion about reporting and further notifications that were to be made.

Kittilä AFIS officer received a telephone call from the Finnish ground handling service personnel informing him that the rear fuselage section of the aircraft was damaged.

Kittilä AFIS tried to call the airport manager but the call was forwarded to his voice mail. Kittilä AFIS called in additional personnel to the airport. Telephone communications worked well.

1.10 Aerodrome information

Kittilä aerodrome is a primary international airport. The Aerodrome Reference Point is at N 67°41' 55", E 024°50' 53" and runway elevation is 196 m (644 ft MSL). There is one runway; 16/34, magnetic bearing 166.10°/346.12°: The runway is 2,500 m long and 45 m wide. The size of the runway strip is 2,620 x 300 metres. At both ends of the runway there are turn pads which are 126 m long and 86 m wide. The size of the runway end safety area at both ends of the runway is 90 x 90 metres. One taxiway connects the runway to the apron. There are no obstacles in the approach sector to runway 34. The rescue class of the aerodrome is CAT 7. At the time of the incident the number of personnel at the airport fulfilled the rescue class requirement.

Runway 34 has white high intensity approach lights and red low intensity approach lights. The approach lighting system is 720 m long. The threshold is marked with green threshold lights. The runway edge lights are white high intensity lights and the end lights are red high intensity lights. There is a PAPI light system for runway 34 indicating a 3.4° approach path. The PAPI system provides for a 57 ft minimum eye height over the threshold. Aerodrome lighting arrangements meet the terms of ICAO Annex 14.

Two instrument approaches exist for runway 34 (ILS or LLZ RWY 34 and NDB RWY 34). The ILS/LLZ approach has two alternative IAFs for a straight-in approach, through which traffic is directed via Intermediate Fix (IF) to LLZ. The initial approach occurs at 3,000 ft, from which altitude one is permitted to descend to the intermediate approach altitude at the specified DME distance. The intermediate approach altitude is 2,500 ft. After initiating the descent after the Final Approach Fix (FAF), the LLZ approach contains two altitude checkpoints, based on the DME distance. The Missed Approach Procedure (MAP) is similarly established for both approaches. The MAP instructs one to climb on track 337° to 2,200 ft, then to turn right to locator KIT maintaining 2,500 ft. Locator KIT is also the IAF for the racetrack procedure.

The permanent airspace structure in the Kittilä Flight Information Zone (FIZ) was the following:

During the operational hours of Kittilä AFIS the airspace class of Kittilä FIZ is G+ from surface to FL 95 (2,900 m). G+ is uncontrolled airspace in which AFIS service is provided and where all traffic is to maintain radio contact with AFIS. Pilots-in-command make individual decisions and report their action on the AFIS frequency. AFIS will ascertain that the information gets through to other traffic. Kittilä AFIS is responsible for the FIZ airspace.

Airspace class C begins at FL 95, above which is controlled airspace. This airspace is the responsibility of Rovaniemi ACC and flights therein are controlled by Rovaniemi ACC. This permanent arrangement is published in AIP Finland.

At the time of the incident the airspace structure in Kittilä FIZ was temporarily classified in the following way:

During the operating hours of Kittilä temporary TWR airspace, class D was in force from surface to 4,000 ft MSL. Kittilä temporary TWR was responsible for the airspace. At the time of the incident Kittilä temporary TWR was closed.

During the operational hours of Kittilä AFIS, the airspace class in Kittilä FIZ was G+ from surface to 4,000 ft MSL. At the time of the incident Kittilä AFIS was open.

From 4,000 ft MSL to FL 95 (2,900 m) the airspace class was D, which is controlled airspace. Rovaniemi ACC was responsible for this airspace.

From FL 95 (2,900 m) upwards the airspace class was C, which is controlled airspace. This airspace is the responsibility of Rovaniemi ACC and flights therein are controlled by Rovaniemi ACC.

This temporary arrangement was published in AIP Finland supplement 66/2004. The purpose of the temporary airspace structure change was to guarantee the safe and flexible conduct of air traffic to Kittilä aerodrome in response to changes in traffic volume. This was implemented by providing ATC services at Kittilä aerodrome during times of high traffic volume and by controlling Kittilä traffic from a separate feeding sector that was established at Rovaniemi ACC. At the time of the incident this arrangement was not in force. Air traffic clearances did not make use of airspace class D between 4,000 ft and FL 95.

Kittilä AFIS and the temporary Kittilä TWR took turns in providing ATS service at Kittilä aerodrome. This rotation was implemented on the basis of forecasted traffic volumes. The type of service provided at any given time, including operational hours, was notified by NOTAMs that were to be published seven days at the latest before their entry into force.

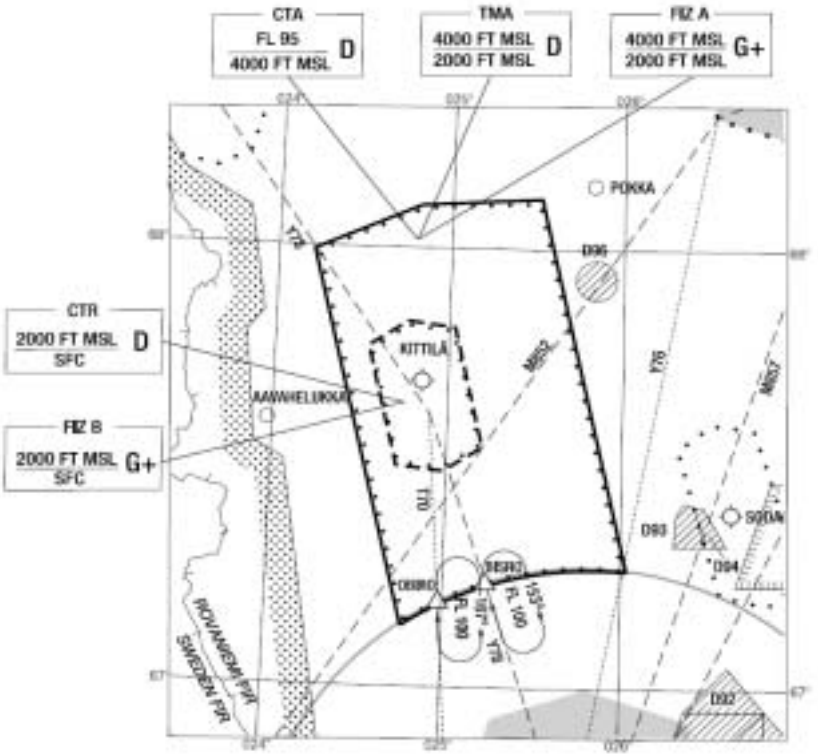

Figure 1. Airspace structure (Source: Finnish AIP)

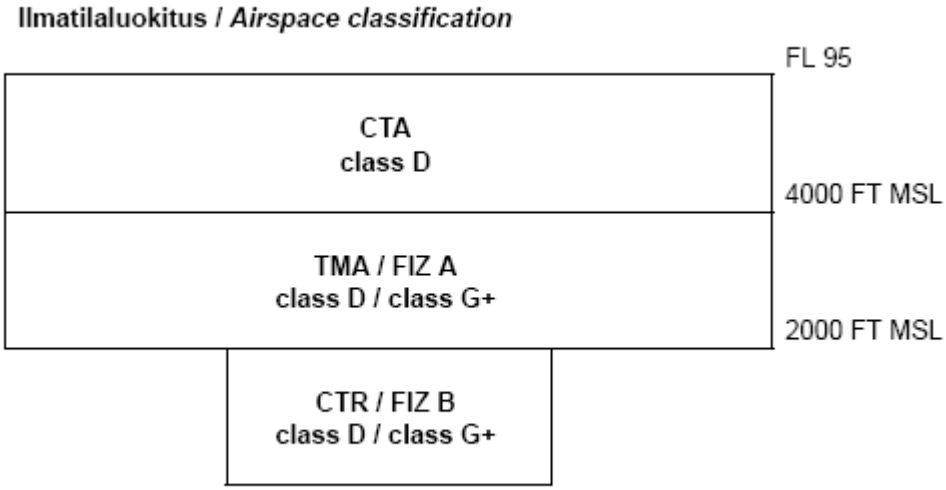

Figure 2. Airspace classification (Source: Finnish AIP)

The Memorandum of Agreement between Rovaniemi ACC and Kittilä ATS service was updated to comply with the changed airspace. It entered into force on 3.12.2004.

1.11 Flight recorders

At the request of the investigators the airline's flight engineers travelling onboard the occurrence flight disconnected the Cockpit Voice Recorder (CVR) and the Flight Data Recorder (FDR). The German accident investigation authority, *Bundesstelle für Flugunfalluntersuchung* (BFU), assisted in analysing the data of both recorders. The analysis was conducted at BFU's premises on 16–17 February, 2005. CVR data covered the final 30 minutes of the flight. FDR data provided information on 109 parameters, on the basis of which it was possible to make a thorough analysis on the phases of the flight. This information is appended to this report. For its part, the combined information also formed the basis for the incident narrative.

1.12 Wreckage and impact information

Kittilä police conducted the preliminary investigation of the incident site as executive assistance. They photographed and measured the damage to the aircraft, the landing marks and the damage done to the approach lights. After having arrived on the scene, AIB investigators continued the on-site investigation. A report on the damage to the aircraft was made.

Figure 3, Fuselage tail end damage

The tips of both trailing edge flap shrouds on number 1 flap rails on both wings were dented, torn and laterally shifted. The affected area was approximately 300 x 200 mm. Fuselage skin panels were torn on the lower right side between bulkheads 68 and 69.

The tears were ca. 600 mm long. The fuselage itself was structurally intact. The glass top cover of the lower beacon light was broken.

The APU (Auxiliary Power Unit) air inlet flap hinge fixtures were damaged. The inlet flap was bent and after the aircraft taxied to the stand and the crew started the APU, it got stuck in its opening. The left bracket was damaged and the right bracket had shifted. There was a 30 mm long tear in the fuselage panel. The APU air duct was deformed; a 150 mm section had moved all the way to the number 2 engine oil reservoir strut. The reservoir itself was intact. The vertical firewall between the APU cowlings displayed shallow depressions, approximately 0.15 mm deep. The depth of the depression for the entire length of the lower wing spar (area) was approximately 8 mm. The rearmost antenna was deformed.

The detachable mount for engine number two front and middle cowl doors was damaged. The cowling displayed some deformation; the skin panel was bent inwards and also partially torn. The panel stiffener had been deformed. Cowl attachments and both cowl door locks were intact.

The door mountings of avionics compartment no. 5 were torn. The cargo door mounting was damaged on the left side. There were dents in the fuselage skin, although no damage on the inside. Rearmost bulkheads displayed dents and deformation.

The main undercarriage oleo struts were examined to exclude possible bottoming out during landing. There was no indication of full bottoming out, nor were there any signs of hydraulic leaks on the strut legs.

Figure 4. Touchdown point

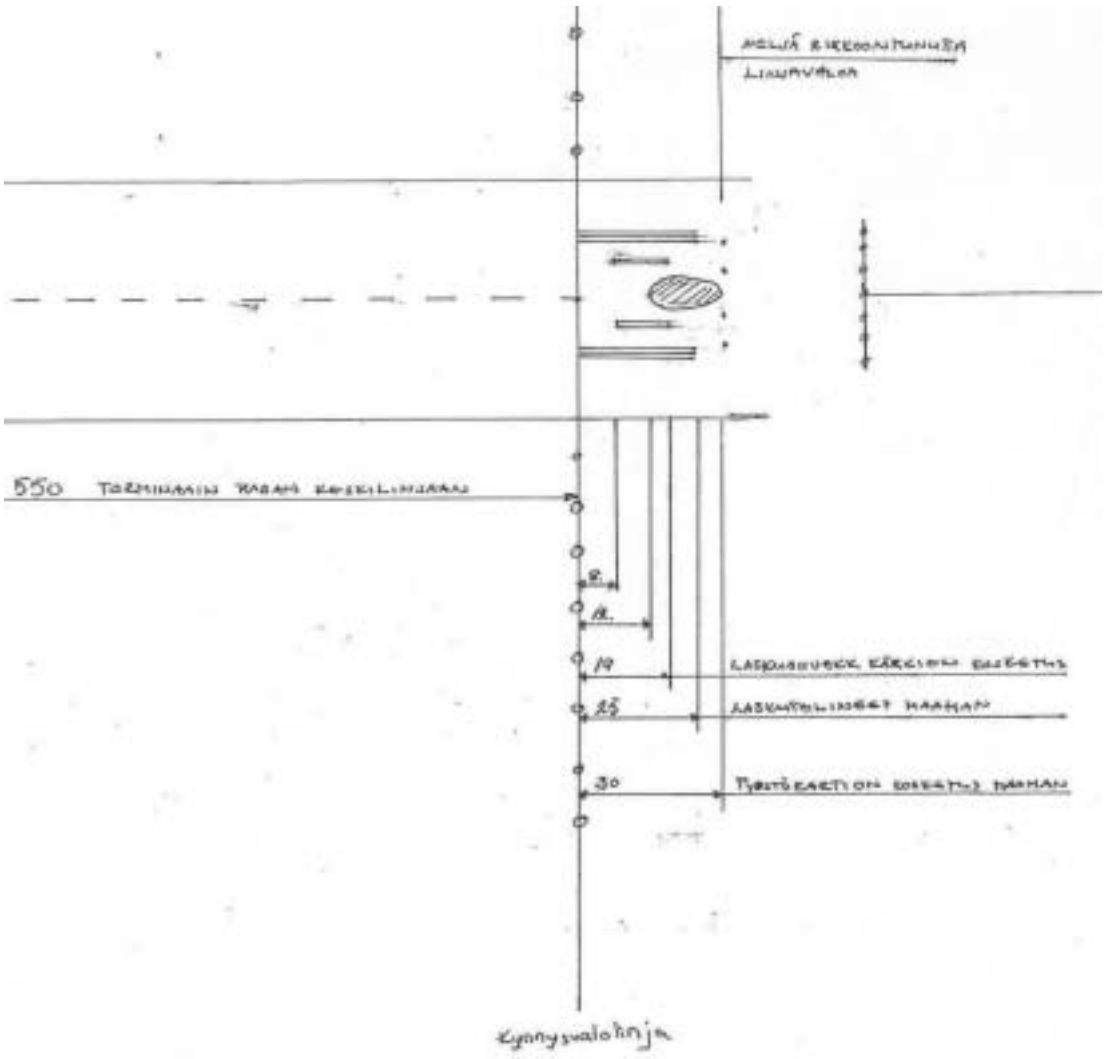

Figure 5. Site sketch (Source: Kittilä police)

The first time the undercarriage touched down was 25 metres before the runway 34 threshold lights. The tail cone left marks 30 metres before the threshold and the trailing edge flap tips left marks 19 metres before the threshold. When the fuselage tail end touched down, it broke four approach lights prior to the threshold.

1.13 Medical and pathological information

A breathalyser test was performed on the flight crew and on the AFIS officer. All tests showed zero blood alcohol.

1.14 Fire

There was no fire.

1.15 Survival aspects

Pursuant to ICAO Annex 14 and Doc 9137-AN/848, Kittilä aerodrome met the Aerodrome Rescue and Fire Fighting Service requirements for the aircraft type and traffic category in question.

There was an air rescue alerting manual at Kittilä AFIS tower. The manual was comprehensive and covered all actors at the aerodrome. As per the manual the AFIS officer is to sound an alert upon having received information of an air incident from an aircraft, the ACC, other authorities or from individual citizens. In accordance with the manual the AFIS officer should alert the aerodrome rescue service, the Emergency Response Centre and the ACC.

In this case the flight crew did not report of anything unusual. The AFIS officer received the information from the airport ground service when the aircraft was already parked in front of the terminal and the passengers were normally deplaning down the steps. The immediate danger was already over and, therefore, no evacuation was initiated. The manual did not warrant the sounding of an alert in this case, but the AFIS officer reported the matter to the ACC as well as to airport maintenance who, in turn, dispatched a vehicle to inspect the runway and airfield equipment.

1.16 Test and research

The investigation commission interviewed the persons from the Northern Finland Air Navigation Centre (ACC) who were responsible for providing instruction on operating procedures and the changed airspace structure. The commission also interviewed the chief of the ACC.

Kittilä airspace structure had been changed to facilitate air traffic control during times of heavy traffic volumes. The ACC had established procedures under which a separate feeding sector handed air traffic to Kittilä temporary control tower. The procedure was analysed, simulated and then trained to air traffic controllers as well as to some operators. During this activity, specific staff were on duty.

Simultaneously, the airspace structure for low traffic volumes was also changed. At these times AFIS service is in force at Kittilä. The ACC had not completed the regulations or training for the low traffic volume airspace structure. The Memorandum of Agreement between Kittilä and Rovaniemi ACC had been updated.

Regardless of the traffic situation, the altitude clearances issued to Kittilä-inbound traffic prior to issuing clearances into uncontrolled airspace varied.

The flight profile of the aircraft was analysed on the basis of recorded radar information. The following table, plotted on the basis of said data, illustrates the descent profile.

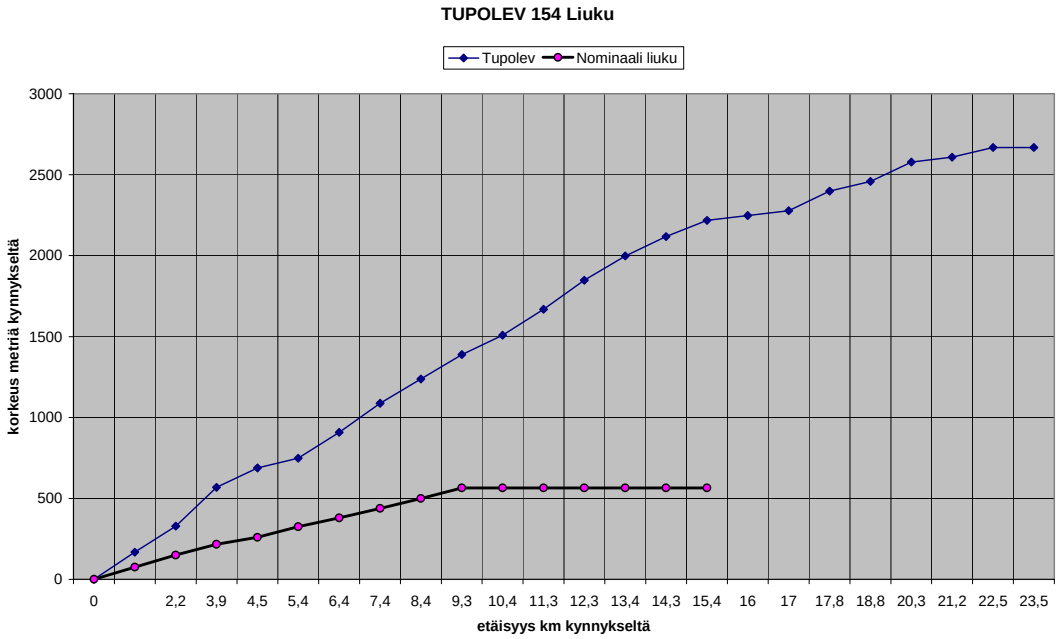

Table 1. Descent profile, plotted on the basis of radar data

1.17 Organizational and management information

1.17.1 Standards hierarchy

The tasks of the International Civil Aviation Organization, an agency of the United Nations (UN), were established in the Chicago Convention, signed on 7.12.1944. Up to this point over 180 nations have become contracting (member) states to the organization. One of ICAO's key activities is the establishment of International Standards, Recommended Practices and Procedures, described in Annexes to the Convention. The contracting states must implement the standards as closely as possible as regards legislation pertaining to aviation within their territory and with regard to aircraft in their registration. Should a contracting state deviate from some ICAO Standard, it must inform the organization of this. As regards Recommended Practices, it is up to the contracting states to decide whether they follow them or not. There are no reporting obligations regarding compliance to Recommended Practices. AFIS service is mentioned in an ICAO Circular. Circulars are informative publications and they are not updated. Both Russia and Finland are contracting states to ICAO.

The European Civil Aviation Conference (ECAC), encompassing 42 member states, has agreed on cooperation for promoting the general safety of aviation as well as on developing common legislation regarding standards and procedures. The European Joint Aviation Authorities (JAA) commenced operations in 1970 with the initial objective of developing European standards for aircraft design, manufacture and certification. Subsequently, their work extended with the aim of setting up a comprehensive European aviation regulatory framework. One of the aims in this development was to harmonize the aviation standards of Europe (JAA) and the United States (FAA). Finland is a member

state of ECAC and committed to complying with the European Joint Aviation Requirements (JAR). Russia has observed the work in ECAC meetings.

Regulation (EC) 1592/2002 of the European Parliament and of the Council on 15.7. 2002 provided for the common rules in the field of civil aviation as well as for the establishment of the European Aviation Safety Agency, EASA. The Agency commenced operations on 28.9.2003. The intention was to transfer all regulatory activities from JAA to EASA within a short transition period. Pursuant to EU regulation, the production of all EU legislation and implementation material related to the regulation of civil aviation safety is transferred from the member states' national aviation authorities to EASA.

All ECAC member states that have contracted to JAA are not members of the European Union. However, the aim is to guarantee their participation in EASA's activities.

Eurocontrol refers to the European Organisation for the Safety of Air Navigation, a body created in the Eurocontrol International Convention relating to Cooperation for the Safety of Air Navigation (Eurocontrol, SopS 70/2000).

When drafting its own regulations, Finland's aviation authority takes into consideration the Standards and Recommended Practices of the Chicago Convention as well as the standards and recommendations of JAA, ECAC and Eurocontrol.

1.17.2 Airline information

Aircompany Yakutia is a limited company registered in Russia operating in, among other things, domestic and international air transport of passengers, cargo and mail. The company operates 14 airplanes, some of which are leased. Some 440 flight crew members work for the company. Despite requests, the company did not provide any documents to the investigation commission with regard to the organization of flight operations. Neither did the company provide any information on aircrew training.

1.17.3 Cockpit procedures

Multi Crew Cooperation (MCC) is based on the instructions in the airplane flight manual, published by Tu-154's manufacturer. The International Civil Aviation Organization ICAO requires that flight operators prepare Standard Operation Procedures (SOP) for their flight crews that instructs them on safe, effective, logical and predictable performance. In its publications Doc 8168, Doc 9376 and Doc 9683, ICAO has provided guidelines and safety considerations regarding the drafting of SOPs. An SOP defines the sequence of tasks and procedures which secure the successful completion of a flight procedure. In order to achieve these aims, an SOP should unequivocally express the following:

a) What the task involves,

b) When the task shall be performed (time and order),

c) Who performs the task,

d) How the task shall be performed (procedures),

e) What the sequence of procedures include, and

f) What the feedback for procedures (oral acknowledgment, instrument indication, switch position etc.) is.

The flight crew of the flight on 4.1.2005 was made up of four members: The pilot-in-command (PIC), the co-pilot (COP), the navigator (NAV) and the flight engineer (F/E). During this approach the PIC was the Pilot Flying (PF).

Tu-154 is certified for a three or a four-person flight crew. The cockpit procedures and checklists published in the flight manual are designed for a three-member MCC. Said lists regulate the procedures of the PIC, COP and F/E. In this case the NAV was the fourth crew member. The PIC, the COP and the F/E completed the required procedures and the NAV read out loud the checklists, was responsible for navigation, enroute and approach charts and performed radio communication up until initial approach. The COP performed the radio communications during the approach.

The PIC flew the aircraft and called the required procedures to the rest of the crew. The F/E controlled the thrust levers, also during the approach and landing, in accordance with the PIC's orders.

1.17.4 Civil Aviation Administration

Subsections 1.17.4–1.17.11 show the organizations and arrangements of the Civil Aviation Administration, the Flight Safety Authority and air navigation services as they were at the time of the occurrence.

The Civil Aviation Administration (CAA) is a Finnish state enterprise whose aim is to manage airports and provide air navigation services for civil and military aviation as well as to conduct any other business under its field of activities.

The task of the CAA is also to see to general aviation safety, issue aviation regulations and directives, process licences and operating licences as well as matters related to aircraft flight operations, airworthiness, registration and mortgaging. Moreover, the CAA should also otherwise promote aviation in general and see to the development and control of aviation as well as to other civil aviation public authority functions. Without prejudice to the powers of another authority, the CAA is also responsible for international civil aviation conventions and international civil aviation cooperation

The rules of procedure at the time of the incident established the basic organization of the CAA as follows: Head Office, a separate public authority unit responsible for flight safety issues as an aviation authority (Flight Safety Authority), profit centres (aerodromes, air traffic control centres and Avia College) as well as accountable profit centres internal to the CAA. In addition, the business conglomerate included subsidiary companies on whose establishment the CAA board of directors would make separate decisions.

1.17.5 Flight Safety Authority

The activities of the Flight Safety Authority are run by a Director General, assisted by a development team including, among others, a quality and training officer. The quality assurance system of the Flight Safety Authority is detailed in its Operations and Quality Manual. The task of the Flight Safety Authority as an aviation authority is to see to general aviation safety as well as to issue aviation regulations and directives to ensure flight safety. The Flight Safety Authority also processes licences and operating licences as well as matters related to aircraft flight operations, airworthiness, registration and mortgaging. In addition, the Flight Safety Authority controls the safety of aviation as well as sees to the public control and certification of air navigation services and aerodromes.

The Flight Safety Authority organization comprises the flight operations and licensing division, the technical division, administrative services as well as the airports and air navigation services division.

1.17.6 Civil Aviation Administration Head Office

At the time of the occurrence the Head Office comprised the Chief Executive Officer (Director General of the CAA), a secretariat, Administrative and Personnel Department (administration), Finance Department (finances), Airports Department (aerodromes), Air Navigation Services Department (air navigation services) as well as the Air Transport Authority (aviation authority regulations and international operating licences). The Director General was supported by the three following management teams:

- The Executive Steering Group, which included the CEO, department heads, Director General of the Flight Safety Authority as well as other members appointed by the CEO.
- The CAA Safety and Quality Committee, chaired by the CEO with members comprising of the heads of airports and air navigation departments and the director-general of the public administration unit. The quality managers of airports and air navigation departments acted as referendaries and experts to the committee.
- Environmental Management, chaired by the CEO with members comprising the heads of airports and air navigation departments, the chief of environmental affairs as well as the manager of Helsinki–Vantaa airport.

1.17.7 Air Navigation Services

The Air Navigation Services (ANS) department is responsible for the planning, development and coordination of air navigation services, aeronautical information services and aviation weather services. It is also responsible for air navigation systems, the branch's environmental issues (noise, aviation emissions, energy) as well as for guiding the environmental steering group with regard to the CAA' s environmental policies. ANS is responsible for providing air navigation services to aerodromes and airways as well as to aeronautical information services.

ANS is run by a director, assisted by staff and consists of the following sections: air traffic management, ANS systems, aeronautical information, safety and quality assurance, environment and Eurocat-support. ANS engineering operates as a CAA internal service unit and its head reports directly to the director of ANS.

1.17.8 Safety and quality assurance

The CEO of the commercial enterprise Civil Aviation Administration is in overall charge of safety and quality assurance. The heads of both airports and air navigation services departments are the safety and quality managers within their respective departments. The profit centres are responsible for their own safety and quality.

A Safety and Quality Committee in the CAA head office manage and monitor safety and quality assurance activities. The CEO chairs the committee. The committee's members comprise the heads of airports and air navigation departments with the quality managers of airports and air navigation departments as secretaries. It is the task of the committee to manage and coordinate the preparation, development and maintenance of safety and quality systems, and to supervise the ANS and airport activities from this perspective. The ANS and Airports departments audit and monitor the safety and quality of their services and subsequently report to the CEO in the Safety and Quality Committee.

The Air Navigation Services and Airports departments operate a separate Safety and Quality Commission. The head of each department decide independently on the remainder of the department's quality assurance organization. Departments are responsible for tackling any safety and quality issues observed in the activities of the profit centres and for planning, training for and implementing corrective action.

The quality assurance activities of profit centres are implemented in the Safety and Quality Group. The head of each profit centre bears the responsibility for safety and quality within his unit and he appoints the quality manager for the profit centre as well as the remainder of the quality assurance organization.

Air Navigation Services comprises a safety and quality assurance unit, run by the quality manager. There are no written rules of procedure for this section, nor does it bear responsibility for the preparation of decisions in the field. The main area of its activity is to manage occurrence-related information. This comprises the management of incident and occurrence reports as well as internal auditing within the CAA. Furthermore, the section is responsible for acting as the referendary in the department's own safety and quality assurance commission and also for supporting the CEO in the CAA Safety and Quality Assurance Committee.

1.17.9 Regional air navigation services

Regional air navigation services are under the administrative control of the Air Navigation Services Centre for South Finland. Regional air navigation services buy some ACC services from Rovaniemi aerodrome and provide the rest of them with their own personnel working in Rovaniemi. The Northern Finland Air Navigation Centre, situated in the

rural municipality of Rovaniemi and operating at premises within Rovaniemi airport area, is responsible for providing air navigation services for Northern Finland.

1.17.10 Northern Finland cooperation region

Kittilä airport belongs to the Northern Finland cooperation region. The airports in Northern Finland: Rovaniemi, Kajaani, Kemi–Tornio, Oulu, Enontekiö, Ivalo, Kittilä and Kuusamo, together form a profit centre. A profit centre is responsible for its own profitability as well as for the quality and safety of its services. The manager of Rovaniemi airport runs this profit centre.

1.17.11 Kittilä airport

The function of Kittilä airport is to provide passenger, ground transportation, apron, manoeuvring area and air navigation services as well as any other commercial services that suit aerodrome operations. The manager of the airport decides on the organization and division of duties at the airport.

According to CAA statistics, a total of 3,401 flight operations took place at Kittilä airport in 2004. One flight operation consists of a landing and a takeoff. Of all the operations 2,408 were commercial aviation, 581 of which were international. Of all chartered flights to Kittilä, international operations represent the vast majority, 449 operations. The total number of chartered operations was 510.

1.17.12 The principles of AFIS service in Finland

The Aerodrome Flight Information Service AFIS is part of the Finnish ATS system. AFIS service is provided to secure IFR operations at airports where the service provider (CAA, municipality or trust) considers the traffic volume to be too low to warrant air traffic control. Traffic at and around an AFIS airport is given information regarding e.g. other traffic, weather and airfield conditions. Based on information received from AFIS as well as on the basis of his own information and observation the pilot-in-command determines the required procedures, maintains safe separation to other traffic and reports his intentions over the radio. The methods of operating air navigation systems and directing vehicle traffic are identical to airports where ATC services are provided.

1.17.13 Notifying of changes in airspace structure

As regards changes, an AIP SUPPLEMENT 66/2004 was published on 22.11.2004. The change contained therein entered into force on 1.1.2005.

The information was appropriately promulgated before the change entered into force. The information reaches all who utilize AIP Finland for briefing and flight operations. Airlines' airway manuals are normally made by commercial entities and these kinds of airspace structure changes are not published in airway manuals.

2 ANALYSIS

2.1 Incident analysis

2.1.1 Touchdown

The aircraft landed on a paved section before the threshold of runway 34 at the airspeed of 130 kt (240 km/h). The main landing gear wheels cleared the military arrester net, which was lowered to the ground and lay on the snow, by approximately one metre. The main landing gear's contiguous marks on the ground began 25 m before the threshold. The tail end of the fuselage left a mark on the ground which began 30 m before the threshold. The marks left by the trailing edge flap tips began at 19 m before the threshold. On the basis of these marks it can be deduced that the aircraft landed in an unusual attitude, with an approximate 15° nose-up angle.

As per FDR recording the sink rate immediately before touchdown was 2,500 ft/min (12.7 m/s) whereas the correct 3.4° glidepath at 130 kt (240 km/h) produces the resultant sink rate of 780 ft/min (4 m/s). Calculated on the basis of the average sink rate on the final leg the aircraft's descent angle was ca. 10°, whereas the ILS glidepath follows a 3.4° slope. Based on FDR recording the aircraft pitch angle increased by 11° during the final ten seconds of the flight, peaking at two seconds after landing. Taking SYL9923's landing weight of 78,600 kg into account, the airplane was in a fully developed stall at landing. The deployed middle spoilers, i.e. speedbrakes, and the low engine RPM at landing contributed towards the aircraft's aerodynamic stall. During final approach the N_1 RPM of all engines was ca. 30% which, however, increased to 65–69% during the final six seconds. Under the airline's Operation Manual the minimum permissible engine RPM below the altitude of 200 m is 75%. If engine RPM requirement decreases below 75%, the crew must abort the approach and execute a missed approach procedure.

The PIC who also flew the aircraft attempted to recover from the steep descent by increasing pitch angle as well as by requesting 85% engine RPM from the flight engineer. According to FDR data engine RPMs began to increase six seconds before touchdown. The engines spooled up normally. Before the increase in engine RPM the engines were running at 30%, whereas under company regulations engine RPM may not be reduced to under 61% during final approach due to the risk of a flameout. In this case the flight crew used engine RPMs which were below those regulated. The increase in engine RPM came too late for it to make any difference on the trajectory of the aircraft. The pitch angle increase executed by the PIC also came too late for it to moderate the descent angle.

The PIC was unable to recover early enough from the steep approach path on the final leg, which was three times greater than the normal three degree path angle. Due to the contours of terrain around the airport the ILS GP for Kittilä runway 34, also indicated by the PAPI lights, is 3.4°. The middle wing spoilers which were deployed in the speedbrake position increased drag and decreased lift, lessening the PIC's chances of recov-

ering from the descent angle by aerodynamic control input. Moreover, when the flight crew reduced engine RPM to 30% during this approach, even though company regulations expressly prohibit reducing engine RPM to under 75% below the altitude of 200 m, the pitch angle increase input made by the PIC also added to wing loading and drag without actually affecting the sink rate. The aircraft sank below the published 3.4° glidepath and the main undercarriage wheels cleared the arrester net, which lay on the snow, by approximately one metre. The arrester net's tensile strength is 25,000 kp. Had the main landing gear hit the arrester net, this would probably have caused major structural damage to the aircraft.

2.1.2 Final approach

According to company regulations an approach must be aborted and a missed approach procedure executed if any of the following conditions during final approach are not met:

In order to maintain the correct glidepath, either engine RPM must be increased above the nominal RPM or reduced to below 75%.

Decision altitude or ground proximity warning system alert is received before establishing reliable visual reference to approach or landing lights.

The position or the trajectory of the aircraft in relation to the runway at decision altitude does not permit a safe landing.

A safe landing is not assured.

During final approach engine RPMs remained below those regulated and the risk of a flameout was apparent. Due to the excessive sink rate the GPWS system continually sounded an alert for 21 seconds, all the way to touchdown. The position and trajectory of the aircraft in relation to the runway were such that an experienced instructor captain such as the one flying the aircraft should have realized that a safe landing was not assured. Moreover, the crew had access to the ILS glidepath indicator as well as PAPI lights, which indicated the correct glideslope. On the basis of information available to the PIC, he should have aborted the approach, executed a missed approach procedure and flown a new approach.

2.1.3 Initial approach and interception of the ILS glidepath

The aircraft left FL 100 (3,050 m) at the distance of 11.5 NM (21 km) from runway 34 and flew a straight-in approach. In a normal straight-in approach FL 100 (3,050 m) is left at around 30 NM (56 km) from the runway. Under company regulations the ILS glidepath should be intercepted from below. In accordance with the instrument approach chart published for Kittilä airport the aircraft should have descended to 2,500 ft (750 m) and maintained this altitude until intercepting the 3.4° ILS glidepath approximately 5 NM (9.3 km) from the runway touchdown point. At a distance of 5 NM (9.3 km) from the runway the aircraft was ca. 5,200 ft (1,590 m) above runway 34 elevation. It is impossible to execute a safe straight-in approach and landing with an airliner from such a position.

A published racetrack procedure for Kittilä runway 34 exists, with locator KIT as the entry point. Pursuant to ICAO publication Doc 8168-OPS/611 Volume I, the racetrack procedure is designed to facilitate a reduction in altitude in the initial approach segment and/or establish the aircraft on the extended runway centreline when it is not practical to join a reversal procedure.

ICAO publication Doc 8168-OPS/611 Volume I Chapter 3 establishes a requirement for operators to define the parameters of a stabilized approach in their Operations Manuals. Yakutia Airlines had established said parameters in its Operations Manual. All flights must be stabilized by 300 m (1,000 ft) above airport elevation during instrument meteorological conditions (IMC). According to Kittilä METAR at 07:20 the weather was overcast at 1,700 ft (500 m). It was dusk at the time of the landing.

The aircraft did not intercept the ILS glidepath in accordance with the published approach chart, nor did the approach comply with the requirements of a stabilized approach at any stage. In order to achieve a stabilized approach they should have entered the racetrack procedure at locator KIT in order to reduce altitude and to subsequently intercept the ILS glidepath.

FDR data and crew statements contradict each other. The crew told the investigation commission that they passed locator KIT only slightly above the glidepath and after this, they followed the ILS glidepath as well as the approach path indicated by the PAPI lights. FDR data does not corroborate the crew's statements.

2.1.4 Multi Crew Cooperation during approach and landing

Joint Aviation Requirements define Multi Crew Cooperation (MCC) as follows:

The flight crew functioning as a team of cooperating members led by the pilot-in-command. (JAR-FCL 1.001)

This definition is specified in Appendix 1 to JAR-FCL 1.261(d):

> *The aim of the course is to become proficient in multi-crew cooperation (MCC) in order to safely operate multi-pilot, multi-engine aeroplanes under IFR and to that end ensure that:*
>
> *a) The pilot-in-command fulfils his managing and decision-making functions irrespective of whether he is PF or PNF;*
>
> *b) The tasks of PF and PNF are clearly specified and distributed in such a manner that the PF can direct his full attention to the handling and control of the aircraft;*
>
> *c) Cooperation is effected in an orderly manner appropriate to the normal, abnormal or emergency situations encountered;*
>
> *d) Mutual supervision, information and support is ensured at all times.*

Even though the company, registered in Russia, is not required to comply with European Joint Aviation Requirements, the investigation commission considers that the above-mentioned definition well describes the requirements for MCC. Furthermore, ICAO has detailed its recommendations for the implementation of MCC and cockpit procedures in its publications Doc 8168, 9376 and 9683.

The pilot-in-command was the pilot flying (PF) during the approach. The co-pilot (COP) was the pilot not flying (PNF), called out loud the checklists and performed radio communication during the final phase of the flight. The navigator (NAV) handled navigation, prepared the approach charts for the pilots, performed radio communication during the initial approach and monitored compliance to the approach procedure. The flight engineer (F/E) controlled the engine RPM levers as per PIC's orders and monitored aircraft systems.

The cockpit procedures to be completed during the approach were contained in the aeroplane flight manual and in the company's Operations Manual.

The PIC called the procedures during the various phases of flight. The other flight crew members implemented these procedures in accordance with task allocation contained in the company's Operations Manual and monitored that the defined parameters were fulfilled.

The approach profile as well as engine settings deviated from the standard during the approach. The PIC should have seen to it that the aircraft was being flown according to regulations. The other crew members should have monitored compliance to nominal parameters and they should have pointed out the deviations to the PIC.

MCC did not work during the approach as intended because procedure-specified parameters were ignored, nor was a missed approach executed even though the parameters for a safe landing were not fulfilled.

The flight was a training flight for the COP, the purpose being to certify him to operate abroad. The PIC was the instructor pilot. Due to this set-up and because of the big age difference between the PIC and the COP it may be possible that neither the COP nor the NAV expressed themselves emphatically enough with regard to parameter deviation during the approach.

In accordance with company SOP either the PF or the F/E is permitted to control the engine RPM levers during the flight. The investigation commission maintains that the PF should be the only one operating the engine RPM levers in order to avoid delays caused by flight crew communication when engine RPM settings are changed.

2.2 Air Traffic Service

2.2.1 Notifying of AFIS operations

Pursuant to section 10 of the Accident Investigation Decree (79/1996) , the investigation commission sent out a notification during the investigation. Its purpose was to draw the attention of the Civil Aviation Administration and the Flight Safety Authority to the fact that Finland has not formally informed of compliance or of non-compliance to ICAO Annex 11, concerning the Standards and Recommended Practices (SARPS) of ATS services. Moreover, domestic AFIS radio communication phrases are only published in Finland. The full notification is appended to the investigation report.

2.2.2 AFIS operations and licence requirements

Familiarity with AFIS service is not a requirement in international flight crew licensing. If AFIS service is in fact considered to be among the generally accepted forms of air traffic control and, therefore, does not warrant special notification, then familiarity with AFIS service should be included in international flight crew licensing requirements. In the present situation there is a clear gap between information and practice. With regard to ATS services the requirements refer to AIS service as it is defined in Annex 11 and in ICAO publication Doc 4444. Neither definition mentions AFIS service. ICAO circular 211-AN/128 from 1988 does describe AFIS service. The service is not intended to be provided at airports which international commercial flights use as their destinations or as alternate airports.

2.2.3 AFIS operations and radio communication

In the final stage of the flight the flight crew's radio communication does not follow ICAO standard phraseology, or the nationally published AFIS phraseology. Instead, every message exchanged implies the crew's uncertainty regarding the type of ATS service provided. When the flight crew did not receive the expected clearance during the different phases of the flight, they ended up clearing themselves for their desired procedure. The fact that neither the air traffic controller nor the AFIS officer later on corrected the errors in the radio communication or the erroneous readbacks, only added to the confusion. The flight crew were used to operating in an environment where air traffic control plays a clearly more dominant and commanding role.

The uncertainty begins when they are cleared to descend to FL 100 and the ACC reclears them to continue the descent and informs them that the transition altitude is FL 60. The crew acknowledge that they will descend to FL 60, to which the ACC replies that they are cleared to leave controlled airspace while descending and instructs the crew to contact Kittilä AFIS. The crew only read back the radio frequency from this message. Erroneous readbacks were not corrected.

The cockpit crew were unaware that their destination was an uncontrolled airfield. Communication with Kittilä AFIS reveals that the crew expected to land at a controlled airport, as some of them had already done on previous flights to Kittilä.

The crew finally decide to leave FL 100; at that time they are already in a position from which it is impossible to execute a straight-in approach, 11.5 NM (21 km) from the threshold. Once having left FL 100 the crew request further descent clearances several times. Kittilä AFIS informs them that the airspace is not controlled and requests the crew to report locator Kittilä inbound. When the crew report passing Kittilä locator, AFIS provides the “runway is free” announcement, permitting SYL9923 to land. The crew continue with “ready to land” messages and finally clear themselves to land on runway 34.

Kittilä AFIS used poor English when it resorted to non-standard phraseology in the attempt to make the crew understand their right to descend and to land.

2.2.4 How the change in airspace structure was observed in air traffic control procedures

The airspace structure had been changed with the intent of controlling traffic farther and to facilitate the use of the area control radar in maintaining separation to any possible essential traffic. At the time of the incident there was no essential traffic and, therefore, it was acceptable to release the aircraft at the so-called normal point.

The ACC issued the altitude clearance to FL 100 as if the airspace structure had not been changed. The established practice in Finland is to clear an aircraft above uncontrolled airspace as close as possible to the boundary of controlled airspace and then to reclear them to descend further. When the airspace structure in question was in force, the lower limit of controlled airspace was at 4,000 ft MSL.

Rovaniemi ACC had provided training to air traffic controllers on the temporary change in airspace structure regarding the situation of Kittilä providing ATC services. During such activity, specific personnel were on duty. However, controllers were not trained for the change in airspace structure when Kittilä provided AFIS service.

The purpose of the temporary airspace structure change was to guarantee the safe and flexible conduct of air traffic to Kittilä aerodrome responding to changes in traffic volume. This was implemented by providing ATC services at Kittilä aerodrome during times of high traffic volume and by controlling Kittilä traffic from a separate feeding sector that was established at Rovaniemi ACC. At the time of the incident this arrangement was not in force.

2.2.5 Notifying of the change in airspace structure and the circulation of the information

Regarding changes, an AIP SUPPLEMENT 66/2004 was published on 22.11.2004. The change contained therein entered into force on 1.1.2005.

Kittilä AFIS and the temporary Kittilä TWR took turns in providing ATS service at Kittilä aerodrome. This rotation was implemented on the basis of forecasted traffic volumes and the type of service provided at any given time, including operational hours, and was notified by NOTAMs. It was the intention that the NOTAMs be published no later than seven days before their entry into force. The NOTAM regarding the service and the operational hours had not come to the flight crew's attention.

Under international rules of the air *"the pilot must become familiar with all available information appropriate to the intended operation*" (ICAO Annex 2, Paragraph 2.3.2). The flight crew only had access to a trigger NOTAM referring to AIP-Supplement 58/2004, which contained information on the operating hours of ATS units. The content of the supplement itself was not available. For some reason the crew had no access to Kittilä ATS information which had been published after 31.10.2004 for briefing purposes.

Information regarding the change in Kittilä airspace structure was appropriately promulgated prior to its entry into force. The information reaches all who use AIP Finland for briefing and flight operations. Airlines mainly use commercial airway manuals. This kind of airspace structure change is not published in airway manuals and so the information does not reach the flight crew.

3 CONCLUSIONS

3.1 Findings

1. The pilot had the required licence and qualifications.

2. The co-pilot was on a training flight with the purpose of certifying him to operate abroad.

3. The airworthiness certificate of the aircraft was valid.

4. The pilot-in-command flew the aircraft during approach and landing.

5. The ACC controller had the required licence and qualifications.

6. The AFIS officer had the required licence and qualifications.

7. The ACC cleared the aircraft to descend to FL 100 (3,050 m) and five minutes later recleared it to continue descending on Kittilä QNH 991 and also informed of the transition level 60 (1,850 m).

8. The flight crew read back the latter clearance incorrectly.

9. The ACC did not correct the erroneous readback and cleared the aircraft to leave controlled airspace and mentioned the QNH 991 again. The crew replied: *"QNH 991"*.

10. The ACC still advised of radar service termination and instructed the crew to contact Kittilä AFIS on the frequency 118.95. The crew replied: "*118.95, good day"*

11. The aircraft maintained FL 100 and the flight crew did not understand that they were cleared to descend for approach.

12. The flight crew repeatedly requested clearances to descend and finally left FL 100 at the distance of 11.5 NM (21 km) from runway 34. The normal point for leaving that altitude for a straight-in approach would have been approximately 30 NM (56 km).

13. The aircraft did not intercept the ILS glidepath in accordance with published procedure, nor did its approach angle at any time of the approach stabilize on the 3.4° glidepath as indicated by ILS and PAPI lights.

14. The engines were set to idle approximately four minutes before touchdown. Engine RPM was approximately 30%, whilst the regulated engine RPM during approach is at least 61% and 75% below the altitude of 200 m, respectively.

15. The flight engineer controlled the engine RPM levers during the flight in accordance with the orders of the pilot-in-command.

16. During final approach the sink rate varied between 1,500–2,000 ft/min (7.6–12.7 m/s), and was 2,500 ft/min (12.7 m/s) right before touchdown. The nominal sink rate on the 3.4° ILS glidepath at 130 kt (240 km/h) is 780 ft/min (4 m/s).

17. Due to the excessive sink rate the GPWS system continually sounded an alert for 21 seconds, all the way to touchdown.

18. The PIC did not execute a missed approach procedure even though the parameters for a safe landing were not reached.

19. From the safety perspective, MCC did not work as intended during the approach . The training level and the flight crew's age structure possibly played a part in this.

20. During final approach the average pitch angle was -6°. However, eight seconds before touchdown it rapidly began to increase, peaking at +5°, two seconds after touchdown.

21. All thrust levers were pushed from the zero degree position to the 60° position eight seconds before touchdown. The RPM of engine number one at touchdown was 60% and engines number two and three 69%, respectively. Thrust levers were retarded to the zero degree position two seconds after touchdown.

22. The middle wing spoilers were deployed in the speedbrake position during approach and landing.

23. The PIC could not recover early enough from the steep final approach descent angle, which was approximately three times greater than the normal three degree path angle.

24. The aircraft landed on a paved section before the runway 34 threshold in an unusual nose-high attitude, clearing the lowered military arrester net by approximately one metre. The mark left by the tail section began at 30 m before the threshold, the main landing gear tyre marks began at 25 m and the marks left by the inner tips of the flaps 19 m before the threshold.

25. The FDR recorded a +3.5 g momentary vertical acceleration at touchdown and, three seconds later, another momentary peak of +2.1 g.

26. Kittilä METAR at 07:20: Wind 020° two knots (1 m/s), visibility over 10 km, overcast at 1,700 ft (510 m). The AFIS officer reported a 060° four knot (2 m/s) surface wind to SYL9923 before landing. On the day of the incident the sun did not rise above the horizon in Kittilä. It was dusk at the time of the landing.

27. According to the meteorologist's statement windshear played no significant role in the incident.

28. The fuselage tail end section and the trailing edge flap system sustained considerable damage.

29. Rescue service was not alerted because the AFIS officer received word of what had transpired only after the aircraft was already standing on the apron and the passengers were normally deplaning down the steps.

30. Regulations and instructions provided by the aircraft manufacturer and the airline to the flight crew were otherwise sufficient for the safe conduct of flight, except for the fact that information provided to the investigation commission did not contain any instructions with regard to flight operations in an AFIS environment.

31. When the investigation commission interviewed the flight crew it became evident that, from the perspective of flight operations, they were neither sufficiently aware of how the AFIS system works nor how they should operate in that environment.

32. During the approach and landing the cockpit crew did not realize that their destination was an uncontrolled airfield. Communication with Kittilä AFIS reveals that the crew expected to land at a controlled airport, as some of them had done on previous flights to Kittilä when the control tower was active.

33. The permanent airspace structure for Kittilä FIZ is published in AIP Finland. At the time of the incident a temporary airspace structure was in force, as per AIP supplement 66/2004, published on 22.11.2004. The change contained therein entered into force on 1.1.2005. The flight crew's documentation contained neither supplement 66/2004 nor the NOTAM informing of it.

34. Under international rules of the air the pilot must become familiar with all available information appropriate to the intended operation (ICAO Annex 2, Paragraph 2.3.2).

35. The purpose of the temporary airspace structure change was to guarantee the safe and flexible conduct of air traffic to Kittilä aerodrome, responding to changes in traffic volume. This was implemented by providing ATC services at Kittilä aerodrome during times of high traffic volume and by controlling Kittilä traffic from a separate feeding sector that was established at Rovaniemi ACC. At the time of the incident this arrangement was not in force.

36. The temporary change also included the lowering of the lower limit of controlled airspace (class D) to 4,000 ft MSL in Kittilä temporary CTA during AFIS service. This practice deviated from the airspace structure established for other AFIS aerodromes.

37. The airline used the Jeppesen Sanderson, Inc. *Jeppesen Licensed to RUSSIA* airway manual (OM-C, which is comparable to JAR regulations). Airspace structure changes that are published in AIP supplements are not published in commercial airway manuals.

38. The description on AFIS procedures in Finland was both inadequate and erroneous in the airway manual. During the investigation the manual's description was corrected.

39. Examples of standard AFIS phrases are published in domestic regulations. However, they are not published internationally nor has anyone seen to it that this information reaches operators or pilots.

40. ICAO circular 211-AN/128 from 1988 describes AFIS operations. The circular states that AFIS service is intended for general aviation. It is not intended that AFIS service be provided at airports that international commercial flights use as their destinations or as alternate airports. As far as the investigation committee knows, this is the only ICAO publication in which AFIS service is described.

41. The flight crew's proficiency in the English language was inadequate. Communication with air traffic control did not fully comply with standard phraseology. Due to their inadequate language proficiency they had obvious problems in communication when non-standard phraseology was used. In addition, Kittilä AFIS used non-standard phraseology in its communication.

42. This incident falls under ESARR 2 Severity Classification Scheme A, serious incident.

3.2 Probable cause

3.2.1 Direct causal factors

The AFIS environment

During the flight crew interview it became apparent that they did not know in which ATS operating environment they were flying. They were also unfamiliar with AFIS operating principles.

Initiating the descent too late

The flight crew initiated the descent from FL 100 for approach at a distance which is approximately three times shorter than the normal.

The decision to fly a straight-in approach

In spite of the fact that the aircraft was approximately three times too high for a straight-in approach profile, the PIC decided to fly a straight-in approach to Kittilä anyway. The approach procedures in Kittilä would have facilitated an appropriate reduction in altitude during the intermediate approach segment. The aircraft remained too high for almost the entire approach.

The decision to land

Notwithstanding his too high altitude during the final leg and the fact that engines were at idle, in violation of regulations, the PIC decided to land. The aircraft sink rate was high during the final phases of the approach. When the RPM increased and the pitch angle changed, both done at the very last moment and were incorrectly timed, the aircraft plummeted and powerfully impacted the paved area clearly before the threshold.

3.2.2 Contributing causal factors

Information available to the flight crew

The flight crew employed a commonly used commercial airway manual in their briefing. The manual's description of AFIS procedures in Finland was inadequate and somewhat erroneous. This was partly due to the fact that no description of Finnish AFIS services exists which would appropriately reach all operators who fly to AFIS aerodromes. During their briefing, the flight crew did not have access to NOTAM information as regards the type of ATS service available in Kittilä at any given time.

ATS services in Finland

The present practice of the ATS provider of only publishing AFIS procedures domestically does not facilitate the dissemination of complete information to operators nor to flight crews. This, partially, is a reflection of the fact that the risks inherent in this form of ATS service have not been analysed. According to ICAO, AFIS service was originally designed only to be provided at airports where commercial heavy air traffic does not operate. Therefore, no international harmonization of procedures has taken place, nor are any specific requirements for AFIS training included in international or Joint Aviation Requirements as regards basic and recurrent training. Whilst AFIS service has been considered appropriate even at aerodromes where scheduled and chartered commercial aviation operate, neither AFIS procedures nor information on them are adequately tailored to correspond to traffic volume requirements. Individual aerodromes have tried to control air traffic volumes by instituting various temporary arrangements. However, no uniform practice among Finnish aerodromes exists.

Multi Crew Cooperation

Section 2.1.4 of this report states that MCC did not work as intended. Neither the COP nor the NAV expressed themselves emphatically enough with regard to parameter deviation and the PIC flying the aircraft disregarded them. This, for its part, may indicate shortcomings regarding the company's aircrew training and its safety culture.

Language proficiency and phraseology

The flight crew's proficiency in the English language was inadequate. Communication with air traffic control during the phases of flight preceding the approach did not fully

comply with standard phraseology. Due to their inadequate language proficiency they had obvious problems in communication when non-standard phraseology was used.

The air traffic controller and later the AFIS officer had little possibility in steering the operation of the flight crew in the desired direction when they noticed the communication shortcomings. No international standard AFIS phraseology exists. Examples of standard AFIS phrases are published in domestic regulations but no one has seen to it that this information reaches operators or pilots. Therefore, the meaning and content of the phrases are not communicated to pilots while operating at AFIS aerodromes nor do they infer information with regard to the type of ATS service provided at the time.

4 RECOMMENDATIONS

1. If AFIS service is in fact considered to be among the generally accepted forms of air traffic control and, therefore, does not warrant special notification, then familiarity with AFIS service should be included in international flight crew licensing requirements. At present there is no requirement in flight crew licensing requirements regarding AFIS service. With regard to ATS services the requirements refer to AIS service as it is defined in Annex 11 and in ICAO publication Doc 4444. Neither definition mentions AFIS service. ICAO circular 211-AN/128 from 1988 describes AFIS operations. As per this circular, it is not intended that AFIS service be provided at airports which international commercial flights use as their destinations or as alternate airports.

> The investigation commission recommends that the Ministry of Transport and Communications see to it that the air traffic service provider or the appropriate public authority ensure that the user of air traffic services be at all times aware of the content of the service provided or that the service provided comply with international standards.

2. The investigation revealed that the flight crew did not fully comply with established flight procedures or company regulations. The flight crew's decision-making at different phases of the flight was lacking or could not be considered fully proper or correctly timed. Multi Crew Cooperation did not work as intended. The flight crew's language proficiency was inadequate. The flight crew did not have access to the latest ATS briefing information on Kittilä aerodrome.

> The investigation commission recommends that the Federal Aviation Authority of Russia inspect the airline's operating practices and procedures as well as aircrew training in order to ensure that they are in full compliance with the requirements established for safe international aviation and the rules of the air.

3. With regard to every Annex, every contracting state to ICAO must inform the organization of whether it intends to deviate from or follow the procedures published therein. The investigation revealed that Finland has not issued any such notification regarding, among others, Annex 11 – Air Traffic services.

> The investigation commission recommends that the Ministry of Transport and Communications see to it that the appropriate authority promulgate all ICAO Annex notifications pursuant to the obligations of ICAO's contracting states.

Helsinki January 10th 2007

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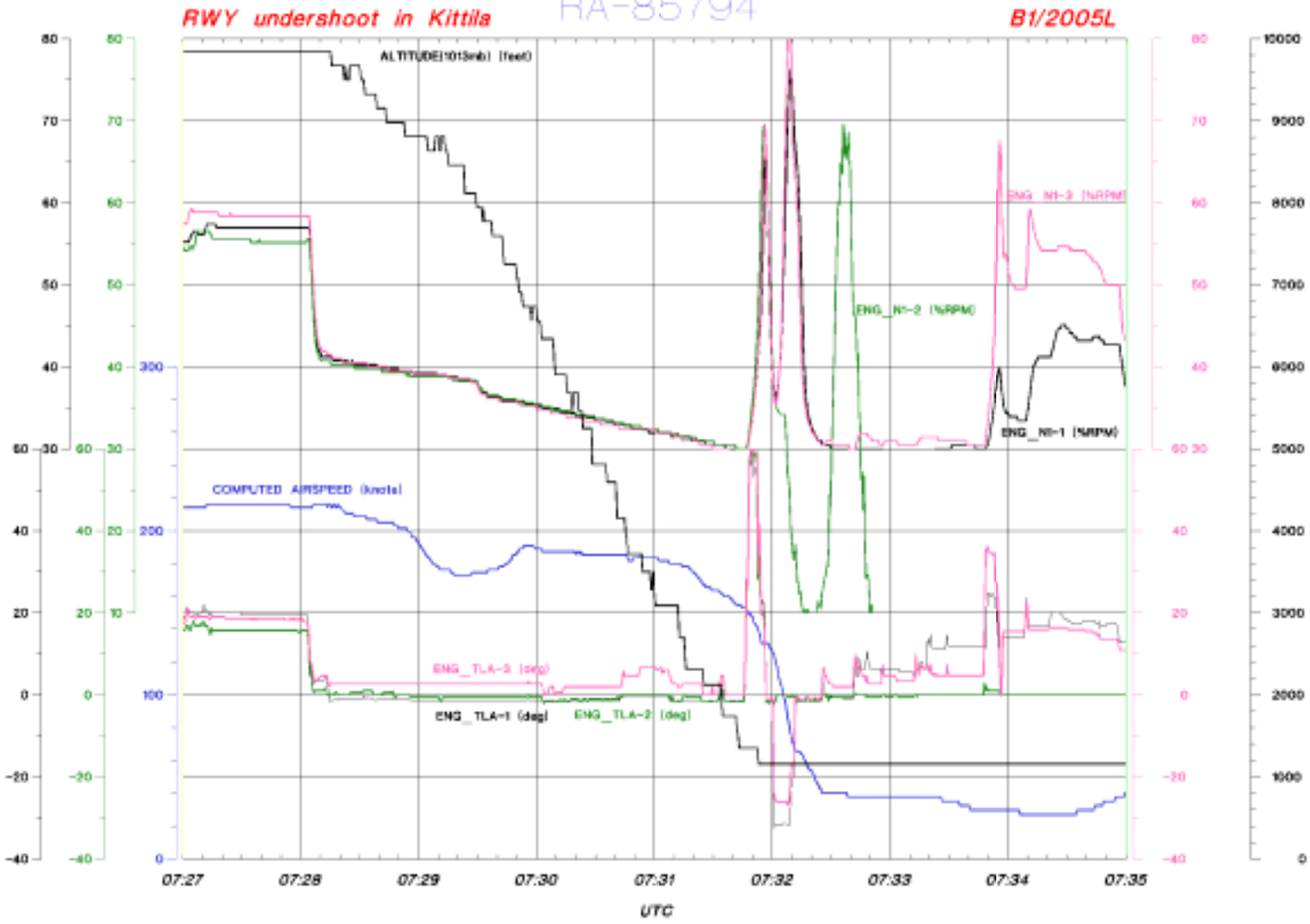

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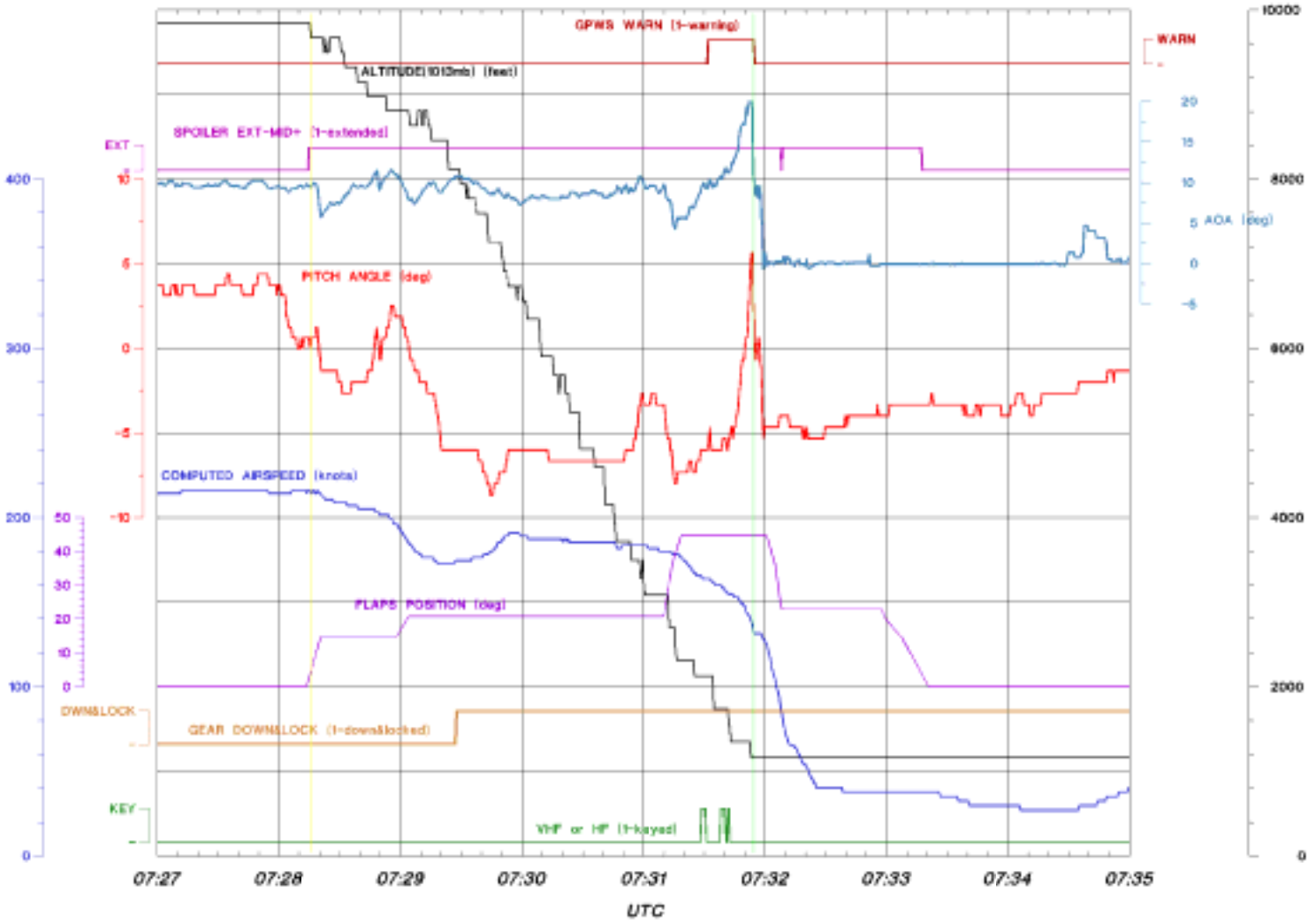
Created: February 17, 2005

BFU Germany

RA-85794

RWY undershoot in Kittila *B1/2005L*



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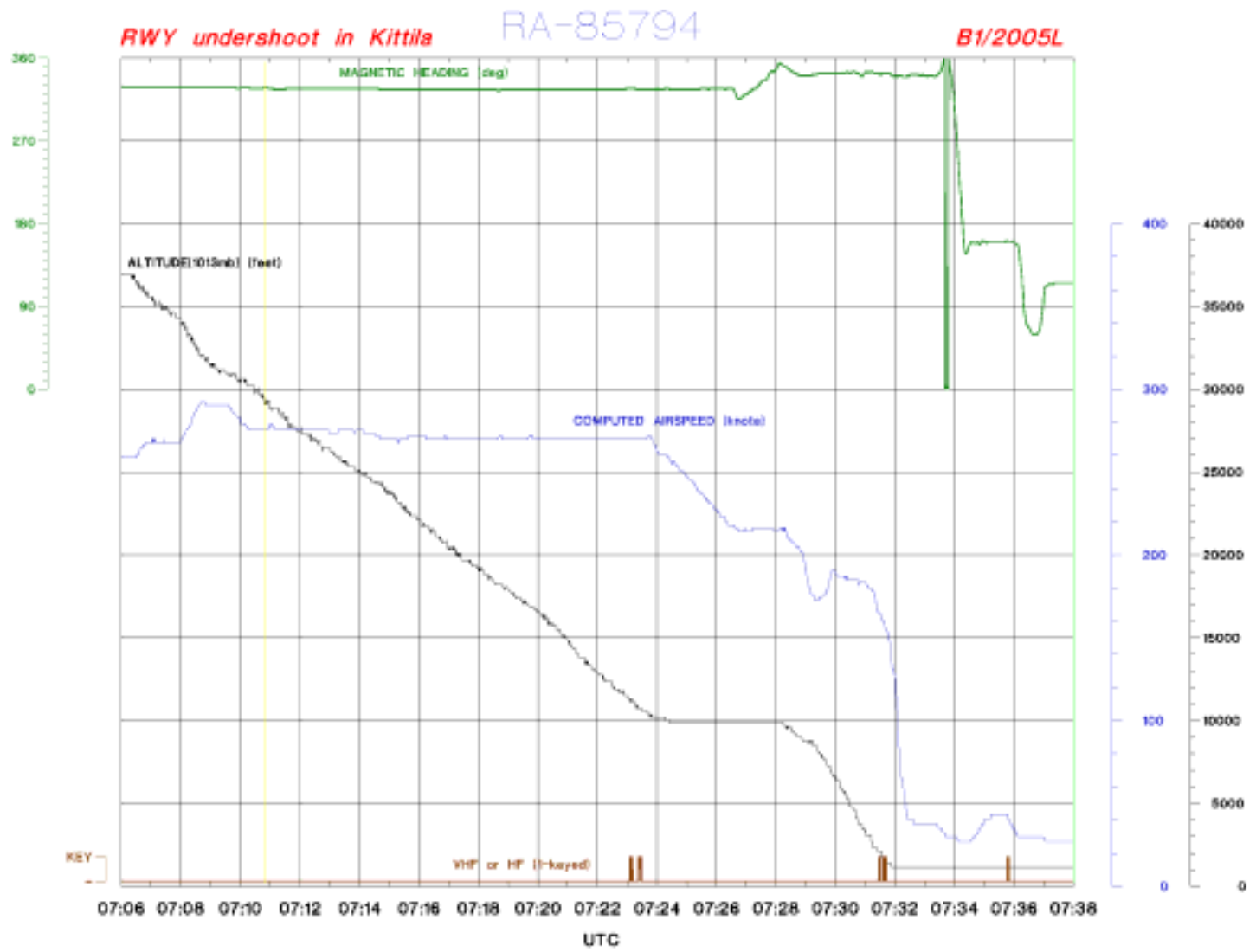

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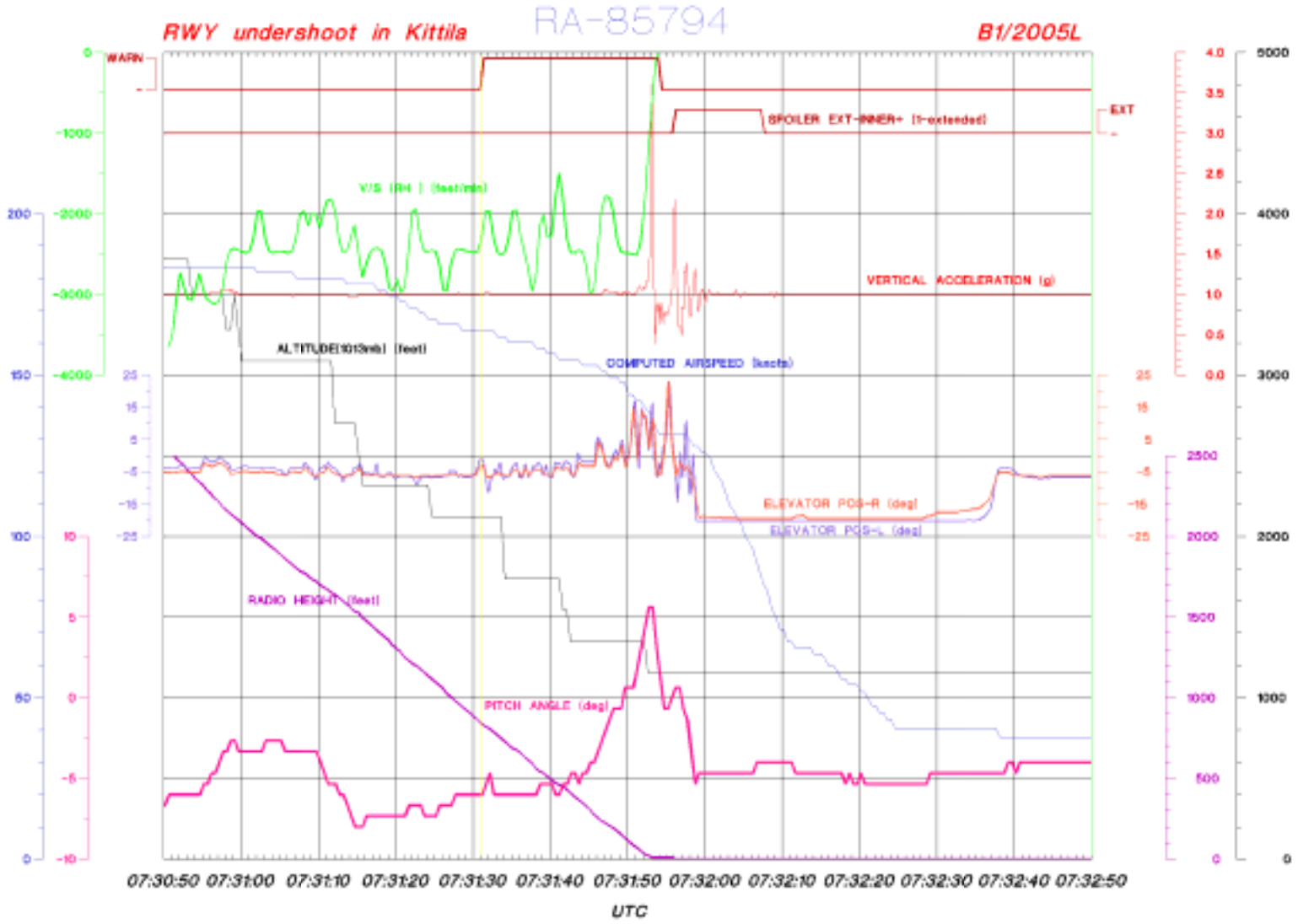
BFU Germany



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BFU Germany