This document is an English translation of the Final Report on the accident on 8 July 2006 in Irkutsk, to the Airbus 310-324 registered F-OGYP, *operated by* OAO Aviakompania Sibir.
The use of this translation for any purpose other than for the prevention of future accidents could lead to erroneous interpretations.
As accurate as the translation may be, the original text in Russian issued by the Interstate Aviation Committee is the work of reference.

Ce document est une traduction en langue anglaise du rapport final sur l'accident survenu le 8 juillet 2006 à Irkoutsk, à l'Airbus 310-324 immatriculé F-OGYP *exploité par la compagnie aérienne* OAO Aviakompania Sibir.
L'utilisation de cette traduction à d'autres fins que la prévention de futurs accidents pourrait conduire à des interprétations erronées.
Aussi précise que puisse être la traduction, le rapport original en russe établi par l'Interstate Aviation Committee fait référence.

"Approved"
Deputy Chairperson of the Interstate Aviation Committee
O. K. Ermolov
2007

INTERSTATE AVIATION COMMITTEE

FINAL REPORT
ON THE RESULTS OF THE INVESTIGATION OF THE ACCIDENT

Type of aircraft	A-310-324
State of Registry	France
Registration	F-OGYP
Owner	Wilminton Trust Company acting as the holder of fiduciary rights
Lessor	Airbus leasing II.Inc
Operator	OAO Aviakompania Sibir
Date and time of accident	8 July 2006, 10:44 pm UTC (07.09.06, 7:44 am local time)
Place of accident	At a distance of 2140 m and on a magnetic azimuth of 296° from Irkutsk ARP

In accordance with the standards and recommendations of the Intergovernmental Civil Aviation Organization, this report was issued with the sole purpose of preventing accidents.

The investigation conducted for this report does not presume to establish the share of any party's guilt or liability.

Any criminal aspects of this accident are treated in separate criminal proceedings.

Table of Contents

Glossary

ACAFA	- Aktyubinsk Civil Aviation Flight Academy
ACT	- airport control tower
AeMS	- aeronautical meteorological station (civilian)
AMS	- aviation meteorological station
ANO	- autonomous noncommercial organization
A & AE	- aviation and avionics equipment
AS	- airport service
CRT	- crash and rescue team
CRTr	- crash and rescue training
CRW	- crash and rescue work
CRS	- crash and rescue station
AMC	- aviation maintenance center
AMB	- aircraft maintenance base
AS	- air squadron
FS	- flight safety
MM	- middle marker
SSN	- spring-summer navigation
SSP	- spring-summer period
PEB	- physical evaluation board
AQC	- advanced qualifications commission
DFB	- departmental fire brigade
ASCC	- auxiliary start control center
APU	- auxiliary power unit
AT	- air transport
CA	- civil aviation
HV	- horizontal visibility
PAS	- public address system
SSRICA	- State Scientific and Research Institute of Civil Aviation
GPT	- glide-path transmitter
ArCC	- area control center
AppCC	- approach control center
TCC	- taxi control center
OM	- outer marker
US	- unified system
ZAO	- closed joint-stock company
ASDC	- air squadron deputy commander
AES	- aviation engineering service
ICAO	- International Civil Aviation Organization
ILS	- instrument landing system
MP	- maintenance personnel
ASC	- air squadron commander
ATC	- air traffic control

PIC	- pilot in command
SW	- short waves
KCAFA	- Kirovograd Civil Aviation Flight Academy
ADD	- aircraft division director
PRC	- People's Republic of China
LB	- localizer beacon
ARP	- airport reference point
FRI	- flight research institute
FS	- flight section
IAC	- Interstate Aviation Committee
MH	- magnetic heading
MLH	- magnetic landing heading
MT	- main taxiway
PA	- parking area
MU	- medical unit
MES	- Ministry for Emergency Situations
AAERC IAC	- Air Accident Engineering and Research Commission of the International Aviation Committee
AOS	- Airport Operating Standards
AAS	- Aircraft Airworthiness Standards
CAMM	- civil aviation meteorological manual
NOTAM	- notes to airmen (changes in aeronautical information)
CAFOM	- civil aviation flight operations manual
CAMRM - 93	- Civilian Aircraft Maintenance and Repair Manual – 1993
NSM	- navigation service manual
OAO	- open joint-stock company
UAE	- United Arab Emirates
TOC	- departure control
ATS	- air traffic service
HIL	- high-intensity lights
VHF	- very high frequency
OOO	- limited-liability company
MOP	- main observation point
SLB	- separate locator beacon
ATM	- air traffic management
LSE	- landing system equipment
OCS	- operations control service
ACS	- approach controller station
CRP	- compulsory reporting point
FPTC	- flight personnel training course
RIAAI-98	- 1998 Rules for Investigating Air Accidents and Incidents
PM	- periodic maintenance
TORA	- takeoff run available
ASDA	- accelerate-stop distance available

RF	- radar facility
FM	- flight manual
FOM	- flight organization manual
FOO	- flight operations officer
AFOD	- airport flight operations director
CAFSRM	- civil aviation flight search and rescue manual
LDA	- landing distance available
FOM	- flight operations manual
RSRB	- regional search-and-rescue base
PMP	- periodic maintenance procedure
AMG	- airplane maintenance guide
TCL	- throttle control lever
RTL	- reverse thrust lever
RF	- Russian Federation
RC	- regional center
RF CAOG	- RF Civilian Airport Operations Guideline
ICC	- integrated control center
FME	- forensic medical examination
TTSN	- total time since new
TMS	- transport management service
FSRS	- flight search and rescue service
USA	- United States of America
CMEA	- Council for Mutual Economic Assistance
M&R	- maintenance and repair
ATC	- air traffic control
USW	- ultra short waves
FIA	- flight inspection authority
RFPL	- required fire protection level
TC	- training center
FAR	- federal aviation rules
FCAMCR	- federal civil aviation medical certification regulations
FSUE	- federal state unitary enterprise
FTOA	- Federal Transportation Oversight Authority
CPEB	- Central Physical Evaluation Board
CIL	- central indicator light
EIF	- electrical illumination for flights

A/C	- aircraft
AFS	- automatic flight system
ATIS	- automatic terminal information system
BEA	- Bureau d'Enquêtes et d'Analyses (French accident investigation authority)
BFU	- Bundesstelle für Flugunfalluntersuchung (German accident investigation authority)

CBT	- computer-based training
CRM	- crew resources management
CVR	- cockpit voice recorder
DFDR	- digital flight data recorder
DGAC	- Direction Générale de l'Aviation Civile (French civil aviation authority)
EASA	- European Aviation Safety Agency
ECAM	- electronic centralized aircraft monitoring
EGT	- exhaust gas temperature
EPR	- engine pressure ratio (determines thrust)
FADEC	- full authority digital electronics control
FC	- flight cycles
FCOM	- flight crew operating manual
FCU	- flight control unit
FDR	- flight data recorder
FFS	- full flight simulator
FH	- flight hours
Flare	- (caption on flight mode annunciator)
FMA	- flight mode annunciator (on primary flight display)
FWC	- flight warning computer
GE	- General Electric
GLB	- ground log book
IATA	- International Air Transport Association
Reverse Idle	- reverse idle mode
ILS	- instrument landing system
IOSA	- IATA operational safety audit
LOW	- automatic braking mode
Max Rev	- maximum reverse thrust
MEL	- minimum equipment list
MMEL	- master minimum equipment list
N1	- low rotor rotation speed
N2	- high rotor rotation speed
NOTAM	- notices to airmen
NTSB	- US National Transportation Safety Board
PFD	- primary flight display
P&W	- Pratt & Whitney
Retard	- engine shift to idle (caption on flight mode annunciator)
Rollout	- (caption on flight mode annunciator)
SIGMET	- significant meteorological information
SOP	- standard operating procedure
STC	- supplement type certificate
TLB	- technical log book

UTC	- coordinated universal time
VOR-DME	- VHF omni-directional radio range/distance-measuring equipment

Background Information

On July 8, 2006 at 22:44 UTC[1] (7:44 local time on July 9, 2006), as it was landing at Irkutsk airport, an A-310 airplane, registration F-OGYP, operated by OAO Aviakompania Sibir [Sibir airlines], ran down the runway, overran the runway threshold and, at a distance of 2140 m and on a magnetic azimuth of 296° from the aerodrome reference point, collided with barriers, broke apart and burst into flames. As a result of the accident 125 individuals died, including both pilots and 3 of the cabin crew; 60 passengers and 3 cabin crew suffered physical injuries of varying degrees of severity.

The investigation of the accident was conducted by a commission appointed by Order no. 13/379-R dated July 8, 2006 of the Deputy Chairman of the Interstate Aviation Committee (IAC), as amended by Order no. 33 dated July 18, 2006 of the IAC Chairman:

Commission chairman	**A.N. Morozov**, Chairman of the Accident Investigation Commission of the Interstate Aviation Committee
Deputies of the commission chairman:	**V.V. Chernyaev**, Deputy Chairman of the Accident Investigation Commission of the Interstate Aviation Committee
	Yu.V. Zhuravlyov, Director of the East Siberian Administration of Gosavianadzor (Federal Transport Oversight Authority) of the Ministry of Transportation of Russia
Commission members:	**V.A. Trusov**, Chairman of the Commission for the Scientific and Technical Support of Air Accident Investigation of the IAC;
	S.A. Maryshev, branch consultant of the Inspection board for flight safety and the investigation of accidents of the Federal Transport Oversight Authority (Rostransnadzor);
	V.I. Volobuyev, director of the Department of Aerodromes and Airports of the Airport Operations Administration of the Federal Air Transportation Agency (Rosaviatsia);

[1] Hereinafter, unless otherwise specified, UTC is used. Sunrise at Irkutsk was at 20:50 UTC.

A.P. Dovzhik, chief maintenance engineer of the aviation maintenance center OAO "Aeroflot - Rossiskiye avialinii";

R.A. Teimurazov, IAC technical director for safety issues;

A.G. Kruglov, advisor to the Chairman of the IAC;

V.V. Biriukov, class 1 test pilot of the federal state unitary enterprise "M.M. Gromov Flight Research Institute"

Specialists from FTOA, Rosaviatsia, Rosaeronavigatsia, Irkutsk airport, the airlines Aeroflot - Rossiskiye avialinii and Sibir, as well as the accredited representative of BEA, who represented the State (France) of the airplane Design, Manufacture and Registry, and of NTSB, which represented the State (USA) of the engine developer and manufacturer, as well as their advisors from Airbus and P&W, participated in the investigation.

During the course of the investigation the Commission requested information about the cabin reconfiguration carried out by Lufthansa Technik (Germany). In accordance with Annex 13 to the ICAO Convention, this information was provided via BFU, which also appointed an accredited representative.

Start of investigation - July 9, 2006
End - 2007

1. Factual Information

1.1. History of Flight

On July 8, 2006 an A-310 airplane with state registration number F-OGYP (France), leased by OAO Aviakompania Sibir, and with a flight crew consisting of the Captain and the co-pilot, was flying scheduled passenger flight C7 778 from Domodedovo to Irkutsk.

Apart from the two cockpit personnel, there were 6 flight attendants and 195 passengers on board (of these, 2 worked for the company), which included 181 nationals of Russia, 3 of Germany, 3 of the PRC, 2 of Poland, 3 of Belarus, 2 of Moldova and 1 of Azerbaijan.

The airplane's payload according to the flight manifest was 19,800 kg (which included about 80 kg of hazardous freight - perfume), its take-off weight 140414 kg (maximum permissible – 150,000 kg), and center-of-gravity position 25.5% (the range of permissible center-of-gravity positions for take-off is 18% - 32%).

Upon completion of the pre-flight preparation, the crew took off from Domodedovo airport at 17:17 (17:15 – as per schedule) and after climbing set a course for its destination airport of Irkutsk (alternate airport Bratsk). The flight proceeded without incident and at 22:17 the crew initiated descent for an approach and landing at Irkutsk airport. At 22:43:40 the airplane landed without misalignment on runway 30 at Irkutsk airport.

Note: *Before the flight, in accordance with Sibir's MEL, the maintenance personnel deactivated the thrust reverser on the airplane's left engine after hearing the crew's observation about this thrust reverser's malfunction during a previous flight.*

After touchdown all spoiler sections prepared ("armed") by the crew for utilization were deployed and the autobrake in Low mode, previously selected by the crew, was activated. The pilot moved the right engine (no. 2) thrust reverser forward. However, simultaneously with the subsequent reduction of the reverse mode of engine no. 2, engine no. 1 started to speed up (forward thrust), which led to an increase in airplane speed and the onset of torque that pulled the airplane to the right.

The crew failed to perceive the cause of what was happening. In spite of intense wheel-braking efforts, the airplane used up the entire length of the runway and overshot its end at a speed of about 180 kph. The airplane then continued to travel on wet soil. At a distance of about 300 m from the departure threshold of the runway, the airplane collided with a concrete barrier of the aerodrome and then with some garages located directly behind the barrier, after which the airplane, now seriously damaged, stopped. As a result of the destruction of the fuel tanks the fuel ignited and fire penetrated the airplane's interior.

As a result of the accident, 125 individuals died, including the two pilots and three of the flight attendants. The airplane was practically completely destroyed by the fire.

1.2. Injuries to Persons

	fatal	serious	minor	n/a
passengers	120	38	22	15
crew	2/3	0/3	-	-

1.3. Damage to Airplane

As the airplane was overshooting the runway, it collided with a concrete barrier of the aerodrome and with some garages behind it. As a result of the break-up of the airplane's structure and the subsequent fire, the airplane was practically completely destroyed.

1.4. Other Damage

As the airplane was overshooting the runway, its left engine cowling and air intake damaged six first-row elements and one second-row element of the localizer antenna array. The shock struts of the landing gear then broke the aerodrome's concrete barrier, after which the airplane collided with the garage structures behind the barrier, resulting in the destruction of 20 garages.

1.5. Personnel information

1.5.1. Flight Crew

The Captain	
Date of birth	May 16, 1961
Class	1
Civil aviation pilot's license	I P no. 001109
Date of issue of license	Nov. 25, 1996
License valid until	Dec. 23, 2006
Education	Special tertiary, graduated from the Aktyubinsk Civil Aviation Flight Academy in 1982
Conversion training on A-310 aircraft	Aviation Training Center of OAO Aviakompania Sibir on the aircraft captains’ course

Appointed to position of A-310 airplane captain	Order no. 836 of June 1, 2005
Weather minima	ICAO category II: landing 30x350 m, take-off 150 m
Total flight experience	10,611 hours
Flight experience on A-310 airplane of which Pilot trainee Flight experience as A-310 airplane captain	1,056 hours 43 hours 1,013 hours
Flight experience over the last month	34 hours 34 min
Flight experience on the day of the accident	5 hours 27 min
Total working time on the day of the accident	7 hours 29 min
Number of landings over the last three days	3
Rest period before flight	33 hours, at Sibir's Neftyannik hotel (from July 7, 2006 to July 8, 2006)
Medical exam before departure flight	July 8, 2006 at 15:15
Preliminary training	combined with spring-summer training (see below)
Date of last testing (evaluator, mark):	
- piloting technique	April 28, 2006, air squadron commander, mark - five
- airplane navigation	April 28, 2006, air squadron commander, mark - five
Simulator training	March 31, 2006, Emirates Training Center (UAE)
Authorization to fly during spring-summer period	as per Order no. 22 of Apr. 24, 2006 of flight section commander

The Captain graduated from the Aktyubinsk Civil Aviation Flight Academy in 1982. After his conversion training on the An-24 airplane, he carried out flights as a co-pilot from 1983 to 1987. His flight experience was 2,445 hours. From 1987 he carried out flights as airplane captain on the An-24 and flew 2,077 hours. After graduating from the CMEA Ulyanovsk Civil Aviation Center in 1991 he flew on the Tu-154B as co-pilot. His flight experience was 2,930 hours.

In January 1993 he obtained his civil aviation first-class pilot's license.

In November 1995 he underwent conversion training on the Boeing 757 airplane at the NORTHWEST NATCO training center on the airplane captains' training course.

In May 1997 he received authorization to carry out flights on international air routes.

From November 2000 he flew as airplane captain on the Tu-154, totaling 2,140 hours as Tu-154 airplane captain. In August 2002 he received his pilot instructor's license for the Tu-154 airplane.

He had been flying the A-310 airplane since May 2005. In December 2005 he received authorization to fly under the ICAO CAT II minimums (take-off – 150 m, landing 30 x 350 m).

Co-pilot	
Date of birth	March 4, 1958
Class	1
Civil aviation pilot's license	I P no. 01123
Date of issue of license	Dec. 13, 1996
License valid until	Dec. 9, 2006
Education	Special tertiary. Graduated from the Kirovograd Civil Aviation Flight Academy in 1983
Conversion training on A-310 airplane	Aviation Training Center of OAO Aviakompania Sibir
Appointed to position of A-310 co-pilot	Order no. 1218 dated May 5, 2006 of Airplane Division Director (ADD)
Weather minima	ICAO category I: landing - 60x550, take-off - 200 m (as member of crew)
Total flight experience	9,771 hours 3 min
Flight experience on A-310 of which as trainee as co-pilot	158 hours 66 hours 92 hours
Flight experience over the last month	23 hours 17 min
Flight experience on the day of the incident	5 hours 27 min
Total working time on the day of the accident	7 hours 29 min
Number of landings over the last three days	2
Rest period before last flight	33 hours, at Sibir's Neftyannik hotel (from July 7 2006 to July 8 2006)
Medical exam before departure flight	July 8, 2006 at 15:15

Preliminary training	combined with spring-summer training (see below)
Date of last testing (evaluator, mark):	
- piloting technique	18 May 2006, air squadron commander, mark - five
- airplane navigation	18 May 2006, air squadron commander, mark - five
Simulator training	May 18, 2006 on the A-310 conversion training course at the AIR FRANCE Training Center
Authorization to fly during spring-summer period	as per Order no. 218/1 of May 4, 2006 of the flight section commander

The A-310's co-pilot graduated from the Kirovograd Civil Aviation Flight Academy in 1983.

He had been flying as co-pilot since 1983 and since 1989 as airplane captain on the An-26. He had been a co-pilot on the Tu-154 since 1992. Flight experience as co-pilot on the Tu-154 airplane is 4,796 hours. In February 1995 he obtained his civil aviation first-class pilot's license.

Thus, the airplane captain's total flight experience as airplane captain on the A-310 airplane was 1,056 hours, of which 1013 were solo as captain. That means that his flying experience as a trainee before he achieved his position as airplane captain was 43 hours over three weeks. The airplane captain had no flight operations experience as a co-pilot on the A-310. Total flight experience of the co-pilot on the A-310 was 158 hours, of which 92 hours were solo.

Note: *The Captain had valid recognition (validation) of his pilot's license which was issued by the Aviation Authority of France on the basis of Art. 32 of the ICAO Convention. The Co-pilot did not have such a validation. It should be noted that this validation is necessary only when carrying out flights on international air routes.*

The Commission studied and analyzed the procedure for conversion training and the admission of the Captain and co-pilot of the A-310 airplane. The tables below show how the pilots met the current requirements.

Requirements to be met by candidates for conversion training on the A-310[2]

Parameter	Requirement	Airplane captain	Co-pilot
Education	**Tertiary**	**ACAFA-82**	**KCAFA-83**
Class	**no lower than 2**	**Class 1 (Order no.4 of the Advanced Qualifications Commission of Jan. 27, 1993)**	**Class 1 (Order no.5 of the Advanced Qualifications Commission of Feb. 1, 1995)**
Medical requirements	**Fitness as pilot without restrictions**	**Fit**	**Fit**
Proficiency	**Psychologist's examination**	**Recommended**	**Recommended**
Authorization to carry out flights on international air routes	**Authorized**	**Order no. 94/g of May 2, 2005**	**Order no. 55/l of March 29, 2006**

Before undergoing conversion training on the A-310 airplane in 2005, the Captain was a class 1 airline pilot of civil aviation, had tertiary aviation training, had authorization to carry out flights on international air routes, was authorized to fly based on his health and proficiency (psychologist's examination) and was recommended for conversion training on the A-310 airplane on the airplane captains' training course.

Co-pilot went through conversion training in April 2006 and met the requirements for candidates for conversion training on foreign airplane: class 1 airline pilot of civil aviation, tertiary aviation education, authorization to carry out flights on international air routes, and met the health and proficiency requirements (psychologist's examination).

The conversion training of both pilots was carried out at Sibir's Aviation Training Center (ATC), whose license no. 053 was issued by FTOA on October 14, 2004, with addenda valid from January 28, 2005, allowing it to train individuals, including members of flight crews of the A-310 airplane.

The professional training of crew members was conducted based on the flight personnel training course developed by the airline and approved by the aviation authorities of the Russian Federation.

[2] Hereinafter the provisions stipulated by Sibir flight personnel training course are quoted.

ATC Training

	Airplane captain	Co-pilot
Theory (CBT)	**165 hours**	**165 hours**
Examination	**99 (out of 100)**	**86 %**
Oral exam	**Five**	**Four**
Simulator training. Total: **Including:** **- fix base** **- full flight** **- check**	**Air France Training Center** **52 hours** **16** **32** **4**	**Air France Training Center 52 hours** **16** **32** **4**
Aerodrome training	**4/4 (1 go around)** ***ADD Sagindykov***	**4/4 (1 go around)** ***Pilot Instructor***
ATC certificate of graduation from the A-310 training course	**received on Apr. 13, 2005**	**received on Apr. 14, 2006**

The A-310 flight training course includes theoretical training using CBT computer programs totaling 165 hours with final check. Based on the test results, The Captain and the co-pilot were permitted to undergo simulator training.

The simulator training of the pilots was carried out at the Air France Training Center with instructors from Sibir.

Note: *The initial training course for instructors at Sibir does not exist. The instructors undergo corresponding conversion training in corresponding foreign schools according to their courses.*

After completion of aerodrome training on the A-310 airplane at Sibir's ATC, the Captain and the co-pilot were issued certificates of graduation from the A-310 conversion training.

Completing the Flight Personnel Training Course (FPTP) in a flight squadron

Stage	**Content**	
	Airplane captain	**Co-pilot**
Ground training	**11 hours (as per FPTP 2005)**	**30 hours**
Simulator	**Conversion training course simulator**	**Conversion training course simulator**
Flights as observer	**Not required by FPTP 2005**	**2**
Flights as trainee	**ADD no.3 Order no.70/l of Apr. 15, 2005 on the assignment of airplane captain trainee to pilot instructor (10 flights).**	**ADD no. 4 Order no. 197 of Apr. 19, 2006 on the assignment to airplane captain instructor; because of the replacement of instructor as of May 3. 2006 - no. 197 to airplane captain instructor (16 flights).**
Conversion training course check flights	**2 - air squadron commander**	**2 - deputy air squadron commander**
Flights under surveillance of pilot instructor	**2 - Deputy air squadron commander.**	**not required**
	Order no. 836 dated June 1, 2005 on the transfer to A-310 airplane captain position	**ADD Order no. 4 dated May 5, 2006 on authorization to make solo flights no. 1218**

The ground training of the Captain and co-pilot was conducted by airline pilots and instructors at 4LO in Moscow in accordance with the A-310 FPTP flight operations manual. Simulator training was conducted at the Air France Training Center based on the A-310 crew conversion training course. The trainee aircraft captain carried out flights in accordance with the requirements of the A-310 FPTP flight operations manual, App. 2, task 3, without significant remarks. The co-pilot was given 6 additional flights because of an instructor replacement. The Captain and the co-pilot completed test flights and received a mark of five according to the A-310 FPTP flight operations manual.

It should be noted that Sibir A-310 flight personnel training course allows commissioning of pilots as airplane captain who have solo flight experience as a captain on class 1 Russian airplanes without undergoing the co-pilot training course and without flight operations experience in this position. About 20 A-310 airplane captains, including The Captain, underwent this commissioning course. Analysis showed that out of 62 A-310 airplane captains who worked for Sibir from the middle of 2004 to August 2006, only 20 pilots underwent the training course, which included co-pilot training, commissioning as a co-pilot, flight operations experience in this position for up to one year, conversion training on the airplane captains’ training course and commissioning as an airplane captain.

At the same time, the standard flight experience on the Sibir FPTP for those undergoing conversion training from the position of airplane captain of Russian airplane was 30 flights; and for those pilots who had no solo flight experience as an airplane captain, it is 300 hours. This is 3-5 times less than what is prescribed by the FPTP of Aeroflot (for details please refer to section 1.18.1).

Tests of piloting technique and airplane navigation

Airplane captain	Co-pilot
28 Apr. 2006, mark - five. Air Squadron Commander	**18 May 2006, mark - five. Air Squadron Commander**

Qualification tests were completed in accordance with App. 10 of the A-310 ATC flight operations manual and within the stated periods.

Last simulator training

Airplane captain	Co-pilot
31 March 2006. with exercises on landing approach at CAT-2 weather minimum, approaches under inexact systems.	**18 May 2006 based on the A-310 conversion training course.**

After successfully passing App. 2 of the A-310 FPTP, the Captain underwent training to complete the flights necessary to meet ICAO minimum category 2 in accordance with the requirements of App. 3 of the A-310 FPTP during regular training and simulator testing within the stated periods. The co-pilot did his simulator training while undergoing conversion training on the A-310 airplane.

Note: *Crew training courses on A-310 type airplane do not provide exercises on landing with one deactivated thrust reverser. Accordingly the airline does not train its flight crews to develop these skills. It should be noted that the manufacturer's Master MEL and the* Sibir *MEL, which was in force at the moment of the accident, contain a warning about the need to check the position of the throttle control lever while on idle, in case of deactivation of the corresponding thrust reverser.*

Authorization to carry out spring-summer navigational flights - 2006

Airplane Captain	Co-pilot
Preliminary training June 2, 2006 consisting of the Captain and the co-pilot was conducted by ADD and a Senior Flight Section Navigator	
Order no. 22 dated Apr. 24, 2006 on the authorization to carry out spring-summer navigational flights in 2006	**ADD Order no. 218/1 dated May 4, 2006 on the authorization to carry out spring-summer navigational flights in 2006**

Training to complete spring-summer navigational flights in 2006 was conducted in accordance with clause 2.1.16, part D, of Sibir's flight operations manual and procedural recommendations issued by FTOA. The final stage of training was a technical flight conference and the authorization to carry out spring-summer navigational flights in 2006.

Crash and rescue training

	Airplane captain	**Co-pilot**
Water	**December 23, 2005. Task 26504m-10**	**February 4, 2005. no. 108-05**
Ground	**23 March 2005. Task 26379m-37**	**February 16, 2006. no. 26343m-02**

CRM training

During the initial stage Crew Resource Management (CRM) training was conducted in accordance with section 1.25 of the theoretical conversion training course for the A-310 airplane.

As per clause 2.1.12, part D of Sibir's flight operations manual, the Captain and the co-pilot completed CRM training on the following dates:

Airplane captain	Co-pilot
Apr. 13, 2005	**Apr. 14, 2006**

Note: *Further regular qualification tests also presuppose checks for compliance with CRM requirements (para 4.6 during line checks, and para 1.8 during simulator checks).*

Note: *There are no special courses (unified programmes) in the Russian Federation for flight crew advanced training that focus on learning the characteristics of crew resource management (CRM) when undergoing conversion training from Russian airplane with three or more crew members to airplane with a two-person flight crew.*

The crew consisting of the Captain and the co-pilot was created and approved by Order no. 34 of the flight section commander dated June 2, 2006. In this make-up the crew performed 12 flights. According to FDR data analysis, there have been no deviations in piloting technique or actions at all stages of the flights.

1.5.2. Cabin Crew

Position	Sibir airline A-310 flight attendant
Date of birth	July 13, 1981
Class	3
Civil aviation flight attendant's license	no. IVBP019978
Date of issue of license	December 10, 2003
License valid until	March 3, 2007
Initial training	Sibir ATC, certificate no. 3114C-04 of May 15, 2003
A-310 conversion training	Istanbul Training Center no. B/N April 29, 2004
A-310 authorization	Order no. 349\l of the General Director of the OAO Aviakompania Sibir of July 20, 2004
Advanced training course on May 31, 2005	no. 5121M-08 Sibir ATC
Medical exam	March 3, 2005. ZAO Aviakompania Domodedovo
Ground crash and rescue training	Apr. 25, 2006. OAO Aviakompania Sibir ATC
Water crash and rescue training	May 27, 2005. OAO Aviakompania Sibir ATC
Date of last testing	Feb. 14, 2006
Authorization to fly during spring-summer period	Order no. 99 of the General Director of OAO Aviakompania Sibir, of May 4, 2006
Total flight experience	2,133 hours
Flight experience on given type	699 hours 38 min
Flight experience in June	72 hours 33 min
Flight experience over the last month	12 hours 00 min
Flight experience on the day of the accident	5 hours 47 min
Total working time on the day of the accident	7 hours 17 min
Pre-flight rest	43 hours 46 min
Physical exam before departure flight	July 8, 2006 at 19:35

Position	Sibir airline A-310 flight attendant
Date of birth	January 28, 1985
Class	3
Civil aviation flight attendant's license	no. IVBP017416
Date of issue of license	July 12, 2004
License valid until	June 1, 2007
Initial training	Sibir ATC, certificate no. 4120M-14 of June 9, 2004
A-310 conversion training	Sibir ATC, certificate no. 5126M-02 of May 16, 2005
A-310 authorization	Order no. 304\l of the General Director of the OAO Aviakompania Sibir of June 29, 2005
Advanced training course on June 23, 2006	no. 26051-04 Sibir ATC
Physical evaluation board	June 1, 2006. OAO Aviakompania Vnukovo
Ground crash and rescue training	June 19, 2006. OAO Aviakompania Sibir ATC
Water crash and rescue training	June 20, 2006. OAO Aviakompania Sibir ATC
Date of last testing	March 4, 2006
Authorization to fly during spring-summer period	Order no. 99 of the General Director of OAO Aviakompania Sibir, of May 4, 2006
Total flight experience	1,257 hours
Flight experience on given type	252 hours 47 min
Flight experience in June	37 hours 8 min
Flight experience over the last month	23 hours 45 min
Flight experience on the day of the accident	5 hours 47 min
Total working time on the day of the accident	7 hours 17 min
Pre-flight rest	22 hours 34 min
Physical exam before departure flight	July 8, 2006 at 19:29

Position	Sibir airline A-310 flight attendant
Date of birth	Feb. 17, 1984
Class	3
Civil aviation flight attendant's license	no. IVBP018223
Date of issue of license	Aug. 17, 2004
License valid until	June 2, 2007
Initial training	Sibir ATC, certificate no. 4137M-01 of July 15, 2004
A-310 conversion training	Sibir ATC, certificate no. 5112M-08 of Feb. 17, 2005
A-310 authorization	Order no. 186\l of the General Director of the OAO Aviakompania Sibir of May 3, 2005
Advanced training course on February 26, 2006	no. 26005M-04 Sibir ATC
Physical evaluation board	June 2, 2006-June 2, 2008. OAO Aviakompania Vnukovo
Ground crash and rescue training	February 26, 2006. OAO Aviakompania Sibir ATC
Water crash and rescue training	February 21, 2006. OAO Aviakompania Sibir ATC
Date of last testing	March 11, 2006
Authorization to fly during spring-summer period	Order no. 99 of the General Director of OAO Aviakompania Sibir, of May 4, 2006
Total flight experience	1,387 hours
Flight experience on given type	360 hours 38 min
Flight experience in June	78 hours 16 min
Flight experience over the last month	20 hours 22 min
Flight experience on the day of the accident	5 hours 47 min
Total working time on the day of the accident	7 hours 17 min
Pre-flight rest	22 hours 34 min
Physical exam before departure flight	July 8, 2006 at 19:27

Position	Sibir airline A-310 flight attendant
Date of birth	March 4, 1972
Class	
Civil aviation flight attendant's license	no. IVBP021542
Date of issue of license	June 21, 2004
License valid until	February 3, 2007
Initial training	Non-commercial educational institution of civil aviation - Flight Attendant School, certificate no. 1144 of January 22, 1999
A-310 conversion training	Sibir ATC, certificate no. 5116M-07 of March 14, 2005
A-310 authorization	Order no. 349\l of the General Director of the OAO Aviakompania Sibir of July 20, 2004
Authorization to undergo A-310 conversion training, Mar. 14, 2005	Order no. 143/l of April 11, 2005
Advanced training course on June 8, 2006	no. 26047M-06 Sibir ATC
Physical evaluation board	November 9, 2005-November 9, 2007. OAO Aviakompania Vnukovo
Ground crash and rescue training	February 16, 2006. OAO Aviakompania Sibir ATC
Water crash and rescue training	June 21, 2006. OAO Aviakompania Sibir ATC
Date of last testing	July 5, 2006
Authorization to fly during spring-summer period	Order no. 99 of the General Director of OAO Aviakompania Sibir, of May 4, 2006
Total flight experience	3,566 hours
Flight experience on given type	274 hours 57 min
Flight experience in June	68 hours 37 min
Flight experience over the last month	22 hours 8 min
Flight experience on the day of the accident	5 hours 47 min
Total working time on the day of the accident	7 hours 17 min
Pre-flight rest	43 hours 46 min
Physical exam before departure flight	July 8, 2006 at 19:33

Position	Sibir airline A-310 flight attendant
Date of birth	October 4, 1976
Class	3
Civil aviation flight attendant's license	no. IVBP021548
Date of issue of license	June 21, 2004
License valid until	February 3, 2007
Initial training	Sibir ATC, certificate no. 4114M-01 of May 5, 2004
A-310 conversion training	Sibir ATC, certificate no. 5158-02 of October 5, 2005
A-310 authorization	Order no. 536\l of the General Director of the OAO Aviakompania Sibir of November 17, 2005
Advanced training course on August 8, 2006	no. 526047-06 Sibir ATC
Physical evaluation board	June 2, 2006-June 2, 2008. OAO Aviakompania Vnukovo
Ground crash and rescue training	February 26, 2006. OAO Aviakompania Sibir ATC
Water crash and rescue training	February 21, 2006. OAO Aviakompania Sibir ATC
Date of last testing	June 13, 2006
Authorization to fly during spring-summer period	Order no. 99 of the General Director of the OAO Aviakompania Sibir, on May 4, 2006
Total flight experience	1,456 hours
Flight experience on given type	188 hours 21 min
Flight experience in June	68 hours 15 min
Flight experience over the last month	21 hours 50 min
Flight experience on the day of the accident	5 hours 47 min
Total working time on the day of the accident	7 hours 17 min
Pre-flight rest	29 hours 50 min
Physical exam before departure flight	July 8, 2006 at 19:45

Position	Sibir airline A-310 flight attendant
Date of birth	Jan. 9, 1983
Class	3
Civil aviation flight attendant's license	no. IVBP108213
Date of issue of license	Sept. 7, 2004
License valid until	May 25, 2007
Initial training	Sibir ATC, certificate no. 4139M-09 of Aug. 6, 2004
A-310 conversion training	Sibir ATC, certificate no. 5155-11 of Sept. 30, 2005
A-310 authorization	Order no. 478\l of the General Director of the OAO Aviakompania Sibir of Oct. 14, 2005
Advanced training course on August 6, 2004	no. 4139-M-09 Sibir ATC
Physical evaluation board	May 25, 2006-May 25, 2008. OAO Aviakompania Vnukovo
Ground crash and rescue training	Oct. 5, 2005. Turkish airline ATC, Istanbul
Water crash and rescue training	July 16, 2004. OAO Aviakompania Sibir ATC
Date of last testing	Apr. 21, 2006
Authorization to fly during spring-summer period	Order no. 99 of the General Director of the OAO Aviakompania Sibir, on May 4, 2006
Total flight experience	1,351 hours
Flight experience on given type	190 hours 41 min
Flight experience in June	91 hours 51 min
Flight experience over the last month	15 hours 21 min
Flight experience on the day of the accident	5 hours 47 min
Total working time on the day of the accident	7 hours 17 min
Pre-flight rest	46 hours 15 min
Physical exam before departure flight	July 8, 2006 at 19:31

1.6. Aircraft Information

1.	**Type of airplane**	**A-310-324**
2.	Registration number	F-OGYP
3.	Serial number	442
4.	Manufacturer	Airbus Industry (France)
5.	Date of manufacture	June 11, 1987
6.	Country of registration	Republic of France
7.	Owner	Wilminton Trust Company as the holder of fiduciary rights (USA)
8.	Lessor	Airbus Leasing II, INC. (USA)
9.	Operator	OAO Aviakompania Sibir
10.	Operating time	TTSN - 59,865 hours 12,550 landings
11.	Service life limit (SLL)	80,000 hours; 35,000 landings
12.	Number of repairs ("D check")	2 (periodicity – 120 months)
13.	Date and place of last "D check"	May 18, 2004, Airplane Services Lemwerder GmbH (Germany)
14.	Operating time after "D check" maintenance	7,076 hours; 1,933 landings
15.	Date and place of last periodic "A check" maintenance (periodicity – after every 450 hours)	June 1, 2006 on site at OOO C7 ENGINEERING, maintenance record MJSS # 123 (Domodedovo airport)
16.	Operating time after last "A check" maintenance	370 hours 26 min, 111 flights
17.	Date and place of last operational servicing "DLY check" and "PF" (daily and pre-flight maintenance)	July 8, 2006, Domodedovo airport, maintenance record MJSS # 7649
18.	Initial type certificate	no. 145 of 27 May 1987, issued by the Civil Aviation Authority of France (DGAC)
19.	Russian type certificate	no. 15-310 of October 25, 1991, issued by the USSR Gosaviaregistr, with amendments from October 1, 1993 issued by IAC Aviaregistr
20.	Airplane certificate of registration	no. B23968 of June 2, 1995, issued by the Civil Aviation Authority of France (DGAC)
21.	Airworthiness certificate	no. 25076047462 of March 22, 2006, issued by the Civil Aviation Authority of France (DGAC)

		.Valid until October 7, 2006

1.	**Engine no. 1**	**P&W 4152 (USA)**
2.	Serial number	P717713 CN
3.	Manufacturing plant	Pratt & Whitney (USA)
4.	Date of manufacture	April 15, 1987
5.	Total time since new	51,300 hours; 10,680 cycles
6.	Number of repairs	3
7.	Organization that performed last repair	Lufthansa Technik AG (Germany)
8.	Date of last repair	December 3, 2002
9.	Operating time after last repair	10,172 hours; 2,627 cycles
10.	Date and place of installation in airplane	December 14, 2002, OAO Aeroflot, Sheremetevo airport
11.	**Engine no. 2**	**P&W 4152 (USA)**
12.	Serial number	P717712
13.	Date of manufacture	Apr. 11, 1987
14.	Manufacturing plant	Pratt & Whitney (USA)
15.	Total time since new	51,137 hours; 10,363 cycles
16.	Number of repairs	3
17.	Organization that performed last repair	Lufthansa Technik AG (Germany)
18.	Date of repair	June 6, 2001
19.	Operating time after last repair	15,072 hours; 3,599 cycles
20.	Date and place of installation in airplane	July 17, 2001, OAO Aeroflot, Sheremetevo airport

A study of the maintenance record of the F-OGYP airplane revealed, in addition to the information indicated in the table above, the following data:

The last periodic “C check” maintenance (periodicity of performance - after every 15 months) was completed on July 12, 2005 as per maintenance record JSS no. 8/0 and tally sheet C001/2005 on site at Lufthansa Technik AG in the city of Frankfurt-am-Main (Germany).

The last “S check” maintenance (weekly maintenance) was completed on July 6, 2006 - maintenance record (MJSS #7603) and job no. A110261SBI - on site at the organization performing the maintenance and repair, OOO C7 ENGINEERING at Domodedovo airport.

Note: *Operational and periodic servicing of the airplane (up to and including a 4A check) was performed under an agreement with Sibir by specialists of OOO C7 ENGINEERING (Russia), which has the necessary certificates from aviation authorities of Russia and EASA to perform this type of work. It should be noted that according to EASA regulations the certificate from the Russian authorities is not required.*

For the period after the last periodic "A check" maintenance as indicated in the Table, from June 1, 2006 to July 8, 2006 the content of the three TLBs and two GLBs used was analyzed:

- Flight log: period from May 27, 2006 to June 11, 2006; AT no. 254951 – AT no. 255025 (taken from archive).
- Flight log: period from June 11, 2006 to July 1, 2006; AT no. 265376 – AT no. 265450 (loose pages stored in the archive are used). The logbook was destroyed in the fire in the airplane.
- Flight log: period from July 2, 2006 to July 8, 2006; AT no. 268451 – AT no. 268480 (loose pages stored in the archive are used). The logbook was destroyed in the fire in the airplane.
- Ground maintenance logbook: period from May 23, 2006 to June 16, 2006; no. AG206800 – AG206899 (taken from archive).
- Ground maintenance logbook: period from June 17, 2006 to July 8, 2006; no. AG205400 – AG205471 (taken from archive).

For the period in question the airplane carried out 111 flights, and operating time was 370 hours 26 minutes. During this period 50 malfunctions and failures were recorded.

Total number of recorded failure reports in flight logs according to types of detection

Failures and malfunctions reported by crew and noted down in the TLB	Failures and malfunctions reported by maintenance personnel and noted down in the GLB
32	18

Malfunctions and failures according to airplane systems were distributed as follows:

System	Qty malfunctions	of these, repeated	Remark numbers	Defect numbers	Opening date
Air conditioner	1		AG206836	637	06.03.06
Auto-pilot	5	3	AT265407	654	06.23.06
			AT268458	663	07.04.06
			AT268461	-	07.04.06
			AT268465	-	04.07.06
			AT268470	-	07.07.06
Commun-ication	4		AT265390	-	06.14.06
			AT265395	-	06.15.06
			AG206868	645	06.10.06
			AG205464	670	07.07.06
Airplane control	2		AT268460	662	07.04.06
			AT268477	-	07.07.06
Airplane fuel system	2		AT255008	640	06.08.06
			AT268459	-	07.04.06
Hydraulics	1		AT265404	-	06.22.06
			AG205420	655	06.23.06
Landing gear	7		AT254969	-	05.30.06
			AG206848	-	06.05.06
			AG206852	-	06.06.06
			AG205424	-	06.24.06
			AG205428	-	06.25.06
			AG205455	-	07.06.06
			AG205456	-	07.06.06
Lights	1		AT254996	-	06.06.06
Navigation	8		AT254967	-	05.30.06
			AT255009	-	06.08.06
			AT255018	-	06.10.06
			AT265403	-	06.22.06
			AT265409	-	06.23.06
			AG206869	646	06.10.06
			AT268471	-	07.07.06
			AT265412	656	06.24.06
Oxygen equipment	1		AG205436	658	06.29.06
Water system	4		AG206856	-	06.07.06
			AG206865	643	06.09.06

			AG205445	661	07.04.06
			AG205460	668	07.07.06
APU	1		AT265419	-	06.25.06
Doors	4		AT255017	644	06.09.06
			AT265397	-	06.15.06
			AG206889	650	06.14.06
			AT265442	660	06.29.06
Engine fuel system	2		AT254987	-	06.04.06
			AT268472	-	07.07.06
Thrust reverser	2		AT268467	667	07.06.06
			AT268474	669	07.07.06
Engine air system	4	2	AT254975	635	06.02.06
			AT265394	-	06.15.06
			AT268473	-	07.07.06
			AG206894	652	06.15.06

So over the period in question there were 50 observations of malfunctions in airplane systems reported. 29 of these observations were rectified before the next flight departure. Over the period in question a total of 21 defects were identified. Their rectification was postponed in accordance with the MEL established by the maintenance manual. Fifteen of these defects were corrected before July 8, 2006. Five failures were again recorded; of these five, four were fixed before July 8, 2006.

Of the 50 observations indicated in the tables above, those observations whose rectification was postponed in accordance with the Minimum Equipment List (MEL) during the last flight were singled out. Of the 18 failures and malfunctions reported by maintenance personnel in the GLB, 6 were recorded in the TLB (flight log) for the crew's information:

Number of defect	Date of detection	Required date of rectification	Failure	Grounds
AG205445	07.04.06	07.14.06	Leak in drain pipe of left tank of toilet	MEL 02-38-01B-1 category C
AT268460	07.07.06	07.14.06	Failure of system no. 2 for the retraction and deployment of flaps	MEL 02-27-02-18 category C
AT268474	07.07.06	07.17.06	Thrust reverser of engine no.1	MEL 02-78-01B-1

			deactivated	category C
AG205460	07.07.06	07.14.06	Toilet on left side not working	MEL 02-38-01B category C
AT268458	07.04.06	07.14.06	Failure of autopilot no. 2 system	MEL 02-22-02-5B category C
AG205464	07.07.06	07.14.06	Speaker system for flight attendants not working in seats 1R and 3R	MEL 02-23-02-9 category C

Note: *The* Sibir *Minimum Equipment List (MEL) that was in force at the time of the accident was approved by the Federal Transportation Inspection Service on June 7, 2006 and was amended by Revision no. 1 on June 20, 2006.*

The A-310 airplane was awarded the initial certification of the MAK Aviaregistr in a three-class configuration and it was deemed compliant with clause 5.8.5.3 of AAS-3 (Airplane Airworthiness Standards) in terms of the portable oxygen and protective breathing equipment.

According to drawing no. AI 004-80.1123 of August 6, 1996, airplane F-OGYP, upon delivery to Aeroflot, had 4 smoke hoods for the flight attendants that were located in the forward and rear sections of the airplane. There was no smoke control equipment prescribed for the flight attendants in the middle section of the airplane.

Before Sibir started to operate this airplane, the passenger cabin was converted from a three-class layout with 185 seats into two classes with 205 seats, and photoluminescent path markings were installed on the floor. The conversion was carried out by Lufthansa Technik AG (Germany) by order of Sibir (engineering order no. 142524 of June 16, 2004). Lufthansa Technik AG received Supplemental Type Certificate (STC) for the two-class layout from EASA: STC EASA A.S.0025 and STC EASA A.S.0027, which were issued on the basis of LBA (Germany) certificate no. TA0816 of June 20, 2004. The photoluminescent system was installed on the basis of STC EASA A.S.0024 and STC EASA A.S.0027. MAK did not receive a request to obtain the Supplemental Type Certificate (STC) for the two-class layout.

Note: *The airplane was delivered by Airbus to the Sibir airline on June 18, 2004 in a three-class layout. The Certificate of Release to Service was issued by Lufthansa Technik AG on July 16, 2004 after completing the modifications mentioned above.*

None of the STCs deals with on-board emergency equipment, with the exception of the installation of additional life jackets on passenger seats and the alteration of routes for supplying oxygen to passengers. In particular, no protective breathing equipment was removed or added.

So the F-OGYP airplane had no protective breathing equipment (PBE) for the flight attendants responsible for the emergency exits in the middle part of the cabin. Smoke control equipment for flight attendants in the tail section of the cabin was located on the wall on the side of the passenger cabin. This did not allow flight attendants to quickly fetch it if the need arose.

Note: *Another* Sibir *airplane (serial number 453, reg. F-OGYQ), which went through the same cabin modernization, has smoke control equipment on board for each of the 6 flight attendants.*

The availability of this equipment was regulated by clause 5.8.5.3 NLGS-3, by which the A-310 was certified in the USSR. This clause states that "...Flight attendants to whom the flight manual assigns duties of providing assistance to passengers when smoke appears in the cabin should be supplied with additional smoke masks. The device with the smoke mask attached to it should meet the requirements of 5.8.4.2.4 and should be installed in a place that is easily accessible by the flight attendants".

According to the information received from EASA the certification basis for A-310-300 (FAR-25 amendment 1 to 45) and particularly item 25.1439 amendment 38 do not require the installation of smoke protection masks for each cabin crew member. The smoke protection masks were compliant with JTSO-C116. This kind of equipment is used only for in-flight firefighting. There are no procedures or requirements to use it during emergency evacuation. The corresponding cabin crew training does not exist.

However, clause 1.3.1 of the flight attendant work manual of the OAO Sibir Airline stipulates the need for using an anti-smoke hood when extinguishing a fire or in the event of smoke formation. The emergency schedule for the 6 crew members assigns duties for each of them during passenger evacuation.

1.7. Meteorological Information

The following was established on the basis of an analysis of the available meteorological information:

On July 8, 2006 the crew of the A-310 airplane performed pre-flight meteorological preparation correctly and decided to take off from Moscow to Irkutsk. The time of departure from Domodedovo was 17:17.

The actual weather at Domodedovo airport at 15:00 on July 8, 2006 was as follows: wind 220 degrees - 2 m/s, visibility 10 km, cloud cover - scattered cloud at 1500 m, cumulonimbus, temperature 26 degrees, dew point 12 degrees, pressure 1020 gPa, recent storm. Forecast for landing: occasional visibility 2000 m, storm with moderate rain.

Weather forecast at Domodedovo airport from 13:00 to 21:00 on July 8, 2006: surface wind - 220 degrees - 6 m/s, visibility 10 km, cloud cover - diffused at a height of 900 m, occasional visibility 200 m, storm with moderate rain.

Along the flight route there were no hazardous events forecasted whose avoidance would have been impossible. The weather forecast along the route to follow via the airports at Ekaterinburg, Kemerovo, Tolmachevo and Yemelyanovo was also provided to the crew before the flight and met the conditions for authorizing departure.

According to AT700 at 12:00 on July 8, 2006 at the altitude of the leading airstream, the region around Irkutsk airport was under the influence of the northern periphery of a cyclone whose center was south of Ulan Bator. Currents at 080 degrees and traveling at 40-50 kph were observed over regions of Irkutsk. The currents were not expected to change during the course of the day. The weather near the surface of the ground in the region of Irkutsk airport was determined by the rear part of a cyclone whose center was south of Ulan Bator. A cold front with waves was situated along the eastern shore of Lake Baikal and further to the south-west towards the regions of Mongolia. The front was clearly indicated in the field of weather elements. The AT850 for 12:00 on July 8, 2006 showed that the temperature contrast in the area of the front was 12 degrees at 500 km. Satellite data for 22:58 on July 8, 2006 showed that the area of Irkutsk airport was at the northern periphery of a cloud mass, in an area of thick stratified cloud cover interspersed with cumulonimbus clouds.

The actual weather and weather forecast at the destination and diversion airports:

The weather at Irkutsk airport at 15:00 on July 8, 2006: surface wind 310 degrees - 8 m/s, visibility 5500 m, weak showers, cloud cover - unbroken at an altitude of 240 m, cumulonimbus, temperature 12 degrees, dew point 11 degrees, pressure 1004 gPa, forecast for landing "without changes", friction 0.5.

Weather forecast at Irkutsk airport from 16:00 to 04:00 on July 8, 2006: surface wind 300 degrees - 10 m/s, visibility 2000 m, moderate showers, cloud cover - significant at an altitude of 150 m, cumulonimbus, turbulence - moderate outside of clouds, frequent in the layer above ground of up to 300 m, occasionally from 16:00 to 02:00: visibility 1100 m, cloud cover – significant, at an altitude of 90 m, significant cumulonimbus, cloud base 150 m.

Information from SIGMET no. 2, valid from 08:00 to 22:00 on July 8, 2006: along the flight information region (FIR) of Irkutsk the forecast was hidden storms with cloud tops of up to 390 (flight level) over the entire flight information region, shifting to the north at a velocity of 20 kph without changing intensity.

The weather at Bratsk diversion airport at 15:00 on July 8, 2006 was as follows: surface wind 300 degrees - 6 m/s, visibility 5000 m, cloud cover - complete at an altitude of 450 m, cumulonimbus, temperature 12 degrees, dew point 10 degrees, pressure 1006 gPa, forecast for landing "without changes", friction 0.6.

Weather forecast at the diversion airport of Bratsk from 16:00 to 04:00 on July 8, 2006: surface wind 280 degrees - 6 m/s, with gusts of 12 m/s, visibility 5000 m, weak showers, cloud cover - significant cumulonimbus, cloud base 180 m, complete at an altitude of 3000 m.

Weather data for flights at Irkutsk airport is provided by Irkutsk AMS, which is part of the autonomous noncommercial organization Irkutskoye Meteoagentstvo on the basis of the following:

1. Civil Aviation Meteorological Manual 95;
2. License no. R/2002/0272/100/L of August 12, 2002
3. Charter of the autonomous noncommercial organization Irkutskoye Meteoagentstvo
4. Regulations governing the Irkutsk AMS;
5. Instructions for providing meteorological data for flights at Irkutsk airport;
6. Contract no. MO-013-06.

Irkutsk airport has an airport meteorological information and measuring station (KRAMS-4) which started to operate on Dec. 1, 2003 and whose certification is valid until Aug. 9, 2011. The station is operational and tested (the certificates of inspection of the measuring instruments were valid until Nov. 18, 2006). KRAMS-4 meets the 1992 Airport Operating Standards (AOS-92) in terms of location. The meteorological equipment of Irkutsk airport includes no weather radar.

Personnel of AMS Irkutsk have undergone training during the spring-summer period of 2006. There is a record of authorization to work dated March 24, 2006.

On July 8 meteorological data at Irkutsk airport were provided by the duty meteorologist. She had access to work on the KRAMS-4. She had been working as a meteorologist for 17 years. In 2001 she graduated from Irkutsk University by correspondence course with a degree in meteorology. There was no advanced training conducted at AMS Irkutsk for weather observers.

The forecast was compiled by a category 1 weather forecaster S. She had been working as a forecaster for 24 years. She underwent advanced training in 2005 at the Irkutsk branch of the Institute of Aero navigation.

The actual weather at Irkutsk airport at 22:00 on July 8, 2006 according to LIMA, as obtained by the crew via the ATIS channel:

"Irkutsk - ATIS, information for arrival LIMA 22:00: approach LSE, VOR/DME runway 30, wet 100%, 2 mm. Friction 0.50. Transition level 1800, reference altitude 1217 m, passage of birds in the area of take-off and landing possible. Surface wind 280 degrees - 4 m/s, altitude 30 m: 280 degrees - 5 m/s, circuit: 350 degrees - 10 m/s, visibility 3500 m, weak showers, complete cumulonimbus 170, temperature 11 degrees, dew point 10 degrees, pressure 707 mmhg or 943 gPa. No major changes. There is work in progress at the threshold lip of runway 30 at a distance of 340 m, equipment at a height of 3 m."

The actual weather at Irkutsk airport at 22:30 on July 8, 2006 according to Mike information:

"Irkutsk - ATIS, information for arrival Mike 22:30: approach LSE, VOR/DME runway 30, wet 100%, 2 mm. Friction 0.50. Transition level 1800, reference altitude 1217 m, passage of birds in the area of take-off and landing possible. Surface wind 270 degrees - 4, altitude 30 m: 290 degrees - 5, circuit: 350 degrees - 10, visibility 3500 m, weak showers, 8 octants cumulonimbus at an altitude of 190 m, temperature 11 degrees, dew point 10 degrees, pressure 707 mmhg or 943 gPa. No major changes. There is work in progress at the threshold lip of runway 30 at a distance of 340 m, equipment at a height of 3 m. Please confirm receipt of MIKE information".

Note: *According to the conversion tables provided in AIP AD 1.2-1 of Russia the friction of 0.5 corresponds to "good" calculated braking effectiveness.*

At the request of the approach controller via the PA system at 22:36 (6 minutes before landing), the altitude of the cloud base was measured. The result of the measurement was 190 m.

Upon hearing the alarm signal on 22:49, the duty meteorologist carried out an extraordinary observation of the weather. The following weather was observed: surface wind: 280 degrees - 5 m/s, wind at an altitude of 30 meters: 290 degrees - 5 m/s, visibility 3500 m, weak showers, cloud cover - complete cumulonimbus, cloud base 190 m, atmospheric pressure 707 mmhg, temperature 10.7 degrees, air humidity 93%. Additional information: MKp 295 degrees, wind at the altitude of the circuit: 350 degrees - 10 m/s, friction 0.5. Forecast for approach "without changes".

According to data from the visibility detectors mounted at the threshold of runway 30 and in the middle of the runway, visibility was 4400 m - 5600 m from 22:30 until the moment of the accident. According to the Instructions for providing meteorological data for flights at Irkutsk airport, visibility is determined visually according to natural reference points if instruments set visibility at more than 3000 m. The meteorologist visually determined visibility to be 3500 m.

According to the on-board weather data, AMS Irkutsk did not receive any information about any hazardous events from airplane crews on July 8, 2006.

During the course of the 24 hours starting from 12:00 on July 8, 2006, weak and moderate showers were observed at Irkutsk airport. According to data from the observatory of Irkutsk Meteorological Office, precipitation in Irkutsk totaled 23 mm over the preceding 12 hours. Information about continuous precipitation was received from surrounding stations: "rain for 12 hours and continuing".

Specialists of Irkutsk AMS and air traffic control collaborated in a timely manner as prescribed by the Instructions for providing meteorological data for flights at Irkutsk airport and other documents regulating the provision of meteorological data for flights of civilian aircraft.

The following conclusions can be drawn from an analysis of the available material:

1. The approach to the airport and the landing of the A-310 airplane at Irkutsk airport were carried out in the area of a cold front, in the presence of cumulonimbus clouds and showers.
2. The actual meteorological conditions at the landing airport of Irkutsk coincided with the forecast. The weather forecast for Irkutsk airport given to the crew of flight no. 778 in July 2006 before departure at Domodedovo airport proved true.
3. The provision of meteorological data to Sibir airline flight C7 778 on July 8, 2006 meets the requirements of the 1995 civil aviation meteorological manual and other regulatory documents governing the provision of meteorological data to flights of civilian aircraft. The crew possessed accurate information about the meteorological conditions at Irkutsk airport.
4. The actual meteorological conditions at the time when the A-310 F-OGYP airplane was landing at Irkutsk airport did not hinder the execution of a safe landing and were not lower than the established minimum (105 x 2500 m) when approaching by LSE with a fixed approach point in the glidepath.

1.8. Air Traffic Control

As a result of an analysis of the radio exchange between air traffic controllers and the crew of the A-310 F-OGYP airplane, the following was established:

At 21:46 the airplane entered Irkutsk regional ATC airspace. The crew reported the flyover of the "LONKA" compulsory reporting point (CRP) at 11,100 m (control transfer point between civilian sector air traffic controllers of the Irkutsk and Krasnoyarsk regional centers under the unified air traffic management system [UATMS]), the estimated time of flyover at the "Razdolye" NDB of 22:26, and arrival at Irkutsk airport at 22:40 (and at the diversion airport of Bratsk). The controller from the UATMS Irkutsk civilian sector regional center confirmed to the crew the receipt of the information and communicated to them the following: “Maintain 11100 m, descend by calculation to Razdolye 5700, active runway 30”. The crew confirmed the conditions given by the controller. At 22:16 the crew reported the estimated start of descent from 11,100 m. The regional center controller allowed the crew to descend to 5,700 m. At 22:24, after the crew reported that they had reached flight level 5700 m and were flying over the Razdolye NDB (control transfer point between the regional center controller and the AppCC/ArCC (approach controller for Irkutsk airport). The regional center controller instructed the crew to transfer communication with the AppCC/ArCC to the frequency of 125.2 MHz.

At 22:25 the crew reported to the AppCC/ArCC controller that they were flying over the Razdolye NDB at an altitude of 5,700 m. The AppCC/ArCC controller communicated the location (azimuth 284 degrees, distance 79 km) to the crew and instructed them to descend to 2,100 m on the base leg of the left rectangular pattern to land from a heading of 295 degrees. At 22:33 the crew reported that they have reached 2,100 m and requested permission to approach by non-directional beacons. The crew's decision to approach by LSE was fully justified since the ILS was disabled on June 29, 2006 because of earthworks in progress at the threshold of runway 30. This information was published in NOTAM and entered in ATIS.

To control the flight on the final approach leg to runway 30, the crew could also use the VOR/DME system in addition to the LSE. The AppCC/ArCC controller checked the landing approach of the A-310 airplane on the Raduga-2 secondary radar using the Topaz air traffic display system (with range discrimination of 1000 m and bearing discrimination of 4 degrees), permitted the crew to approach according to the chosen LSE system and descend to an altitude of 900 m to the base leg towards runway 30, and communicated the pressure at the airport of 707 mmhg (943 gPa).

At 22:35, the crew reported the setting of airport pressure to 943 gPa and descent to 900 m to the base leg. At 22:36, after the crew reported that they were located at the base leg, the AppCC/ArCC controller communicated to them, as prescribed in clause 6.5.12 of the 1985 civil aviation flight operation manual, the 190 m altitude of the cloud base as clarified from the weather observer and instructed them to descend to an altitude of 850 m to the final leg: "Sibir 778, cloud base 190, descend to final 850". At 22:38 the crew reported that they were at the final leg and were at 850 m (control transfer point between the controllers of the AppCC/ArCC and ICC/ACS). The controller instructed the crew: "Sibir 778, perform final leg, work with tower on 118 point 1".

At 22:38 the crew reported to the ICC/ACS controller: "Irkutsk tower, Sibir 778, good morning, on the final leg, at the boundary point, heading 2-9-5, 850". The ICC/ACS controller notified the crew about the distance to the runway (21 km) and instructed them to continue the approach. At 22:39, the controller, on checking the approach via the controller radar, communicated to the crew the distance of 15 km and notified them that they were on final and were approaching the glidepath. At 22:40 the crew reported that they were descending, that the landing gear had been deployed and that they were ready to land. After the TCC/ASCC controller reported to the ICC/ACS controller that the paved runway was free, the latter permitted the crew to land. At a distance of 11 km from runway 30, the ICC/ACS controller notified the crew that they were somewhat left of course. At a distance of 9 km the crew was notified that they were on course. At 22:41 the ICC/ACS controller again warned the crew: "Sibir 778, distance 6, you are deviating to the right". After 26 seconds the crew reported that they were flying over the outer marker beacon (RMB). The controller confirmed that the airplane was on final.

According to his own statement, ICC/ACS the controller visually observed that, after the airplane had emerged from the cloud cover, it was following the usual trajectory without any significant deviations, when it made a slight turn to the left. The controller then noticed that the A-310 landed at the touchdown zone of the offset threshold of runway 30 and was continuing to run along the center line of the paved runway. The controller also noticed that the crew used the thrust reverser, since he saw the characteristic mist spray (particles of water) rising from the wet surface of the paved runway. While running along the second half of runway 30, approximately in the RD5 sector, the crew reported that they had landed. They then received landing confirmation from the ICC/ACS controller at 22:44 and instruction to exit the runway to the left along taxiway 6.

Note: *The SOP of Russian airlines during domestic flights provides for a "landing" report to the controller after deceleration to taxi speed.*

The TCC/ASCC controller, monitoring the movement of the A-310 along the second half of the paved runway, noticed that the airplane was running at a high velocity past taxiway 6 with the exit to the 400-meter segment of the paved runway over the threshold of runway 12 and, not slowing down, was overshooting the runway.

After the airplane collided with the barriers, and observing the explosion and outbreak of fire in the airplane, both controllers immediately reported this to the aerodrome flight operations director (AFOD).

At 22:45 the AFOD issued the alarm signal to all departments of Irkutsk airport in accordance with the notification flow chart. After checking the passage of the alarm signal, the flight operations director ordered the controller in the airport control tower to send out the initial report of the accident, and ordered the weather observer at the main observation point to compile an extraordinary observation of the actual weather.

At 22:46 the AFOD gave the command to the TCC/ASCC controller to stop releasing other aircraft, and to the ACT controller to send a telegram about the closure of Irkutsk airport for technical reasons until further notice.

At 22:49 a record of the extraordinary observation of the actual weather was drawn up in conjunction with meteorological specialists.

At 23:00, after examining the airfield together with the airport service supervisor and inspector, a record of the condition of the paved runway was drawn up.

***Note:** The pieces of rubber that had been ripped off from the tire of a wheel on the right landing gear bogie while the A-310 F-OGYP airplane was on its landing run, and were lying on the right shoulder of the runway were not found during the examination of the runway after the accident. The pieces of rubber were discovered 3 hours after the accident while the investigation team from the prosecutor's office were conducting their work.*

Analysis of the actions of the air traffic control personnel shows that the flight handling of the A-310 F-OGYP was conducted in accordance with air traffic control requirements and documents establishing the procedure for collaborating with other services during emergency rescue work.

The organization and state of air traffic handling at Irkutsk Airport Control Center comply with established requirements.

1.9. Aids to Navigation

As the A-310 F-OGYP was approaching and landing at Irkutsk airport, the following radio devices were put into service:

- OM-295: PAR-10S locator beacon;
- MM-295: PAR-10S locator beacon;
- VOR/DME: VHF omni-directional bearing station/UHF omni-directional range station;
- LB-295: localizer beacon of the landing system SP-80;
- TCC/ASCC: VHF radio station "Polyot-1";
- ORL-A: "Irtysh" radar facility;
- "Raduga-2" autonomous secondary radar (ASR);
- "Topaz-OVD" display system;
- ARDF-75 automatic radio direction finder;
- VHF radio station "Fazan5";
- "Megafon" compressor station control system (CSCS);
- AS-ATIS automated workstation (AWS);
- AS-ATIS AWS;
- "Monitor 3" AWS

There were no remarks made about the functioning of any radio equipment operating during the approach and landing of the A-310 airplane F-GOYP.

1.10. Aerodrome Information

Irkutsk airport is located on the right bank of the Angar river, in the south-eastern suburbs of the city of Irkutsk, 8 km from downtown. Irkutsk airport is a common base airport managed by the Ministry of Transport of the Russian Federation (RF Government Resolution no. 1197-56 of Oct. 28, 1994). The airport was built in 1956. It was upgraded in 1989.

The airport has Certificate of Operability no. 21, valid until July 14, 2009; MAK Certificate no. 045A-M dated July 14, 2004, valid until July 15, 2009; SSO MKpos 295° Certificate of Operability no. 111 valid until Oct. 10, 2006; and SSO MKpos 115° Certificate of Operability no. 19, valid until Nov. 11, 2008.

The airport includes the following facilities:

- **Paved runway**: measuring 3165x45m with 115°/295° magnetic landing headings, built with three layers of cement concrete and Fibercrete that is 69 cm thick, PCN 72/R/C/X/T, allows take-off, landing and taxiing of all types of aircraft, whose ACN classification code does not exceed the specified value of the PCN. The A-310-300 has ACN 51/R/C/X/T. The paved runway is a class B runway. Length under standard conditions is 2450 m.

The absolute elevation of the airport (H air) is 510.1 m.

The absolute elevation of the airport reference point (H arp) is 497.8 m.

The threshold of paved runway 12 is shifted towards the ARP by 400 m. The runway segment in front of the off-center threshold is utilized for take-off from runway 12 to the discretion of the airplane captain. The usable length of runway 30 is 2765 m.

The paved runway has hard shoulders. The runway is equipped with lights in both landing directions as part of a high-intensity lighting system.

The paved runway has a downward slope from south-east to north-west with a gradient of 0.0094, which complies with AOS-92. There are no transverse slopes.

The paved runway is part of the runway that extends crosswise for 150 m from the center line and lengthwise for 150 m from the thresholds of the runway;

- **16 taxiways** - RD1 (MRD) 2830x21m, RD2 280x21m, RD4 270x18m, RD5 270x21m, RD6 425x21m, RD7 650x21m, RD7A 64x34m, RD8 800x21m, RD9 470x14m, RD10 112x16m, RD10A 80x16m, RD11 125x21m, RD12 330x12m, RD13 250x10m, RD13A 60x10m, RD14 450x12m. The taxiing of aircraft depends on the structural properties and geometric dimensions of the taxiway and the applied load. The taxiways were built over various periods, during restoration work and ongoing maintenance;

- **Apron**, measuring 430x240m, PCN 28 R/C/X/T;

- **Aircraft parking area** with 71 spots divided into 4 blocks (near - 305x95m, middle - 250x56m, far – 485x105m, articulated – 880x100m).

Since it began to operate in 1955, the paved runway has been refurbished three times - in 1989 (reinforcement of the concrete pavement by 29 cm and lengthening by 265 m), in 2003 (lengthening by 400 m and installation of new lights).

Work commenced on July 3, 2006 to extend the runway in the south-east direction by 450 m without interrupting aircraft take-offs and landings. Information about the relocation of the threshold from the threshold of runway 30 towards the airport reference point by 340 m, the markings and information about changes in the functioning of the lights was entered in NOTAM on June 23, 2006, and continuously reported via ATIS.

The available distances at the time of refurbishment were as follows:

Runway 12 TORA (takeoff run available) – 2825m, TODA (takeoff distance available), ASDA (accelerate-stop distance available) – 3015m, LDA (landing distance available) - 2425m;

Runway 30 TORA – 2825m, TODA, ASTA – 3015m, LDA - 2425m;

Types of aircraft accepted – An-124 (with restriction), An-12, An-24, An-26, An-30, An-32, An-74, An-2, Il-96, Il-86, Il-76, Il-62, Tu-154, Tu-204, Tu-214, Tu-134, B-747, B-767, B-757, B-737, B-727, A-310, MD-82, MD-90, Yak-40, Yak-42 and all types of helicopters.

Airport description

The electrical power and lighting department (Russian acronym EhSTOP) and the Airport Service (AS), certified airport divisions with their special-purpose machines and small tools and equipment, are responsible for maintaining the airport's operational condition. The AS has 47 employees (with 95% staffing level) and the EhSTOP has 30 (86% staffing level). Work is carried out around the clock in four shifts. The friction coefficient of the runway is measured in accordance with the 1994 RF Civilian Airport Operations Guideline (CAOG RF-94) using the ATT-2 (airport surface friction tester), which was introduced into spring-summer operations on Apr. 21, 2006. According to data from the airport service, the runway friction coefficient at the time of the accident was 0.5

Every year the airport plans and carries out regular maintenance of the airport pavement within 5,000-8,000 m^2 of the asphalt surface of the taxiways, parking area and apron using workers of contractor organizations, and 100 - 140 m^2 of spalling of joints and corners of slabs, cracks, waterproofing of runway joints using AS workers. From May 15, 2006 to June 30, 2006 hole patching was carried out over 255.9 m^2 and runway joint grouting over 22,190 m (linear).

The repair was necessary because of the increased incidence level of operational damage. In addition, repairs as required were performed over the course of the year when defects that compromise flight safety were discovered.

Inspections performed

The paved runway at Irkutsk airport was last inspected in 2002 in accordance with an agreement with the federal united enterprise and scientific research and design institute of air transport "Lenaeroproekt". The inspection and analysis determined that the main types of defects that have regularly appeared over the last years of operation of the runway pavement (1998 - 2001) were as follows: network of hairline cracks, through cracks, shrinkage cracks with chipping of edges and surface scaling. The distribution of these types of defects follows no consistent pattern. The runway was visually inspected together with the ZAO "NTK Aerotexnichesky Tsentr" in March 2006.

The regular maintenance performed over the recent period to fix the spalling of joints and edges of slabs using materials such as sample blocks and quick-setting fiber-reinforced concrete generally helps maintain the required level of operating condition of the pavement surface. The visual inspection of the runway carried out by the commission on July 9, 2006 did not reveal any deviations from the requirements of AOS-92. The airport is operated in compliance with the Civilian Airport Operations Guideline issued by Order no. DV-98 of the Air Transport Department on Sept. 19, 1994 (the Record of Runway Inspection dated Sept. 9, 2006 is enclosed).

List of equipment intended for use at Irkutsk airport

№	Name of equipment and mechanisms	Year issued	Qty	Department	Condition
1.	PM-130 (ZIL-130)	1983-99	4	AS	repaired
2.	KO-713 (ZIL-130)	1989	2	AS	same
3.	VM-63 (Kraz 258)	1981,91	2	AS	same
4.	TM-59 (T-155)	1986	2	AS	same
5.	D224 (MOA3546)	1983-88	4	AS	same
6.	K-700	1985,88	2	AS	same
7.	D226 (URAL4320)	1988	1	AS	same
8.	D902 (URAL-375)	1983	1	AS	same
9.	SSU "BARS"	2002	2	AS	same
10.	D-470 (ZIL-157)	1984	1	AS	same
11.	T-170	1994	1	AS	same
12.	DZ-122 (Grader)	1988	1	AS	same
13.	PSh-120-01	2000	1	AS	same
14.	VU-1500	2001	1	AS	same
15.	**ATT-2 (semi-trailer)**	**1992**	**1**	**AS**	**same**
16.	ZSh-6 (trailer)	2001	1	AS	same
17.	PKSD-1.75 (set)	2000	1	AS	same
18.	Toyota Hiace	1993	1	AS	same
19.	K-701 loader	1991	1	AS	same
20.	VAZ-21213	2002	1	AS	same
21.	Mounted mower KRN-2.1A	2003	1	AS	same

Note: *The commission was particularly interested in the capability of the airport service of Irkutsk airport to effectively assess the condition of the runway while establishing the coefficient of friction, including at the time preceding the accident, and while making control measurements after the accident.*

It is known that in order to boost the efficiency and quality of the information obtained when measuring the friction coefficient of the paved runways to evaluate their functional properties, and to practice using methods and tools for measuring the friction coefficient in compliance with ICAO requirements (Doc 9137-AN/898 – Airport Services Guidelines), the Ministry of Transport of the Russian Federation issued Directive no. NA-30-r on January 24, 2001, recommending that heads of civil aviation organizations in 25 principal airports of the Russian Federation (Irkutsk airport is no. 4 in the enclosed list) ensure that any measuring devices available on site by 2002, of which there should be at least two, were equipped with measuring modules and to process the results of measuring the friction coefficient instead of using visual recording equipment modules. However, as the commission found out, this directive was not implemented, particularly at Irkutsk airport.

The friction coefficient of 0.50 provided to the A-310 crew in the pre-landing airport information service ATIS, as the runway condition was determined to be "wet 100%, 2mm" and as braking conditions were considered "good", was not confirmed by the result of the mathematical simulation carried *out by Airbus specialists, where the runway surface at the moment of the airplane's landing was evaluated in terms of its frictional properties as "covered with water" for at least the last 2/3 of the runway.*

1.11. Flight Recorders

The A-310 F-OGYP was equipped with a digital flight data recorder (DFDR) (part no. 10077A500-103, model 209, serial no. 156). This device was recovered from the accident site. The outside casing showed traces of soot. There was no external mechanical damage. The lead wires were cut off when the recorder was removed from the accident site. The recording was read out and the data obtained analyzed at the Interstate Aviation Commission. The last 5 seconds of data were irrecoverable, but this did not prevent the investigators from establishing the causes and development of this particular event.

The airplane's voice recorder was removed from the accident site: solid-state memory cockpit voice recorder (CVR), part no. 980-6020-001, serial no. 3644, data code 0030. The recorder had traces of soot. There was no external mechanical damage. The connector was clean.

The Interstate Aviation Commission laboratory listened to and identified the conversations of the crew. The total recording time of the last flight was 31 minutes. The quality of the recording was satisfactory. The CVR was synchronized with the decrypted recording of the DFDR and used during the investigation.

1.12. Wreckage and Impact Information

The following was established during examination of the accident site:

The airplane's center wing section was located 310 m towards the front of the threshold of runway 30, 30 m to the right of the runway center line with the magnetic heading of the construction line of the fuselage at 270°.

Fragments of the fuselage from bulkheads 1 to 39 had major mechanical and heat damage. Some fragments were destroyed by the fire.

Fragments of the forward section of the fuselage were shifted 7 meters to the right of the fuselage's construction line during the emergency rescue work. The original location of these fragments was impossible to determine.

The nose landing gear was separated from the fuselage, had mechanical deformation and traces of the effects of high temperature. The shock-strut piston was beside it, separated from the strut frame. The wheels were attached to the axle, and the tires were almost completely burned off.

Part of the fuselage from bulkhead 39 to bulkhead 63 had significant fire damage. The cabin floor covering and the upper and left sections of the fuselage were destroyed by the fire. The skin of the right cabin above the construction line of the fuselage was cut off during emergency rescue work. The right (above-wing) emergency door was in the open position.

The main gear legs were separated from the center wing section, and were located to the left of the center wing section, have significant damage and traces of the effects of heat.

The wheels were attached to the axles, but the tires were damaged by the fire and were deflated.

The brakes were attached to the axles of the landing gear bogie and were not destroyed.

The left half wing was located separately from the fuselage, was lying on the roof of a garage perpendicular to the center wing section. There was damage from the pylon to the wingtip. The root had melted. The flaps and slats were at full down. The spoilers were at full up. The inner screw starter of the inner flap was separated from the wing and was lying nearby under the wing. There was damage on the forward edge of the tail section of the wing, as well as the second and third segments of the slats as a result of the collision with the barriers.

The right slat was attached to the center wing section and was lying on a garage roof. There were traces of explosion on the midsection of the wing. The flaps were at full down. The midsection of the flap was damaged during the fire. The spoilers were at full up. A large part of the slat cannot be found on site as a result of the explosion and fire in this part of the wing. The remaining part was at full down and was partially damaged by the fire. The wingtip was separated from the wing and was on the ground.

Engine no. 1 was attached to the wing. The midsection of the engine was damaged during the collision with the barrier. 37 of the 38 fan blades exhibited transverse airfoil fractures inboard of their mid-span shrouds. The blade fragments that remained in the fan hub were bent and exhibited leading edge damage consistent with hard object impact. Fan cowl flaps were missing. Reverser doors were ripped off the engine and were lying five meters behind the engine. The right side of the engine had traces of the strong effects of heat caused by the fire.

Engine 2 was separated from the pylon and was laying upside down approximately 80º in relation to the construction line of the airplane's fuselage, four meters from the door of the rear baggage hold. The forward section of the engine was damaged during the collision with the barrier. 16 of the 38 fan blades exhibited transverse airfoil fractures with the remaining blades still being full length. The blade leading edges exhibited less damage than those of the no. 1 engine. The blade airfoils were bent both with and against the direction of rotation. The reverser doors were mounted on the engine and were in "forward thrust" mode. The engine was damaged by high temperatures caused by the fire.

Note: *The characteristic damage to the fan blades of the no. 1 engine combined with the presence of foreign objects in the visible part of the air flow duct was indicative of the engine fan rotor turning at the time of its destruction* *and collision with the barriers. The characteristic damage to the fan blades of the no. 2 engine was indicative of that engine having a lower fan rotational speed as compared to no. 1 engine during its impact sequence.*

Part of the fuselage from bulkhead 63 to bulkhead 72 had significant fire damage. The upper part, the baggage compartment, was intact.

Part of the fuselage from bulkhead 72 and further, including the tail assembly, was completely intact.

The rear right door was open. The escape chute was attached to the door, folded and unreleased. The door opening lever outside was in the open upper position.

The rear left door was open. The escape chute was attached to the door aperture, ejected and released. Most likely the chute was damaged as it was released as a result of contact with sharp objects on the ground. This was confirmed by the presence of punctures holes in it.

The rear kitchen shows traces of fire, but some parts of its structure were in their proper place and have remained in a satisfactory condition. There were containers filled with flight meals that were secured in their proper locations.

The doors of the rear toilets were closed and were charred.

The door of the tail cargo bay was open. The bay was in a satisfactory condition.

The fin had no visible damage or traces of fire. It was located in its proper place in the assembly with the tail section of the fuselage.

The rudder was in its proper place, somewhat shifted to the right. There was no visible damage or any traces of fire.

The horizontal tail assembly was attached to the fuselage. The stabilizer had shifted 5º downwards. There was no visible damage or any traces of fire. The elevator was bent downwards. The right half of the stabilizer was touching the wing located in the immediate vicinity of the building.

Note: *The central engine control console as well as the resolver and the microswitch unit of the right engine were recovered later after all the wreckage had been inspected and evacuated to the hangar. The resolver and the microswitch unit of the left engine were not recovered. Refer to chapter 1.16.6 for results of the central engine console examination.*

1.13. Medical and Pathological Information

1.13.1. Medical information

An analysis of available documents showed the following:

The pre-flight medical examination of the crew was conducted at the medical station of Domodedovo airport on July 8, 2006, after which both pilots were authorized to fly.

According to an analysis of available information, over the last 2 years, the Captain underwent medical examination by the physical evaluation board of the medical unit of the federal state unitary enterprise of Irkutsk airport (referred to hereinafter as PEB MU): on July 30, 2004; December 24, 2004; and December 23, 2005.

The following illnesses were discovered: hypertensive disease stage 1, level 1 (arterial blood pressure 145/90); "transient atypical Wolff-Parkinson-White syndrome", chronic adenomatous prostatitis in remission.

As per Article 20.2, 38.2 para. II of the 2002 Federal Civil Aviation Rules of Medical Examination ("FCARME-02"), the Captain was deemed fit to fly as a pilot, provided the functional integrity of his cardiovascular system was maintained.

He did not fall ill during the period between examinations and did not suffer any trauma. An airline physician examined him every three months. Arterial hypertension was under control because of he was regularly taking hypertensives (Diroton 5 mg 1x day, Hypothiazid 12.5 mg 1x day). Objective indicators of health remained stable for some time.

In preparing for a periodic examination on December 21, 2005, a routine tomoscintigraphy of the myocardium (radioisotopic examination of the heart) was carried out with physical exertion. There were no disturbances discovered in the myocardial perfusion of the left ventricle. The veloergometric test was negative.

Based on conclusions from results of an experimental psychological examination carried out on June 18, 2004 in accordance with recommendations of the RF Ministry of Transport in 2001, the examinee had a high level of principal psychophysiological functions. A high level of performance capability, stability of attention, above-average ability to shift gears and attention span, good short-term and operative memory, normal levels of logical and analytical functions were also observed. Personality test data showed no signs of mental instability. He had a high level of self-control and a sense of socially significant norms and values.

In undergoing conversion training on the A-310 airplane, as noted in documents, The Captain was examined by the Sibir company psychologist in Moscow on Jan. 21, 2005, where the high level of his ability to shift gears, the span and focus of attention, his short-term and long-term memory, and quick assimilation of new information were also established. The following personality features were observed: stress tolerance, self-confidence, positive self-assessment, marked sense of duty.

Over the last two years, the co-pilot underwent medical examinations by the PEB MU FSUE Irkutsk airport three times:

Results from the PEB of June 2, 2004: clinical diagnosis: cardiac type of neurocirculatory dystonia. Varicose disease of the left lower limb. Chronic venous insufficiency stage 1.

As per Art. 19.2, 36.2 para. II of the FCAMCR-02, he was considered fit to fly as a pilot. Recommended to undergo surgical treatment during the period between physicals (phlebectomy), which he did on Nov. 4, 2004.

PEB on Dec. 6, 2004: clinical diagnosis: cardiac type of neurocirculatory dystonia.

As per Art. 19.2, para. II of the 1992 FCAMCR, the co-pilot was considered fit to fly as a pilot.

PEB on Dec. 9, 2005: clinical diagnosis: arteriosclerosis of the aorta. Second degree hepatic steatosis without obstructions in liver functions. First degree hypothyroidism without obstructions in functions of the thyroid gland. Excess body weight.

As per Art. 21.2, 24.2 para. II of the FCAMCR, he was considered fit to work as a pilot, provided functional integrity of his cardiovascular system was maintained.

While undergoing conversion training on the A-310 airplane, the co-pilot was examined by the Sibir company psychologist on Jan. 21, 2005. A high level of the principal psychophysiological functions (capacity to switch gears, span and focus of attention, assimilation of new information, short-term and long-term memory), and a normal level of logical thinking was established. He was characterized by a developed sense of self-control, independence, ability to mobilize to perform tasks, accuracy and rapidity of orientation and decision-making in extreme situations.

The A-310 Captain and the co-pilot underwent the non-stationary examination by the airline physician in due course during the period between physicals. No traumas, acute diseases, work disabilities or deviations from established health requirements were discovered.

Based on their registered place of residence, the Captain and the co-pilot were assigned to the hospital of the MU FSUE at Irkutsk airport (with Maski insurance policies). They did not seek medical assistance in any other medical institutions of the city of Irkutsk over the last two years.

Note: *In the Captain's medical record, because of the presence of a series of entries requiring commentary, including the removal of the Captain from flight duties, as well as the need for additional analysis of the relevance of the recommendations of the airline psychologist on the basis of the Captain's test* *results (in connection with his assignment to undergo conversion training on the A-310), the Commission decided to carry out additional analysis of available information. The results of the additional analysis and expert opinion are presented in sections 1.18.4 and 1.18.5 of the Report.*

1.13.2. Results of pathological and anatomical examinations

Based on the conclusion of forensic medical examination no. 86/75 of Aug. 20, 2006, the Captain died from the onset of acute carbon monoxide poisoning. The concentration of carboxyhemoglobin in his blood was 75%. No alcohol or narcotic substances were found in the deceased's body.

Based on forensic medical examination no. 105 of July 25, 2006, the death of the co-pilot was due to acute carbon monoxide poisoning resulting from the inhalation of combustion gases and acute oxygen insufficiency in the inhaled air. The concentration of carboxyhemoglobin in his blood was 30%. No alcohol or narcotic substances were found in the deceased's body.

1.14. Survival Aspects

Both members of the flight crew died as a result of the accident. The causes of death are indicated in the preceding section.

Of the 6 members of the cabin crew, 3 flights attendants died, and 3 received various types of physical injuries as a result of the accident.

Of the 3 flight attendants who died, only one was identified at the time of completion of the investigation. Forensic medical experts concluded that one died from acute carbon monoxide poisoning. The concentration of carboxyhemoglobin in her blood was 85%. The three unidentified flight attendants, died as a result of acute carbon monoxide poisoning.

Based on the results of the forensic medical examinations presented to the commission, of the 120 passengers who died, 119 died as a result of acute carbon monoxide poisoning in conjunction with oxygen insufficiency in the inhaled air (in one case, the poisoning was accompanied by trauma to the skull and brain) and one female passenger died from severe trauma combined with burns to the body.

Of the 75 passengers who survived, 60 were hospitalized; 38 of the 60 received serious physical injuries and 22 minor injuries. Fourteen passengers refused medical assistance.

The 60 who were injured were brought to medical institutions in Irkutsk, and 8 of these were consequently transferred to Moscow hospitals. Of this number, 23 individuals who had suffered mechanical traumas were subjected to the effect of high temperatures and carbon monoxide poisoning. Thirteen individuals suffered carbon monoxide poisoning and eight received heat burns.

1.15. Fire

Based on the documents made available to the commission and the testimonies of officials and eyewitnesses to the accident (including passengers on this airplane), the circumstances surrounding the onset and development of the situation that arose on board the airplane after it rolled off beyond the runway and collided with the barriers were established, an approximate diagram of how the fire broke out and spread in the airplane was drawn up, the use of on-board emergency and rescue equipment and the actions of the cabin crew to evacuate passengers were evaluated, and the actions of the emergency rescue and fire services at the accident site were assessed.

At the time of the airplane's collision with the barriers (reinforced concrete airport boundary fence and stone garages) there were 9,300 kg of TS-1 aviation fuel (including 0.8 t in the center wing section and 2.4 t in the inner wing tanks), as well as hydraulic fluid from the hydraulic system, oxygen system and electrical batteries.

The airplane was not de-energized before the collision. The airplane's forward velocity was significant (at the time it slid off the runway its speed was 180 kph).

The airplane caught fire at the moment the nose section of the fuselage hit the barrier (22:44:40). The fire gained strength as the fuel pipes were destroyed when the left section of the wing broke off from the center wing section.

The airplane was de-energized about 5 seconds after the collision, which extinguished the lights in the passenger cabins.

Aviation fuel spilled under the fuselage and inside it, under the floor and inside the passenger cabin. This facilitated the rapid spreading of the fire along the entire length of the airplane.

Entry doors (forward left and right) and a section of the skin were destroyed. A powerful fire centre formed under the floor of the entrance way.

The flight attendant, who was responsible for the left entry door, was separated from the passengers by the destroyed structure of the fuselage and the fire. The floor under her was destroyed and she was suspended by her fastened seat belts. After unfastening the belts, she fell to the ground from a height of about 3 m, and received burns to her arms and legs. She did not take part in the evacuation of passengers. The flight attendant who was sitting by the right door and was in the area where the fire broke out, died, most probably during the first seconds after the onset of the fire because of "acute carbon monoxide poisoning", as the forensic medical examination concluded.

This means that the forward entry doors were not used to evacuate passengers.

The central emergency exit doors were served by two flight attendants.

The left door could not be opened since a powerful fire centre with a very high temperature had formed under it. Another flight attendant died here.

The right door was opened by another flight attendant, ensuring the evacuation of passengers on to the right wing which was on the roofs of the garages.

The exits in the tail section of the airplane were served by two flight attendants.

The right rear door and flight attendant, who was sitting near it, ended up being blocked by metal food containers that had fallen as a result of the airplane's collision with the barriers.

The flight attendant who opened the left rear door released the emergency inflatable escape chute, thus ensuring a route for evacuating passengers.

The inflatable chute opened but was damaged by sharp metal objects on the ground and lost its load-bearing capacity.

Another flight attendant, after freeing herself from the metal containers, helped in the evacuation of passengers through the left rear door.

Another flight attendant, while helping passengers inside the cabin, died from acute carbon monoxide poisoning.

Some passengers from business class and the first compartment of the economy class evacuated through gaps that formed along the right sidewall of the fuselage as a result of its deformation.

The relentless spread of the fire in the lower section of the fuselage and along the skin of the upper part of the passenger cabins, the high concentration of combustion products, the smoke, darkness and panic that broke out among passengers greatly hindered the evacuation of passengers.

It was established that from about 22:44:45 to 22:45:50 67 people were evacuated by members of the cabin crew.

During the course of the investigation it was established that the fire and rescue detail of airport fire vehicle AA-40(43105)-189, located with the fire vehicle beside the emergency rescue station (ERS) building off to the side of the paved runway, noticed the irregular behavior of the A-310 airplane (movement at high velocity) during its landing run after touch-down.

The chief of the fire and rescue service detail AA-40(43105)-189 decided to follow the airplane on the fire vehicle and approximately at 22:44 commenced moving after notifying the controller/observer of the departmental fire brigade (DFB), who was at the observation point (crash and rescue station tower), by radio about his decision.

The DFB controller/observer, following the movement of the airplane along the runway using binoculars and after seeing the airplane's collision with the barrier and the outbreak of fire, gave the alarm command at 22:44:50 to the DFB duty shift, indicating in the process the accident site and the type of airplane.

At 22:45:00 the fire vehicles on duty started to leave the crash and rescue station (CRS) bay to head for the site of the accident.

At intervals of 3-5 seconds the following departed for the accident site which was 1,557 m from the CRS: AA-60 - 2 vehicles, AA-40 (131) - 1 vehicle with crews of 17 fire rescuers.

All in all 4 fire vehicles were sent to undertake crash and rescue work with the following total reserve of fire-extinguishing mixture: water – 30,000 l, foaming agent – 2,200 l and 19 firemen.

Note: *The crash and rescue work evaluation team determined that crash and rescue support for flights at Irkutsk airport was provided by the regular flight search and rescue service (FSRS) and by freelance crash and rescue teams (CRT). FSRS had 73 regular employees in its roster and 63 actual employees (86.3%). FSRS includes the departmental fire brigade (DFB) with 62 employees (86.1% from the personnel pool) who had the following firefighting equipment and gear:*

Airport fire vehicles – AA-60 (7313)-160.01		*- 1 unit*
	AA-60 (7310)-160.01	*- 1 unit*
	AA-40 (131) - 139	*- 1 unit*
	AA-40 (43105) – 189	*- 1 unit*
Compressed air apparatus	*ASV-2*	*- 13 units*
Fire proximity suits		*- 8 units*

and other property and equipment prescribed by regulatory documents.

The number of regular fire and rescue service details, the number of airport fire vehicles, and the number of fire-extinguishing substances taken by them, the freelance details of the crash and rescue team on watch met category 8 of the required fire protection level (RFPL).

The crash and rescue support for flights at Irkutsk airport had Certificate of Conformity no. 2051041662, issued by the Transport Safety Administration (TSA) of FTOA and valid until Dec. 30, 2006.

Rescuers from the federal state institution "Irkutsk regular search and rescue base" (RSRB), based at Irkutsk airport, were also called to carry out crash and rescue work.

At 22:44:50 the alarm command was given by the flight director of Irkutsk airport, with notification of officials and departments, according to the notification flow chart.

After receiving the alarm command, the chief of crash and rescue work - shift director of operational control of Irkutsk airport - decided and gave the command to deploy airport crash and rescue details to the site of the accident.

72 freelance CRT rescuers and 24 special-purpose vehicles were deployed. Airport CRT details arrived at the scene of the accident at 22:47.

At 22:45:50 fire vehicle AA-40(43105), which had followed the airplane, arrived at the scene of the accident and began extinguishing the fire on the airplane using mechanical foam generated from a mounted gun barrel.

Starting from 22:46:10 and in intervals of 5 seconds, fire engines AA-40(131), AA-60 - 2 arrived at the scene of the accident and started to extinguish the fire and rescue passengers.

The distance from the fire centre to the fire vehicles and the presence of obstructions hindered the use of the mounted gun barrels. For this reason, the hose line deployment method and hand fire hoses were also used to extinguish the fire.

At 22:46 the RSRB rescue detail with 3 rescuers arrived on a GAZ-66 vehicle and started rescuing passengers. They were later joined by 6 RSRB rescuers and the CRT detail from the aviation engineering department.

DFB firefighters opened the right rear door from the outside and, using a three-section fire ladder, allowed rescuers to reach the interior of the tail section of the fuselage.

The rescue of passengers continued **until 22:50** and stopped because of the powerful flames inside the cabin of the airplane.

A total of 11 people were rescued through the efforts of the DFB firefighters, RSRB rescuers and the CRT detail of the aviation engineering department.

To prevent outsiders from reaching the scene of the accident, the senior officer of the internal security guard at Irkutsk airport installed cordons at 22:47.

At 22:50 partner organizations started to arrive at the scene of the accident. These included:

- MES: 18 fire vehicles and 80 rescuers, 14 fire tank trucks and 8 pieces of special-purpose equipment;
- Accident-related medical assistance: 2 vehicles and 6 doctors;
- First aid: 8 vehicles.

The fire on the airplane was extinguished at 1:05 on July 9, 2006.

In summary:

1. Members of the cabin crew (flight attendants) were located inside the airplane according to the Emergency schedule of actions of crew during airplane take-off and landing.

At the time of the airplane's collision all members of the cabin crew were in their seats with their seat belts fastened.

Members of the cabin crew who were inside the airplane cabins in a state of work preparedness ensured the commencement of evacuation of passengers right after the airplane collided with the barriers.

The actions of the able-bodied members of the cabin crew who were inside the airplane cabins allowed the evacuation of 67 people from the burning airplane within the shortest time in the fast-moving and extreme situation that arose.

2. The actions of the fire and rescue details of the departmental fire brigade of the flight search and rescue service, freelance crash and rescue teams, their personnel, the supply and quantity of fire-extinguishing agents, the time of deployment at the time of eliminating the consequences of the accident met the requirements of the 1992 Guideline for the Civil Aviation Flight Search and Rescue Service (GFSRS CA-92) and ensured that 11 more people were rescued despite the rapidly developing situation.

3. The total number of individuals evacuated from the burning airplane was 78 (75 passengers) out of the 203 individuals on board.

1.16. Tests and Research

1.16.1. Full-scale experiment

During the course of the investigation Airbus specialists performed a full-scale experiment (run-throughs on the paved runway) to determine the longitudinal deceleration load under which the accidental forward movement of the throttle control lever was possible, thereby increasing forward thrust. The experiments were performed on an aircraft with P&W 4000 engines with its friction units removed. The force needed to propel one throttle control lever was less than 400 grams. The run-throughs were performed on runways at the Airbus base in Toulouse.

The results of the experiment show that the magnitude of longitudinal deceleration load whereby the accidental forward movement of the throttle control lever commences is of approximately 0.25 g. If the rate of deceleration was maintained, the throttle control lever would continue to move at a continuous speed, non-stop. These results and a comparison of recordings of the longitudinal load and positions of the throttle control lever of the left engine during the accidental flight allow us to conclude that, even during the complete breakdown of the friction unit that provides additional forces in the control linkage, the accidental movement of the throttle control lever was impossible in practice.

1.16.2. Mathematical simulation

A mathematical simulation was carried out in order to analyze the correct functioning of the aircraft and engine systems, to determine the actual deceleration conditions on the runway, and to assess the effect of any external distortions and possible scenarios of the development of events.

As a result of a reconstruction of the accident flight, it was established that the thrust of both engines, as recorded by the FDR as the airplane was on its landing run along the runway, corresponds to that calculated for the recorded position of the throttle control lever/reverse thrust lever and the actual conditions at Irkutsk airport.

Seven seconds after the main landing gear touched the runway, the LOW braking mode automatically switched on. This facilitated the preset deceleration gradient of 1.7 m/s*s until the crew applied the brakes to manually slow down the wheels.

The actual coefficient of friction (deceleration) on the runway segment where the crew forcibly (non-automatically) applied the brake (~2000 m) corresponded to standard values for a runway "covered with water". It was impossible to determine the condition of the initial segment of the runway because of the use at this stage of automatic brakes in LOW mode where an airplane is slowed down at a given rate under any runway condition (“wet” or “covered with water”).

Aside from the reconstruction of the accident flight, the following scenarios were also simulated (elements whose effect was assessed in every instance are highlighted in bold italics):

№	Scenario	Engine 1	Engine 2	Deceler.	Spoilers	Condition of runway
1.	Condition of runway "WET", remaining parameters similar to those on FDR	FDR	FDR	FDR	FDR	***WET***
2.	No forward thrust of left engine	***idle***	FDR	FDR	FDR	actual
3.	Same as no. 2 but with spoilers until full stop	idle	FDR	FDR	***until full stop***	actual
4.	Both TCL on idle, without thrust reverser, spoilers until full stop	idle	***idle***	FDR	until full stop	actual
5.	Same as no. 4 but with automatic deceleration in LOW mode until full stop	idle	idle	***in LOW mode until full stop***	until full stop	actual
6.	With maximum thrust reverser of right engine until 80 knots then idle, without forward thrust, spoilers and deceleration same as those on FDR	idle	***Max Rev & Reverse Idle***	FDR	FDR	actual
7.	***All as per flight manual***	idle	Max Rev & Reverse Idle	in LOW mode until full stop	until full stop	actual
8.	***As in the accident flight until 22:44:18, then left TCL on idle and repeated activation of thrust reverser of right engine***	As per FDR, idle from 22:44:18	As per FDR, ***Max Rev*** from 22:44:18	FDR	As per FDR, repeated release from 22:44:18	actual

Here are the brief results of the analysis of each of the above scenarios[3]:

1. If the coefficient of friction (deceleration) corresponded to the "wet" condition of the runway, the airplane would have stopped 700 meters before the end of the runway even given the actual forward thrust of the left engine, which was caused by the significantly larger (about 3 times) magnitude of the friction coefficient for the "wet" runway condition compared to a runway "covered with water" at speeds of about 150-180 kph, at which the airplane trim occurred on its accident flight landing run.
2. If the left engine had remained on idle mode, then, given the actual condition of the runway, the recorded reverser mode of the right engine, deviations of the spoilers and deceleration, the airplane would have stopped 500 meters before the end of the runway. It should be noted that this scenario is clearly hypothetical since, given the position of the left TCL on idle mode, the spoilers would have been in the extended position.
3. If the left engine had remained on idle mode and the spoilers had been released before stopping, then given the actual condition of the runway, the recorded reverse mode of the right engine and the deceleration, the airplane would have stopped 900 meters before the end of the runway.
4. This scenario is a complete repetition of the preceding one except for the use of the reverser on the right engine (where the reverser was not used), which allowed us to assess the effect of the thrust reverser that was actually applied along the length of the landing run. The airplane stops 800 meters before the end of the runway, that is, the length of the landing run increases by 100 meters because the reverser on the right engine was not utilized.
5. This scenario imitates normal landing using the automatic brake in LOW mode and spoilers until full stop without using the thrust reverser on the right engine. The airplane stops ~800 meters before the end of the runway, that is, the actual landing run distance is ~1700 meters.
6. This scenario allows us to assess the effect of the thrust reverser on the right engine when it is used in strict compliance with the flight manual recommendations. The procedure for using the brake and spoilers is similar to that in emergency flights. There is no forward thrust of the left engine. The airplane stops ~700 meters before the runway threshold that is, compared to scenario no. 2 the difference is 200 meters.

[3] Simulation and analysis were carried out only to determine actual landing run distances. The airplane's possible movement in the track channel was not considered.

7. This scenario imitates normal landing in the form in which it was conceived by the crew, provided flight manual recommendations are strictly adhered to in the application of different braking mechanisms. It was established that the actual rolling distance in this case would have been ~1550 meters, that is, the airplane could safely land, even given the actual condition of the runway at Irkutsk airport (covered with water).
8. This scenario shows that, after the co-pilot had reported that “the RPM’s are increasing” if the crew had moved the TCL of the left engine back to idle and applied the reverser again (in this case the spoilers would also have been released automatically), then the overrun speed would have been around 70 kph.

Also the very last occasion when the crew would have been able to stop the airplane on the runway was determined by moving the left throttle lever back to idle and applying the reverse thrust of the right engine once again. This occurred et 22:44:16, which means that the crew had more then 25 seconds to diagnose the irregular situation (from the moment the throttle control lever of the left engine started to be moved).

1.16.3. Analysis of materials from previous research work to determine the friction coefficient of a runway with various surface conditions

This series of investigations was conducted in 1986 when analyzing the reasons why an Il-86 overshot as it landed on a runway covered with water. The investigations were carried out at the State Scientific and Research Institute of Civil Aviation (SSRICA). Report No 1.01.02.189 was drawn up and approved on Sept. 17, 1986 based on the results of the investigations.

The results of these investigations showed that with a layer of water on the runway the measured ATT-2 friction coefficient did not typify the actual runway surface friction. It was established that during landings of an Il-86 on a runway covered with water, the average friction coefficient was approximately four times lower than that measured by corresponding airport instruments, and at speeds of 100-200 kph these differences could even be 5-6 times higher.

The above-mentioned magnitudes correlated well with the results of investigations carried out to study the accident in question. Given a measured friction coefficient of 0.5 and the good braking conditions reported, based on this coefficient, the simulation of the emergency landing showed that the actual friction coefficient for speeds of 150-180 kph was ~0.1, which corresponds to braking conditions on a runway "covered with water".

1.16.4. Assessment of forces needed to move the throttle control lever

As part of the commission's work the forces required to move the TCL of engines on some A-310 airplanes with P&W and GE engines were measured.

The investigations showed that, in GE engines that had a fully mechanical control linkage, the magnitude of forces was no less than 2 kg for every TCL.

The picture was significantly different on P&W 4000 engines equipped with FADEC computers. The mechanical part of the control cable for these engines (before FADEC) is short enough and has its own friction of the order of 350-400 grams for every TCL. The standard magnitudes according to section 76-11-00 of the A-310 airplane maintenance guide lie in the 1.17 – 1.54 kg range, and the difference in forces between the left and right TCLs should not exceed 110 grams. To adjust the forces, the control cable has an additional friction unit. The forces are adjusted by changing the tightness of the friction unit. Existing technical maintenance documentation (MPD) does not provide for the periodic inspection and adjustment of the forces. This work is carried out irregularly upon requests of flight crews whenever they feel uncomfortable in controlling throttles. There was no such record found in the log book of the airplane involved in the accident.

The table below shows the results of the control measurements made on the fleet of the Uzbekistan Havo Yullary airline:

REG.	SER №	Date of manufacture	A/C FH	A/C FC	Forces required to move left/right TCLs	Forces required to move left/right TCLs after adjustment
UK 31001	574	1991	51986	12307	0.54/0.4	1.32/1.32
UK 31002	576	1991	53508	12730	0.38/0.55	1.41/1.45
UK 31003	706	1998	30757	6301	1.04/1.09	1.32/1.32

According to the logbooks of these airplanes, no inspection or correction of the friction forces was carried out on them before the investigations following the F-OGYP accident. It should be noted that the friction forces decreased on the "old" airplane in this fleet (1991) to a level corresponding to the inherent friction on the mechanical part of the control linkage for engines (without the friction unit). The commission does not have other official information on actual friction forces of other airplane because in the course of the investigation Airbus failed to comply with the relevant request to carry out a one-time inspection of its fleet of airplane.

Note: *According to EASA regulations a complete fleet inspection is launched when there is a continuous airworthiness concern, but low friction forces in* *throttle control linkage are not considered to be an airworthiness issue as changes are felt by pilots on a daily basis and there are no hidden abnormal conditions.*

1.16.5. Results of investigations made on engine control computers (FADEC)

As a result of a study of the information stored in the non-volatile memory of the computers controlling the left and right engines that were dismantled at the scene of the accident, it was established that:

- during the accident flight, both engines worked in accordance with the commands given by the position of the corresponding TCL;
- there were no signs that the fuel supply to the left engine was shut down using the high-pressure shutoff valve;
- it was impossible to determine whether the high-pressure shutoff valve of the right engine was used;
- three reports about errors recorded by the FADEC of the left engine at the flight level (altitude of 37,415 feet; Mach 0.8) were related to the functioning of the internal system measuring the quantity of fuel supplied and could not affect the outcome of the flight;
- a report about a surge-type error recorded after the airplane overshot the runway at Mach 0.11-0.12 at an altitude of about 2000 feet was most probably related to the destruction of the left engine as a result of its collision with obstructions on the ground;
- there were no reports of any faults in the right engine FADEC during the accident flight.

1.16.6. Results of examining the engine control console

An inspection of the engine console showed that it was heavily deformed and damaged and partially burnt. All the remaining couplings were tightened and locked. Both links from the reverser levers to their crank gears were damaged and deformed at least twice and in opposite directions. The fractures observed on both links were in static mode and due to dynamic load. The rivets from the left cam to the crank assembly were broken and therefore the left cam was free in movement. The speed brake lever was bent to the right as well as the dynamometric rods. The major part of the throttle levers was burnt. The surviving parts of the throttle levers with the rockers were deformed in the opposite direction to the speed brake lever.

After the melted aluminium parts were removed, it was observed that:

- The connection of the left crank to the cam was broken. The position of the left crank corresponded to left cam position between "idle" and "rev idle".

- The position of the left throttle corresponded to a reverse lever somewhere in upward position as the throttle rocker was on stop position (blockage of the throttle).
- The position of the right crank was not broken and corresponded to close to full forward thrust). The right throttle rocker had no more physical link with its crank.

Following conclusions were made as a result:

- The examination showed incoherent information between the positions of the cranks/cams and the positions of the throttle rockers.
- On the base of this analysis and due to the state of the components, additional examination would not allow revealing reliable information about the possible positions of the throttles and reverser levers at the time of the accident.

1.17. Information on Organizations and Management

OAO Aviakompania Sibir

OAO Aviakompania Sibir was the operator of the A-310 airplane F-OGYP and holds operator license no. 31, issued by the FTOA of the RF Ministry of Transport and valid until March 21, 2007.

The founder of the OAO Aviakompania Sibir was the Committee for the Management of the State Property of the Novosibirk oblast. The registered office of the founder is: Krasny prospect 18, Novosibirsk, Russia 630011. The postal address of the airline is: OAO Aviakompania Sibir, Ob-4, Novosibirskaya oblast, Russia 633104.

The airline was licensed by the FTOA of the RF Ministry of Transport to operate Russian-made and Western-made aircraft. At present the airline operates Tu-154M, Il-86, B-737-400-500, A-310 and A-319 aircraft. The B-737, A-319 and 6 A-310 aircraft are registered in Bermuda, while 2 A-310 aircraft are registered in France.

The airline had 896 flight crew personnel among a total number of employees of about 4,500 (S7 group of companies).

In March 2006 the West Siberian State Aviation Inspection Authority of the FTOA of the RF Ministry of Transport carried out a certification inspection of how the airline was conducting its activities and ensuring flight safety. The conclusions based on the results of the inspection were on the whole positive. An action plan to eliminate deficiencies was available.

An agreement was signed for an official IOSA audit in September - December 2006.

ANTO ATC Aviakompania Sibir

Flight and cabin crews are trained at the autonomous non-commercial training organization " Sibir Aviation Training Center " (ANTO ATC), which had training center license no. 053 issued by the Federal Transport Supervisory Authority of the RF Ministry of Transport on Oct. 14, 2004.

***Note**: Flight crew training was also provided at approved training centers for aviation personnel based on procedures established in the Russian Federation:*

- *Aviation Training Center of Tunisia;*
- *Flight Training Center of Emirates;*
- *Lufthansa Flight Training;*
- *Air France Crew Training Center;*
- *United Airlines Flight Training;*
- *Airbus Training Center (Toulouse).*

Co-operation with foreign training centers was carried out on a contractual basis.

The teachers are the Sibir ATC instructor teams, Lufthansa and the Airbus Training Center who are authorized to conduct initial training.

The conversion training courses for flight and cabin crews were developed in accordance with IOSA standards and were approved by the state civil aviation administration of the Russian Federation.

The entire instructor team invited to train aviation personnel went through the corresponding training at foreign aviation centers following the training courses of such aviation centers.

OOO S7 ENGINEERING

OOO S7 ENGINEERING provides maintenance support for Sibir airplane.

OOO S7 ENGINEERING was created as a maintenance and repair organization on Jan. 20, 2006.

The field and place of operational activity of the maintenance and repair organization was validated by license no. 2021060276 from Russian aviation authorities dated Apr. 13, 2006, license no. EASA 145.0130 from European aviation authorities dated March 16, 2006 and license no. BDA/AMO/265 from Bermuda aviation authorities dated Apr. 6, 2006.

OOO S7 ENGINEERING was entitled to carry out the following types of maintenance:

- on A-310 airplane with PW4000 and CF6-80C2 engines (**fine** maintenance checks: PF (Preflight Check), DLY (Daily Check), S (Service Check), **periodic** maintenance checks: A-CHECK, 2A-CHECK, 3A-CHECK, 4A-CHECK, G-CHECK, 2G-CHECK, 3G-CHECK, 4G-CHECK as per the Aug. 9, 2005 program);

- on A-319/320/321 airplane with CFM56 engines (**fine** maintenance checks: T (Trip Check), Z (Daily Check), S (Service Check), **periodic** maintenance checks: A-CHECK, 2A-CHECK, 3A-CHECK, 4A-CHECK as per the Apr. 29, 2004 program);
- on B737-300/400/500 airplane with CFM56-3C1 engines (**fine** maintenance check: TR (Transit Check), DY (Daily Check), **periodic** maintenance check: A-CHECK, 2A-CHECK, 4A-CHECK, 8A-CHECK as per the Sept. 21, 2005 program);

The volume of job types was specified in the organization's Activity Guideline and corresponds to the reported field of activity. The actual performance of the reported types of jobs was confirmed in accounting records of the aviation engineering service.

The operator's structure, management and records correspond to the requirements of the federal aviation rules entitled "Certification requirements for commercial civil aviation operators. Procedures for certification", section 3, approved by Order no. 11 of the RF Ministry of Transport of Feb. 4, 2003 and JAR-OPS Part M.

S7 Engineering also had its own line stations at the airports of Tolmachovo and Irkutsk that performed fine maintenance checks.

1.18. Additional information

1.18.1. Characteristics of the operation of A-310 airplane by Sibir

In accordance with the 1998 Rules for Investigating Accidents and Incidents (1998 RIAAI), issues concerning the flight and technical operation of A-310 airplane by Sibir were studied and analyzed. The result of this work was the corresponding report which describes several features of the operation of A-310 airplane by the airline. The content of this report can be found below.

Sibir holds operator license no. 31 that was valid until Mar. 21, 2007. Based on Decision № 157/007 of the aviation authorities of Russia of June 28, 2004, Sibir was authorized to operate the A-310 airplane.

The operation of A-310 airplanes started on July 7, 2004. In 2004 the airline operated two airplanes. Since then, the number of airplanes has increased to 9 (on July 9, 2006 the A-310 F-OGYP was in an accident). All aircraft are operated under lease.

Out of the total A-310 fleet, three aircraft are registered in France and six in Bermuda.

Airplanes with French registration: F-OGYQ (ser. no. 453)
F-OGYP (ser. no. 442)
F-OHCZ (ser. no. 475)

Bermuda registration: VP-BSY(ser. no. 430), VP-BSZ (ser. no. 468)
VP-BTJ (ser. no. 520), VP-BTK (ser. no. 427)

VP-BTL (ser. no. 487), VP-BTM (ser. no. 486)

In accordance with Art. 33 of the Air Code of the Russian Federation, foreign-registered aircraft may be operated in airlines in Russia, provided the state of the operator and the state of registration have signed an Agreement to support airworthiness. This agreement between the aviation authorities of Russia and representative authorities of Bermuda was signed and was in force.

With regard to the operation of French-registered A-310 airplane by Sibir, a similar agreement between the aviation authorities of Russia and France does not exist. The Agreement on the operation of French-registered A-310 airplane at Aeroflot between the USSR and France had run its course by the time Aeroflot stopped operating these airplane.

The intensity of operation increased as the number of airplane grew. If the fleet's average monthly flight time in 2004 was up to 600 hours, then in 2006 this increased to 2,400 hours.

However, at the time, the number of incidents[4] also increased as the frequency grew. The average flight time per incident decreased more than twice. A similar situation took place at Sibir during the 1998-2002 period when the airline's volume of traffic on its Russian airplane fleet sharply increased. A comparison of the flight safety level (by occurrence of incidents) of Sibir's A-310 airplanes and the fleet of similar airplanes in Aeroflot for the preceding period (2000 - 2004) shows an approximate **doubling** of the ratio (flight hours per incident) at Sibir. For a more accurate assessment, a comparison was made of the ratio for the F-OGYQ and F-OGYP airplanes operated by Aeroflot until 2004 and by Sibir from 2004. The comparison showed that both airplanes were flown by Aeroflot for 26,300 hours from 2000 to 2004, and there were 8 incidents during this time. Flight hours per incident were about **3,300 hours.** These airplanes at Sibir flew about 15,300 hours and there were 18 incidents. The average flight hours per incident were 850 hours. So the level of safety applied to the same airplane operated by Sibir compared to the level for Aeroflot fell approximately **4 times.**

Considering the tendency of the safety level of Sibir **flights to fall as traffic intensifies, for both Russian and Western airplanes, targeted remedial measures have to be developed by the airline and government inspection has to be made stricter, including examination of future assimilation of other types of Western aircraft (B-737, A-319).**

Special characteristics of flight crew training on the A-310 airplane

A comparison of Aeroflot's A -310 FPTP with that of Sibir has shown that in developing the A-310 FPTP, Sibir made several major simplifications regarding the training and commissioning of airplane captains.

[4] Hereinafter the meaning of the word "incident" is in accordance with the list of aviation occurrences that are considered to be incidents as defined in the 1998 Rules for Investigating Air Accidents and Incidents. This list is significantly bigger than ICAO's list of types of incidents.

At Aeroflot, for example, virtually all airplane captains go through training based on the program of co-pilots. They have specific experience in operational flights as co-pilots on the A-310, after which they undergo special training and are commissioned as airplane captains. Exempted are members of the flight command crew who underwent conversion training on class 1-2 airplane with a **two-person crew** and are continuing to work on command duty. These individuals are commissioned without having to undergo the co-pilot training course.

The Sibir A-310 FPTP allows the commissioning as A-310 airplane captains of pilots who have solo flight experience as airplane captains on other types of airplane without undergoing the co-pilot training course and without flight operations experience as a co-pilot. In particular, the Captain (captain of the A-310 F-OGYP airplane that was involved in the accident at Irkutsk airport on July 9, 2006) was authorized to fly as the airplane captain of the A-310 after flying 43 hours as a trainee on this type of airplane, without having to go through the commissioning course as a co-pilot, though having the corresponding flight operations experience in this position. Another 18 pilots went through a similar simplified procedure for commissioning as airplane captain of the A-310.

So, out of 62 captains (working at Sibir from the middle of 2004 to August 2006) only 20 went through the cycle including: A-310 co-pilot training, commissioning as a co-pilot, flight operations experience in this position for up to one year, conversion training on the airplane captains' training course and commissioning as a A-310 airplane captain.

Another example of the peculiarities of flight crew training at Sibir is highlighted by comparing the volume of operational flights of co-pilots at this airline with those at Aeroflot. At Sibir, for example, an airplane captain of a Russian-made airplane who went through conversion training on the co-pilot training course had to carry out no less than **30 flights** (up to 150 hours) as co-pilot under operational conditions until commissioned as an A-310 airplane captain, while pilots who did not have solo flight experience as airplane captains of a Russian-made airplane had to complete **300 hours.** According to the A-310 FPTP at Aeroflot, these figures are, respectively, **500** and **1500** hours, that is, 3 to5 times more.

These circumstances in particular explain the unusually high rate of conversion training of flight crews on the A-310 airplane at Sibir, reaching a level of 6 pilots per month, given the actual number (8 persons) of authorized instructors ensuring the conversion training of pilots in simulators at foreign centers (Toulouse, Paris and Frankfurt).

The instructors underwent the corresponding conversion training at foreign training centers on the training courses at these centers. The initial training course for instructors at Sibir was not written .

At the time of writing (August 2006) there were 47 airplane captains and 49 co-pilots working at Sibir who were authorized to fly the A-310 airplane.

As the analysis showed, this resulted from the need to cater to the intense growth of traffic at Sibir.

There were other shortcomings in the organization of flight duties. In spite of the volume of processed objective information (90% of flights performed) the heavy workload of the command and instructor team caused by the commissioning of crews gave rise to a perfunctory approach in the use of this information in accordance with the procedures prescribed by the 1987 Civil Aviation Flight Organization Manual (CAFOM 87).

Post-flight debriefings in flight squadrons were held once a month.

The debriefing plan was drawn up in accordance with the requirements of category 9.2, item 9.2.7 of CAFOM 87. One should note the formal content of the initial section of the debriefing (ensure execution, take measures, etc.) which was not derived from the general and methodological part of the debriefing.

Debriefings of incidents (for example, the A-310 incident on June 29, 2005 at Domodedovo airport), according to available records, were simply reduced to the statement of facts without any detailed analysis of flight parameters and crew actions. The incident to the A-310 airplane was not mentioned in post-flight debriefings. Insufficient attention was given in post-flight debriefings to the analysis of materials from flight data recorders in spite of the fact that this was occasionally recorded in the methodological section of the debriefing.

If deviations in the execution of flights are discovered, all the more so if incidents occur, the airplane captain and the co-pilot ought to be given the opportunity to come forward with an analysis of flight parameters (based on readouts of recorded results) and of their own actions, and the instructor or commander to state the reasons for these deviations.

The practice of collecting signatures of the flight crew signaling their familiarity with the results of the debriefing, including any entries containing no useful information for them, attests to the perfunctory attitude towards post-flight debriefings (the most important remedial measure ensuring flight safety).

It should be noted that FTOA does not send airlines investigation materials on accidents according to type of airplane for debriefing purposes. The materials, for example, on the accident on March 29, 2006 at Domodedovo airport involving an Il-62 of Libavia airlines (Libya) were submitted to the FTOA. However, this event was not discussed during post-flight debriefings of the airline's flight divisions in spite of its connection to the airplane's rolling off the runway because of the error committed by the crew in the use of the thrust reverser.

<u>Special characteristics of the technical operation of A-310 airplane</u>

The intensification of passenger traffic at Sibir also affected the maintenance support for A-310 airplane. A comparison of requests for consumable items, including spare parts, to rectify defects that have been discovered with their actual availability at airline warehouses has shown that warehouse stocks met requests at percentages of 25% - 30%. In June 2006, for example, 4273 consumable items and 469 spare parts were requested and warehouses actually had 757 and 55 items available, respectively.

These circumstances, as well as the difficulties of customs clearance when importing spare parts from abroad in cases when defects have to be repaired urgently (within 10 days), have led to the ubiquitous use in flight practice of so-called "deferred defects".

The A-310 F-OGYP, for instance, flew on July 6, 2006 from Domodedovo to Irkutsk with an inoperative reverser on the **right** engine. Upon landing at Irkutsk airport the reverser on the **left** engine was not operative. So the airplane was on its landing run when the reverser mechanisms of both engines failed. The Captain's crew made the corresponding entry in the flight log. It should be noted that in compliance with 1998 RIAAI this event was classified as an incident.

During maintenance done on July 7, 2006 the defect on the **right** engine was fixed using parts taken from the **left** engine (with the failed reverser) and the **left** engine ended up under the category of a "deferred" defect. Then the airplane was released for flight on July 8, 2006 (the last trip of this airplane on the Domodedovo-Irkutsk route no. 778) with the deactivated (inoperative) reverser on the **left** engine.

This procedure was covered by current regulations and was mentioned in the Sibir MEL publication, which meets the recommendations of the airplane manufacturer. However, the dynamics of application of the MEL was not efficiently monitored. Moreover, the practice of allowing flights with **extended** "deferred" defects without any form of control procedure exercised by Russian aviation authorities in each specific instance took root at Sibir with the agreement of the Airworthiness Support Administration of the FTOA (RF Rostransnadzor).

So for the first six months of 2006 there were 86 extended deferred defects recorded on A-310 airplane. No steady downward trend in the frequency of these negative factors was observed.

The appropriate training to support flights using MEL was absent from the airline crew training system.

It is perfectly obvious that this practice was instigated by the growth of traffic volumes at Sibir but this cannot justify ignoring the requirements of flight safety.

This state of affairs, in conjunction with insufficient remedial work to prevent repeated defects, determined the low degree of reliability of aviation equipment (1 failure every 23 hours of flight for the A-310).

1.18.2. Flight assessment based on the results of studies conducted during the investigation[5]

A test pilot carried out a flight assessment in terms of the appearance and development of abnormal situations as part of the investigation of the accident in order to determine the most likely scenario for the sequence of events.

Based on the results of all experiments carried out, the test pilot made the following assessments:

<u>1 Effect of the position of the pilot's hand on the possibility of the unintentional movement of the TCL forward while disengaging the thrust reverser</u>

The experiments carried out show that pilots have different ways of gripping the reverse thrust lever (RTL) before shifting it. A situation is possible where the rear part of the palm of a pilot's right hand touches or leans on the knob of the TCL of the left engine after shifting the RTL to MaxRev.

This creates a form of "semi-rigid connection" between the RTL of the right engine and the TCL of the left engine, which functions only in one direction while shifting the RTL forward, that is, when deactivating the reverser. The nature of shifting the TCL, depending on the position of the RTL of the right engine, practically fully coincides with the data from recordings of the FDR during the accident flight.

In conducting the experiment to confirm this version, this connection was artificially created using Scotch tape with different degrees of elasticity. A very "hard" or very "soft" connection did not lead to a precise repetition of the results recorded on the FDR. A medium degree of tape elasticity quite accurately recreated the scenario of shifting the TCL when shifting the RTL. This attests to the fact that the fingers of a pilot's hand did not grasp the knob of the TCL of the left engine and that the palm while resting on the knob was slightly sliding as the RTL was moving forward.

The best congruence of the experiments with FDR recordings of accidental flight was achieved on aircraft with low friction forces in the TCL cable (0.4 - 0.6 kg). This is indirect evidence of the possible existence of small forces when shifting the TCL on the F-OGYP airplane.

Before 22:44:16 the airplane captain, to all appearances, continued to rest his right hand on the TCL of the left engine (this could explain the minor shifting of the TCL backward (22:44:02 – 22:44:16), after which the airplane captain transferred his right hand to the control wheel in his attempt to help maintain the direction of roll by means of the bank displacement of the control wheel.

[5] All findings and conclusions made in this chapter are the opinions of the person who performed this assessment and may differ from the findings and conclusion of the whole report.

A repeated attempt to activate the reverser on the airplane captain's command "reverser once again" (22:44:20) was executed by the co-pilot since the execution of this action by the airplane captain would have led inevitably to the shifting of the TCL of the left engine, which was not confirmed by FDR recordings.

2 Effect of friction forces in the control cable

Measurements of friction forces made on the Uzbek airplane showed that their magnitude depended on the "flight hours" of the airplane and was lower than the standard (**1.17 - 1.54 kg**) in all cases.

The A-310 F-OGYP airplane that was involved in the accident on July 9, 2006 was manufactured in 1987 and had flying hours of more than 59,000 hours, that is, one can assume with a high degree of probability that the forces for shifting the RTL were lower than standard.

The experiments conducted on airplane with various forces (from 0.4 kg to 2.1 kg, see table below) showed that in a specific position of the hand whose rear part of the palm is resting on the TCL knob of an engine with a deactivated reverser the unintentional shifting of the RTL forward is possible when deactivating the reverser on the other engine and when the pilot (pilots) does (do) not have visual control.

In addition, the lower the forces the higher the possibility of imperceptible shifting. So with forces of less than 0.6 kg the position of the TCL almost corresponds to the positions recorded by the FDR on the accident flight. With intermediate forces (0.8 - 1.0 kg) the pilot begins to feel resistance when shifting the TCL and the magnitude of its deviation on all segments is approximately 20% less in comparison to the small forces of friction.

Under the specified forces (**1.17 - 1.54 kg**) the resistance to shifting becomes noticeable and the displacement angle of the TCL on the dial is reduced by 40% - 50% compared to the small forces.

Table 1. Positions of the TCL of the left engine when deactivating the reverser on the right engine on fixed fields in case of different forces of friction when steering (on the TCL dial)

№ of field	Emergency flight	Friction forces 0.4 - 0.6 (kg)	Friction forces 0.8 - 1.0 (kg)	Friction forces 1.2 - 1.5 (kg)	Friction forces 2.0 - 2.1 (kg)
1	6º	5º-7º	3-5º	2º-3º	2º-3º
2	16º	14º-17º	12-13º	10º-12º	8º-10º
3	23º	22º-26º	30-22º	17º-20º	13º-15º

3 Effect of shaking, vibration and negative accelerations arising when an airplane is on a landing run

In experiments in the FFS, two conditions of runway unevenness were simulated: smooth and bumpy runway.

The actual conditions of shaking and vibration on the runway at Irkutsk airport because of the uneven surface (potholes, difference in height at the joints of runway slabs) noticeably differ from the conditions simulated on the simulator. Nonetheless, the results obtained from the experiment demonstrated the degree by which the shaking affects the possibility of unintended shifting of the TCL.

In a specific position of the hand, the pilot inadvertently and partially rests his palm on the TCL knob of the left engine.

The combination of the shaking and deceleration makes the process of uncontrolled shifting of the TCL forward even more unnoticeable.

It must be noted that this effect appears more noticeable to the pilot on a smooth runway if there is only deceleration influence. Other participants in the experiment came to the same conclusions.

Aborted take-offs performed at various rates of deceleration and minimum friction forces in the TCL cable (0.35 - 0.4 kg) showed the impossibility of spontaneous shifting of the TCL because of the negative longitudinal loads recorded by the FDR during the accident flight (~0.2g). Nevertheless, it is obvious that the forces needed to shift the TCL forward and applied by the pilot in this case will be small.

4 Defining the final moment in the emergency situation when it was possible to prevent the accident provided the crew recognized the reasons for the abnormal behavior of the airplane and took appropriate measures

The studies were conducted in a motion simulator (FFS) with different runway surface conditions (dry, wet, covered with a layer of dirt, icy). It was impossible to simulate the condition of a runway covered with a 5-mm thick layer of water. The condition ensuring the prevention of the accident was as follows: rolling beyond the end of a 3000-m runway at a speed of 40 - 60 kph. (The available landing distance of runway 30 at Irkutsk airport plus the 400-meter concrete stopway is 2,825 m). The actions of the crew similar to the flight on July 9, 2006 were simulated in the experiment. Once the crew discovers the reasons for the extraordinary situation (increase in thrust of the left engine of up to EPR = 1.2 and, consequently, the absence of deceleration of the airplane) a 2-second delay was given to decide, after which the TCL of the left engine was transferred to idle and the brake pedals were pressed fully. The speed was 90 - 95 knots. The following distances of the required remainder of the runway were obtained (provided the airplane rolled off at a speed of 40 - 60 kph):

- for a dry runway – 450-500 m;
- for a wet runway – 500-550 m;
- for a runway covered with a layer of dirt ~600 m;
- for an icy runway – 750-800 m.

The acceptable convergence of the simulator recreation of the pattern of movement of the airplane on the runway and the results of the experiment correlate with data of the mathematical modeling adequately well. So the available reserve of time to decelerate the airplane (from the time the "incorrect configuration" signal was actuated until the TCL was removed on idle or until the engines were switched off) would have allowed the pilot to shorten the stopping distance to a length that could have prevented the accident. The deactivation of the engines somewhat shortens the stopping distance compared with the operation of the engine on idle.

5 Psychological aspects of the accident of the A-310 F-OGYP airplane in the area of Irkutsk airport on July 9, 2006

After landing and after deceleration commenced on the roll-off, the crew could have fallen into a state of ***premature mental demobilization.*** This mental state is characterized by a decrease in pilot alertness (relaxation) and a decrease in the degree of nervous and emotional tension at the moment when the principal activity had not yet ended. The discrepancy between the degree of nervous and emotional tension and the requirements of the activity being performed, especially as flight conditions become more complicated, becomes the reason for the decrease in the professional reliability of pilots. The degree of conscious control over flight parameters and actions being performed decreases. The pilot assumed that the main stage of the flight has already ended. It is possible that, after the engine reverser was deactivated and active deceleration started and upon sensing the usual noise and negative acceleration because of the reverser and the start of deceleration, the crew fell into a state of *premature mental demobilization*. After the start of deceleration and before the airplane rolled beyond the runway, control over the rate of change of speed using instruments was probably not exercised (or was exercised only visually, which is problematic at these speeds). As a result of the decrease in the degree of nervous and emotional tension and its discrepancy with the requirements of a flight situation that was becoming complicated, the crew was unable to act in a timely and adequate manner even after they discovered the disparity of the flight parameters (engine rpm, speed) at this stage of the flight (22:44:17.8).

The *psychological factor of the phenomenon of mistrust*, **when the pilot does not trust the operation of the emergency signal because of the improbability of the signal appearing, in the opinion of the pilot under these flight conditions, or because of its incorrect operation, played a role in the**

development of the abnormal situation and its shift to a catastrophic situation. It is probable that this *phenomenon of mistrust* was the reason for the inadequate reaction of the crew to the "*wrong take-off configuration*" **signal. Apparently neither of the pilots was able to assume that the operation of this signal was possible during the landing run. Instead of clarifying the reason for the signal, the co-pilot made sufficiently long inputs to clear the ECAM screen by depressing the CLEAR and RECALL buttons.**

It is probable that at the final stage (after 22:44:20) the sudden deterioration of the situation also quickly brought the crew to an extremely high degree of nervous and emotional tension - ***stress***. Under conditions of *stress* the performance of an individual decreases sharply, mental activity is made difficult, errors in perception and omissions of specific operations appear, the distribution and shifting of attention become difficult, distraction appears, the field of vision and attention narrow, memory fails, movements become impulsive or, on the contrary, restraint and lethargy set in. In analyzing the situation, one can discover signs that the pilots were under stress: distracted crew (crew: "We're rolling off the runway", co-pilot: "Why?", airplane captain: "I don't know", co-pilot: "Oh my"), omissions of specific actions (failure to switch off the engines although the command was given), irregularities in the distribution and shifting of attention, as well as difficulties in mental activity (in spite of the discovery of the increase in engine rpm, the crew failed to control the position of the TCL), narrowing of the field of attention (attention focused only on maintaining the direction at the end of the run), etc. On the whole, the stress condition made it impossible for the pilots to act effectively in a situation that was becoming more and more complicated.

Consequently, the following conclusions can be reached[6]:

1. The involuntary forward shifting by the airplane captain of the left engine TCL while deactivating the reverser on the right engine most probably occurred as his right hand was occupying a specific position on the TCL.
2. The simultaneous coincidence of the following factors contributed to the moving of the TCL that went unnoticed by the airplane captain:
    - the presence of shaking and vibrations that were typical for the runway at Irkutsk airport;
    - the possibly small friction force needed to move the TCL;
    - the presence of negative acceleration during the normal run after landing with an activated right engine reverser and automatic wheel braking in LOW mode (before 22:44:00).

[6] These conclusions are the opinion of the person who performed this assessment and may differ from the findings and conclusion of the whole report.

3. The time taken to recognize the reasons for the development of the abnormal situation from the time the "wrong configuration" signal was actuated until the time the crew started to act (provided they recognized the reasons for the development of the abnormal situation) to prevent the situation from developing into a catastrophe was 10 - 13 seconds.

4. The development of the abnormal situation and its escalation into a catastrophic situation happened because of the crew's lack of the required teamwork as the airplane was on its landing run, as well as the co-pilot's inadequate degree of professional training in terms of controlling the work parameters of the engines and the airplane's speed while on its landing run and, consequently, the late report to the airplane captain about the increase in engine rpm. The audio and light emergency warning signal (incorrect take-off configuration), which is not related to this stage of the flight, was unexpected for the crew and could have made recognition of the developing situation difficult.

5. The unusual behavior of the airplane, especially the strong turn to the right, increased the mental and physiological load on the pilots and facilitated the distraction of attention from control over the engine rpm and speed, especially when it came to the co-pilot.

1.18.3. Information about previous incidents

A-310-associated occurrences

During the course of the Commission's work, it was established that, over the period of operation of A-310 airplane, at least three incidents related to the increase in forward thrust of engines whose reverser was deactivated as the airplane was on its landing run. Reference data about these events is presented in the table below:

№ in order	Date	Place	Registration, operator	Type of airplane, engine
1	March 3, 1999	Moscow (UUEE) Russia	UK-31001 (Uzbekistan), Uzbekiston Havo Yullari	A-310-324 PW4000
2	March 3, 2004	Dacca (DAC), Bangladesh	S2-ADF (Bangladesh), BBC (Bangladesh)	A-310-325 PW4000
3	March 8, 2005	Teheran (THR), Iran	F-OJHH (France), Mahan Air (Iran)	A-310-304 CF6-80

1. On March 2, 1999 a crew of the airline Uzbekistan Havo Yullari on an A-310 airplane UK-31001 was flying on an international route from Tashkent to Moscow, landing at Sheremetevo. At 01:19 (Moscow time) the airplane landed on runway 25R. The runway was damp and in some places was covered with ice. The friction coefficient was 0.35 along its entire length. Before

landing, the engines were brought to idle. The landing was carried out under automatic mode from a distance of 520 meters from the entry threshold. After landing, the spoilers were automatically released and braking commenced in LOW mode. The reverser on the engines was not used since the reverse mechanisms of both engines were deactivated. About 9 seconds after the nose gear was lowered, the TCL of both engines started to move forward (for 9 seconds) to increase forward thrust to 44.5 according to the FDR. The TCL remained in this position right up to a distance of 3000 m from the entry threshold, after which the crew recognized the situation and both TCLs were transferred to idle. At a distance of 1800 meters from the entry threshold and at a speed of about 180 kph the crew initiated active forcible deceleration. Because of the low friction coefficient and late discovery of the irregular position of the TCL, the airplane could not stop on the runway and overran the runway at a speed of about 60 kph.

The investigating commission concluded that this incident was not related to the functioning of the aviation equipment but was a consequence of the involuntary shifting of the TCL to forward thrust mode and the crew's lack of control over engine rpm during the landing run, as well as the little experience of the crew in executing landings on a damp runway that was covered with ice in some places.

The conclusion of the State Center for Flight Safety in Air Transport (SCFSAT) that was based on the results of the investigation into the circumstances of this incident contains the conclusion that "the movement of the TCLs to forward thrust modes most probably occurred inadvertently (that is, with no efforts exercised by the crew on the levers). It was impossible to determine the reason for the inadvertent movement of the TCL based on available data". With the exception of one ground experiment on a similar airplane (and not on the airplane that was in the accident), no studies of the engine control system were presented to confirm this conclusion. The developers of the airplane and engines were not invited to take part in the investigation.

The investigating commission did not share the opinion of SCFSAT regarding the inadvertent movement of the TCL, and the quality and completeness of the studies that were carried out to investigate this incident gave rise to serious criticism.

Based on results of the investigation of this incident, the commission ***failed to draw up specific recommendations*** to the flight crew or developers of the engine control system for the purpose of preventing similar situations in the future.

Airbus, as was mentioned above, was not involved in the investigation of this incident. However, they provided the MAK commission investigating the A-310 F-OGYP fatal accident with the report on the results of their own analysis of this occurrence. The report states that during the landing run with both reversers deactivated after an automatic landing had been performed, the throttles began to increase very slowly (0.1 °/s TRA) from the idle position to forward thrust direction, which, in conjunction with the automatic spoiler retraction as per design, prolonged the landing run distance and caused the airplane to overshoot the runway. The speed of moving the throttles did not correspond to any speed caused by the automatic thrust function.

2. On March 3, 2004 flight BG 085 flew from Bangkok to Dacca. The approach to runway 14 at Dacca airport (DAC) was carried out by ILS[7]. Autopilots 1 and 2 were switched off at 340 feet. Landing was executed normally. After compression of the main struts, the spoilers were released. At the same time, the reverser on the right engine was brought to maximum mode. The reverse thrust lever of the left engine was not used since the reverser was deactivated. 1-2 seconds after the RTL of the right engine was brought to MaxRev, the TCL of the left engine was shifted forward from idle until about 52 degrees according to the FDR. This shift led to the automatic retraction of the spoilers. Deceleration of the airplane within 15 seconds was done with a longitudinal load of -0.05 g without the forcible application of brakes by the crew. After the speed of 100 knots was reached, the crew initiated forcible deceleration and the longitudinal load increased to -0.3g. As the reverser on the right engine was being deactivated, the TCL of the left engine was also shifted forward to "nominal" mode. This led to the sharp turning of the airplane to the right After about 5 seconds the TCL of the left engine was shifted back to idle but this did not prevent the airplane from overshooting to the right about 300 meters beyond the end of the runway.

Based on Airbus conclusions, the development of events during this incident is entirely explicable by the actions of the crew in shifting the TCL and is not related to the functioning of aviation equipment.

3. On March 8, 2005 an A-310-304 airplane of Mahan Air overran the runway at Teheran[8]. According to data from the DFDR, the crew executed an approach in manual mode. According to information received from the aviation authorities of Iran who conducted the investigation into this incident, it was the co-pilot who was actually flying the airplane. He had flown 700 hours on the A-310 and had a total of 1,100 hours of flight experience. The airplane landed normally. After compression of the main struts, the spoilers were released. At the same time the reverser on the left engine was brought to maximum mode. The reverse thrust lever of the right engine was not used since the reverser was deactivated. After deceleration to a speed of 80 knots the RTL of the left engine was brought to the intermediate position between maximum and minimum reverse thrust. As this was happening the TCL of the right engine was brought from idle to the position of ~55 degrees according to FDR data. Further movement of the RTL of the right engine was accompanied by the simultaneous shifting of the TCL of the left engine practically as far as the nominal mode.

[7] Data are taken from the report provided by Airbus
[8] Data are taken from the report provided by Airbus

Based on information from the final report about this event, at this moment the airplane captain interfered in the control, shifted the TCL of the right engine to idle and again activated maximum reverse of the left engine. However, in spite of the actions taken, the airplane overshot the runway at a speed of about 40 knots.

Based on Airbus's conclusion that was agreed with the DGAC, the development of events during this incident is completely explained by the actions of the crew in shifting the TCL and is not related to the functioning of aviation equipment.

Analysis of the last two events shows that shifting to forward thrust of the TCL of engines whose reverser was deactivated occurred simultaneously with the shifting of the RTL of the second engine; and in the case of the Iranian airline, the pilot erroneously moved the TCL nearest him in controlling the RTL that was furthest from him. With regard to the airplane of the Bangladeshi airline, it could not be clarified which of the pilots performed the actual piloting. It should also be noted that these events happened with airplane with P&W engines and GE engines, which involve significantly large forces required to shift the TCL.

Incidents on other types of airplane

According to the information provided by the NTSB the following incidents in fairly similar circumstances (increasing the forward thrust of an engine whose reverser was not used) were recorded on various occasions.

№ in order	Date	Place	Operator	Type of airplane
1	April 6, 1987	Rio-de-Janeiro, Brazil	Varig Airlines	B-747-300
2	September 12, 1988	Denver, USA	United Airlines	DC-10
3	November 5, 2000	Paris, France	Cameroon Air	B-747-200
4	December 19, 2003	Libreville, Gabon	Air Gabon	B-737-30
5	December 14, 2005	McGuire AFB	Atlas Air	B-747-2D7

A short description of the above-mentioned events is given below.

1. After landing on runway 14, the airplane departed the right-hand side of the runway and came to stop with its nose gear and right-hand main gear on grass on a heading 15 degrees to the right of the runway. The pilot stated that no.1 engine would not go into reverse and then accelerated no.1 to 100%, causing airplane to twist to the right. He shut down the

engine. No anomalies were found in the reverser or engine systems.

2. At about 2pm, the DC-10 landed at Denver Stapleton. The weather was overcast with wet runways. After touchdown the crew attempted to apply reverse thrust on all 3 engines. Reverse worked on engines 2 & 3 but no.1 remained in forward thrust and accelerated. There was a loss of directional control and the airplane left the runway to the right. One passenger suffered a minor injury.
3. The initial cause of the accident was the incomplete reduction of thrust on the left outer engine at the beginning of deceleration. This caused the deactivation of the automatic braking systems and the non-deployment of the no. 1 thrust reverser. The inadvertent selection of full thrust on this engine after the landing created high thrust asymmetry, leading to the runway excursion. The lack of co-ordination and of joint control by the crew members, perhaps aggravated by the presence of third parties in the cockpit, contributed to the development of this situation.
4. From the data, it appears that, after touchdown, the left engine throttle lever was advanced in the forward thrust direction, while the right engine reverser was deployed and subsequently deactivated. The forward thrust from the left engine overpowered the brakes, resulting in the airplane exiting the departure end of the runway at >100 kts. Additionally, there is no indication on the CVR that the crew was initiating a go-around. We do not yet have an explanation as to why the throttle levers would have been split in this manner (left throttle forward, right throttle reversed).
5. The airplane went off the side of the runway during a landing run. At the time of the event, the airport was experiencing stormy conditions with a high crosswind. The crew described the approach as challenging but uneventful. No. 4 engine thrust reverser was deactivated and so the crew decided to use symmetrical reverse thrust (no. 2 & 3 engines only). Upon landing, the DFDR data show that the no. 4 engine was never brought back to idle. At approximately 70 knots, when the no. 2 and 3 thrust reversers were brought out of reverse, the data show that the no. 4 engine accelerated from approx 80% to firewall thrust. The crew reported after they came to a stop that the no. 4 throttle was in the firewall position. The maintenance personnel checked the rigging of the throttle cables and found no defects.

1.18.4. Expert conclusion reached by clinical psychologists based on records of the psychological examinations of the airplane captain of the A-310 F-OGYP that was involved in the accident on July 9, 2006 at Irkutsk airport[9]

This expert conclusion was performed by independent clinical psychologists based on records of the psychological examinations of the airplane captain by a psychologist of the Irkutsk physical evaluation board in 2003 and 2004 as well as a record of the psychological testing of the airplane captain by a Sibir psychologist (in Moscow) in 2005 and the Captain's personal characteristics of based on examination results.

Analysis of the Captain's psychological records made it possible to evaluate his individual psychological characteristics and their possible effect on his professional activity, including their effect under the conditions of an abnormal situation.

Original test records of cognitive functions (in 2003 and 2004) reveal a sufficiently high degree of their development and functioning. Data from the Minnesota Multiphasic Personality Inventory (MMPI) allow us to state that the Captain's personality profiles are characterized as "submerged" since the set of scales is lower than 40T and most of the remaining scales are lower than 50T. Combined with high K and L and low F indicators of reliability scales, this reflects the result of his adjustive attitude towards the testing procedure, and his attempts to significantly minimize or hide existing problems and particular traits. Nevertheless, the profiles are open to interpretation. In both profiles, the leading one is the combination of the first and third scales, which reflects the combination of emotional instability (high sensitivity to the effects of the environment and instability of emotional reactions) and increased and excessive control (heightened orientation towards the norm, excessive attention towards deviations from normal functioning, especially in the area of somatic health). The combination of the rise in these scales with the reduced 2 (anxiety) and 6 (aggression) scales attests to the main defense mechanism of suppressing anxiety and aggressive feelings by means of their somatization, that is, transformation into functionally somatic and vegetative disorders. From the standpoint of the dynamic evaluation of the profiles, one should note the decrease in the effectiveness of the basic defense mechanism in the 2004 profile compared to the 2003 profile (increase in 2nd scale – intensification of anxiety). However, this relatively lower effectiveness does not lead to a change in defenses (rise of 3rd and 2nd scales) but to their strengthening and the additional involvement of an even more immature defense along the lines of the repudiation of negative information (rise of 9th scale).

[9] All findings and conclusions reached in this chapter are the opinions of the person who performed this assessment and may differ from the findings and conclusion of the whole report.

Considering the facts available in the medical records about the appearance of strongly expressed psychosomatic reactions by the pilot at the time he was examined by the medical board, the psychologists ought to have focused more specific attention on studying the Captain’s possible behavior in stressful situations and studying the possibility (impossibility) of correcting these features of his personality and temperament.

Original test records of his cognitive functions (2005) reveal a high degree of their development and functioning (test of intellectual stability, "Two rings of Landolt", and “15 words").

We will go into more detail on the analysis of the remaining tests. In completing the "Comparison of Concepts" test, the volume and character of permissible errors (from the point of view of clinical psychologists, these number about 40% and they can be described as a tendency towards support when generalizing and abstracting into weak and insignificant signs and connections) do not allow us to designate the Captain’s thinking as normative. Given intact formal logic, one can identify the indistinctness and amorphism of his conceptual and categorical structure, its insufficient conformity with socially dependent and fixed hierarchical conceptual structures. These features can be manifested in real life in the uniqueness of thinking and decisions, which will not directly depend on the level of difficulty of the task but will be defined more by incidental subjective factors.

Data from the "Tepping test" reflect the instability the Captain’s nervous system (intermediate weak type). Based on MMPI data, the emotionally unstable personality type of a pilot had a physiological reason, that is, is strongly related to the biological characteristics of his nervous system and, consequently, is poorly accessible or almost inaccessible to correction.

The personality profile based on data from the Kettell test is characterized by several marked peaks in scales A (9 points, "emotivism" - emotionality, expressiveness, impulsiveness, sociability), B (10 points, high intellect), G (10 points, "strength-ultra-ego" - high sense of morality, discipline, stubbornness, perseverance), Q1 (1 point, conservatism, rigidity, adherence to subordination), Q3 (10 points, high degree of self-control in behavior and desires). Just as in the MMPI, we can observe here a sufficiently expressed and contradictory combination of high emotional instability with an equally expressed self-control that reaches a level of rigidity and conservatism in terms of both internal personality and the high external criteria of morality and order. At the same time, the conservatism and rigidity here are excessive on account of the simultaneously high points in scales G and Q3. These data are also confirmed by the results of the LSC (“Level of Subjective Control”) test and the morphological test of life values. In real life this can be manifested in highly normative and socially accepted behavior under normal conditions. In stressful situations, however, the emotionally significant details of self-control mechanisms can prove insufficient. There is a high probability of development of acute panic states that significantly complicate organized and focused activity, and in the most complex situations can lead to its disorganization.

According to the data from the "Modified Methods of Sondi", the Captain's condition at the time of examination was characterized by a heightened degree of anxiety and worry (m+!), a tendency towards acute emotive and anxiety-filled reactions as tension rises (e0hy+-). The main defense mechanisms are suppression from consciousness of negative information (k-p0) and emotive-vegetative reaction (e0hy+-). The data correspond practically verbatim to indicators of prior methods.

Based on data from "Luscher's Eight-Color Test", the Captain's condition at the time of examination was characterized by a heightened degree of worry (-17), imbalance in the vegetative system (combination 42 at the start of the first row) of an emotionally unstable personality (+34, +43) that tends to hold back its emotional manifestations using developed and systematic self-control that is frequently irrational (x20, x25). The data correspond to indicators of prior methods.

An analysis of a projective drawing of a "non-existent animal" reveals a fairly adequate self-assessment (standard position of the drawing on the page, size of drawing), simplicity and concrete nature of interests (name of animal, lack of fantastic details), infantile and irrational abilities of protection from negative experiences (features of the story about the lifestyle of the animal). The characteristics of the drawing (presence of "transparent" details) point to insufficiently stable and contradictory personality organization, and the possibility of neurotic disorders.

Based on the analysis of data from the Captain's psychological examinations, the following conclusions can be drawn:

1. The Captain's personality was characterized by a combination of emotional excitability and instability with heightened self-control. The leading defense mechanisms are suppression and somatism of anxiety and aggressive feelings with the subsequent accumulation of negation of emotion-filled problems and symptoms. These personality features are revealed in practically all the personality tests used. Emotional instability and excitability are basic traits of the nervous system and are not eliminated by the method of psychocorrection and self-regulation. The most effective way of smoothing out these features is by working through the maximum possible number of irregular situations, which brings them out of the category of the irregular and stressful towards the category of the normal, familiar and controllable. One should note that heightened rigidity, inflexibility of controllable mechanisms, conservatism, and excessive development of systems of self-control could complicate the retraining process of a pilot and make it longer. People who have these qualities need longer time to process and develop skills until they become automatic. In terms of prognosis, they are more effective in secondary roles.

2. These personality features of the Captain, in combination with the features of his conceptual thinking, could have had a significant effect on his behavior in a stressful situation. In particular, they could cause disorganization. An irregular situation that suddenly appears could have caused the pilot to make an acutely autonomic and psychoemotional reaction, under which only simple and highly automatic skills and actions could have been expressed. Intellectual activity under such conditions is extremely difficult, behavior is disorganized and chaotic, is not mediated by intellect, looks like an inconsistent, disjointed and haphazard set of actions.

3. The set of psychodiagnostic methods used to define the individual personality features of the pilot in the 2005 study is sufficient to evaluate the possibilities of his carrying out his professional activity. We believe that the MMPI method is a more adequate and reliable instrument than the Kettell test in revealing the individual and personality features and pathological personality defense mechanisms, as well as the level and nature of emotional tension. In evaluating, analyzing and interpreting the data obtained from the examination, data from the test data “Comparison of concepts” and “Sondi modified methods” were inadequately expertly analyzed and taken into account. The details of Kettell’s test and “Luscher’s eight-color test” were correctly analyzed but were not taken into account in the final interpretation and conclusions.

1.18.5. Expert conclusion reached by aviation doctors based on records of the medical examinations of the airplane captain of the A-310 F-OGYP that was involved in the accident on July 9, 2006 at Irkutsk airport[10]

This expert conclusion was reached by workers at the AAERC of the Interstate Aviation Committee (IAC) who have basic medical and psychological education.

The following medical and psychological materials submitted to the commission investigating the accident involving the A-310 F-OGYP airplane were used for the conclusion:

1) the Captain’s medical history;
2) two medical records containing a history of illnesses 2649/1049 and data from examinations;
3) sick note no. 6 dated Apr. 9, 2001;
4) consultation sheet (conclusion) from the Central Physical Evaluation Board (CPEB);
5) CPEB excerpt from the Captain’s medical records;

[10] All findings and conclusions reached in this chapter are the opinions of the person who performed this assessment and may differ from the findings and conclusion of the whole report.

6) records of psychological examination of the airplane captain by a psychologist of the Irkutsk PEB in 2003 and 2004;
7) records of psychological testing of the airplane captain by a Sibir psychologist (in Moscow) in 2005 and the Captain's personal records based on test results.

Analysis of the medical and the Captain's psychological records allowed us to establish a series of the pilot's individual features that could have influenced the quality of his flight activity in an abnormal flight situation.

As evident from an extract of the history of illness 2649/1049, in 2000, when the Captain was working at the Sayany airline, he was examined at the non-commercial partnership "Irkutskaviameditsina" and was sent from there to a psychologist who discovered that he had an unstable mental condition and anxiety according to the Lusher test. Soon afterwards he was sent to a psychiatrist who came to the conclusion that on Nov. 15, 2000 the pilot suffered an acute psycho-emotional reaction with moderate anxiety and depressive symptoms. These facts speak about the heightened emotional reactivity of the pilot and inadequate mental self-regulation in response to the effects of unfavorable circumstances, in particular, the circumstances of life.

Later the psychologist of the Irkutsk PEB who examined the Captain in 2003 states, based on results of psychological testing, that the pilot had highly developed intellectual functions and an adequate level of nervous and mental stability. Indeed, original test records of cognitive (perceptive) functions show a high level of performance of attention, perception, thinking and memory in normal work situations, that is, in the absence of stress .

Data about the ways in which this pilot usually reacted to stress factors are reflected in the results of the MMPI personality test (in the form of a questionnaire) where emotional and behavioral features of personality are revealed. Although the duties of the PEB psychologist do not include a detailed description of all the character features of the examinee's personality, since the PEB psychologist evaluates only the presence of norms or signs of psychopathology, nonetheless in accordance with the requirements of the "Guidelines for psychological support for the selection, training and professional activity of civil aviation flight and controller teams in the Russian Federation" (page 127), the psychologist is required to enter the numerical values obtained for each test indicator (for each MMPI scale) in the conclusion. This the psychologist did not do.

The "personality profile" obtained from the MMPI test falls within the range of standard values of 30 to 70 T points, which on the whole indicates the mental integrity of the pilot. However, the psychologist does not focus attention on the fact that the "personality profile" expressed first scale (delineated peak near the 60 T point mark) and this, in turn, means that the captain has problems with his somatic (physical) health caused by nervous and mental tension. We should note that the first scale of the MMPI test is called "somatization of anxiety" since it reveals a person's tendency to relieve nervous tension, not in all external behavioral reactions, but in internal somatic reactions of the organism, which manifest in the form of vascular spasms, irregularities in cardiac rhythms, increased stomach secretions, tremor of the limbs or muscular cramping, etc.

This tendency towards expressed psychosomatic reactions during nervous tension is also confirmed by the Captain's medical diagnoses. In 1983 he was diagnosed with the cardiac type of neurocirculatory dystonia (NCD) and in 2002 with hypertensive disease. These two, as is known, fall under the category of psychogenic illnesses.

There are medical facts confirming the appearance of strongly expressed psychosomatic reactions to factors causing apprehension in the pilot while undergoing physical examinations. In fact, in 2001 the CPEB discovered that the pilot was suffering from the atypical Wolff-Parkinson-White syndrome on the electrocardiogram when his heart was examined under physical exertion. This could have further caused the pilot to worry about the results of the veloergometric test (VET). It is probably for this reason that he had very high indicators of arterial pressure (230/80) and cardiac rate (114) even under a minor exercise ECG test (80 W), which prompted the stoppage of the bicycle ergometry on May 13, 2002. It was altogether impossible to carry out veloergometric testing three days afterwards: initial pressure was at the 180/90 level. The pilot was afterwards sent to undergo rehabilitation using sedative medications (Annex 10) but even after this he was not authorized to undergo VET on May 25, 2002 since his initial blood pressure was again very high - 200/90. For this reason, a neuropathologist sent the Captain in 2003 to be examined by a PEB psychologist, given his strong psychoemotional reaction to the VET and the discovery by the doctor of signs of heightened nervous tension during the examination of the pilot (tremor of the cheeks and hyperhidrosis of the palms).

However, the psychologist does not write anything in the conclusion about the pilot's increased tendency towards psychosomatic reaction and the need for psychocorrective steps, in particular, the need for the pilot to learn techniques of self-control (auto-training).

Note: *The psychologist ought to have made an entry in the medical record about the need for psychocorrective measures, in particular, those that are more suitable in psychosomatics, in accordance with the "Guidelines for psychological support...". The Guidelines state: "Depending on indicators from personality testing, the psychologist is required to give an opinion about the essence of observed deviations, their temporal (situational) or lasting nature, the possible effect on professional activity and the somatic condition. If needed, the issue of psychiatric examination is resolved in conjunction with a neuropathologist. Indicators for psychological rehabilitation and correction also need to be indicated and the method on how to execute them recommended".*

A similar situation involving the medical and psychological examination of the Captain was repeated in 2004. Before going through the next PEB, the pilot undergoes rehabilitation treatment with sedatives but, in spite of this, he exhibits an excessive heart rate (HR) indicator (164 beats per minute) during a veloergometric test carried out on June 29, 2004. This rate is dangerous to health. In view of this situation, the neuropathologist again sent him to be examined by a psychologist but the latter's opinion again contains nothing about the marked tendency towards psychosomatics and the need to undergo psychocorrection. It is possible that the neuropathologist, dissatisfied with the conclusions of the psychologist in 2003 and 2004, again sends the pilot back to the psychologist in 2005 (we note that an annual checkup by a psychologist is not mandatory for persons younger than 50 and is carried out only by special referral from a neuropathologist). The medical history sheet does not contain the results of his visit to the psychologist in 2005.

It is possible that the PEB psychologist did not initiate independent psychological examination in December 2005 on the basis of the referral from the neuropathologist because the psychologist possessed data from the psychological testing of the Captain that was carried out at the beginning of 2005 by a psychologist from Sibir (in Moscow) for the purpose of evaluating the pilot's suitability to undergo conversion training on the new type of airplane (A-310).

Note: *From 1986 to 2001 the rules for selecting candidates among pilots for conversion training on new equipment, including the list of methods for their testing, quantitative criteria for the assessment of results and the rules for drawing conclusions were regulated by the "Guidelines for psychological selection in civil aviation" (1986). In this connection for over 15 years psychologists have carried out examinations to select candidates for conversion training using a standardized set of methods, have applied established criteria for the assessment of results and used one of three prescribed formulations to draw conclusions: "recommended in the first instance", "recommended in the second instance", "not recommended for conversion training". However, these rules were not incorporated in the new 2001 Guidelines for selection because they were planned in the long term for clarification and renewal (considering new types of aircraft). Since this section of the Guidelines was not consequently updated, this now allows airline psychologists to independently apply a select set of tests and their own criteria for selecting candidates for conversion training. Thus, the rules for drawing conclusions when selecting candidates for conversion training turn out to be dependent on such subjective factors as the psychologist's professional expertise and competence, which can prove to be inadequate. This circumstance indicates the need for the fundamental updating of the section of the Guidelines relating to the selection of pilots for conversion training on new equipment, which involves the development of clearer and statistically justified criteria for the previously used testing methods as well as the involvement of new methods with standards developed for the flight crew.*

Given the absence of any clear indications in the rules for selecting candidates for conversion training, the psychologist from Sibir carried out the *psychological testing of* the Captain *in 2005 using a set of tests that she chose independently. It should be noted that the psychologist selected a sufficiently wide range of psychodiagnostic methods to assess both intellectual and personality features.*

Although the pilot again demonstrated in intellectual tests a sufficiently high level of integrity of his psychological functions, the personality methods evaluating not the intellect but emotional reactions and human behavior showed contradictory results. For example, the Sondi test conclusion gives a characterization of his emotional state: "emotional instability, emotionally intense reaction to stress with a tendency towards fears".

The Kettell test indicates the contradictory combination of a high degree of emotional instability with an equally expressed self-control of personality over his behavior and discipline.

Note: *The Kettell test is considered an insufficiently reliable method. For this reason, the main personality method recognized in civil aviation was the MMPI method and not the Kettell test. This is indicated in the "Guidelines for psychological support..." (2001). The reason for such a decision regarding the Kettell test was the following circumstance described in the "Guidelines for the application of personality test methods to reveal delineated psychopathological conditions for psychophysiological selection in civil aviation" (1983): "One shortcoming of the method in its present form is the absence of a population standard for a modified Russian version of the test. To obtain such a standard the test can be used only as an auxiliary method for comparing studied groups among themselves without attempting to make judgments about the relation of the data obtained against a population background. Even in this case we should consider the possible discrepancy between the standardization used (within the limits set) and the actual population standard" (page 6).*

Despite the fact that a population standard for the Kettell test has now been updated, nonetheless the evaluation of the personality traits of a flight crew according to this test has to be treated with a certain degree of caution since its guidelines have not been verified with a flight crew and have not been approved for use in civil aviation.

In conclusion, there is this entry about the other test - the Lusher test: "Worried, irregularities possible in the self-regulating system. Because of the marked preponderance of processes of stimulation of the nervous system, there is increased susceptibility to external factors, and impulsive (hasty) actions are probable."

Typically, the generalized description by the airline psychologist of the pilot's test results did not reflect the negative characteristics of the Captain’s personality and contained only the positive aspects. Accordingly, recommending the Captain for conversion training on the A-310 airplane, based on a non-objective conclusion, was insufficiently justified.

It should be noted that the psychologist who evaluated the pilot's suitability for conversion training on new equipment should base his or her recommendation on a prognosis of the success of such conversion training, for which the psychologist must be especially careful in relating to the content of test results obtained and primarily to any negative characteristics, since they more often than not reflect the ways of behavior of personality under conditions of increased stress and extreme conditions.

The test data obtained by the airline psychologist were not entered by the PEB psychologist in the medical history sheet, despite the fact that the neuropathologist had requested the airplane captain's 2005 data from the psychologist as he was interested in the pilot's level of emotional instability.

Note: *The very fact that the neuropathologist was sending a middle-aged pilot (who still did not have any age-related and neurological illnesses) every year to be examined by a psychologist could mean only one thing: the neuropathologist recognized the presence in* **the Captain** *of serious psychosomatic problems that do not lend themselves to medical treatment and wished to draw the psychologist's attention to this.*

Since the degree of emotional reactivity of a person is a universal characteristic of that person's personality, that is, it manifests in all aspects of the person's life (in everyday life, during medical examination, at work, etc.), then based on test results one can predict the degree of emotional reactivity of the personality, including reactivity during flight, as it is carried out during professional and psychological selections in civil aviation flight academies when test results are used to predict the success of a candidate's future flight activity when training to be a pilot **("Guidelines for psychological support for the selection…", 2001). However, both the airline psychologist and the PEB psychologist do not have a negative prognosis of the success of execution of flight activity by the given pilot under conditions involving stressful factors.**

In addition to the medical documents, it has been established that in April 2001 the Irkutsk PEB was asked to evaluate the airworthiness of the Captain when the pilot was still working at the Sayany airline, and decide on whether to decommission him from flying (as indicated in sick note no. 6 of Apr. 9, 2001).

However, it is important to note that the pilot was decommissioned for incomprehensible reasons based on a diagnosis that was never officially assigned to him according to results of medical examinations, namely, the diagnosis of "ischemic heart disease" (IHD) - Article 21.1 of the Federal Aviation Rules for Medical Certification (1998).

Therefore, when the Captain’s records were sent to CPEB (Central PEB in Moscow) for final confirmation of his diagnosis so he could be decommissioned from flight duties, and when the reasons for the diagnosis of IHD were being considered, it was discovered that the diagnosis was unfounded: studies on ECG and VET gave a doubtful result for IHD, and a scintigraphic test gave a clearly negative result on the presence of IHD. Consequently, the CPEB did not confirm this diagnosis and pronounced the Captain fit for flight duties.

After the pilot returned to flight duties but this time at Sibir, he started undergoing observation for the diagnosis of hypertensive disease (stage 1), which also falls under the category of psychogenic diseases.

The following conclusions can be drawn from a thorough analysis of his medical and psychological records:

1) The Captain was prone to display marked psychosomatic reactions under the influence of stress factors;
2) Psychosomatic reactions are usually manifested in the sharp increase of arterial pressure, acceleration of the heart beat (which was observed during an examination of the Captain), headaches and cardiac pains, which lead to a decline in mental capacity, as well as in muscular cramps and limb tremors, which have a negative effect on the nature of a pilot's movements; considering that psychosomatic reactions are a universal form of an organism's reaction to everyday and professional stress factors, these reactions could also have been anticipated from the Captain when he was flying the airplane, but this prognosis was missing from the psychological records;
3) The recommendation by the Sibir psychologist to have the Captain undergo conversion training on the A-310 airplane, based on a non-objective opinion about the personality features of the pilot, was insufficiently justified.
4) The section of the "Guidelines for psychological support for the selection, training and professional activity of flight and controller teams of civil aviation of the Russian Federation" does not provide psychologists with standardized rules to carry out selection of candidates for conversion training on new equipment and needs to be thoroughly updated.

Therefore, the psychosomatic reactions that were typical for the Captain could have a negative effect under stress conditions on the pilot's quality of work, in particular, on the timely recognition of an abnormal situation and the taking of appropriate steps to prevent its development.

2. Analysis

On July 8-9, 2006 an A-310 airplane with state registration number F-OGYP (France), operated by OAO Aviakompania Sibir, and with a crew consisting of the Captain and the co-pilot, was flying scheduled passenger flight C7 778 from Domodedovo to Irkutsk.

Apart from the two flight crew members, there were 6 flight attendants and 195 passengers on board (of these, 2 worked for the company), which included 181 nationals of Russia, 3 of Germany, 3 of the PRC, 2 of Poland, 3 of Belarus, 2 of Moldova and 1 of Azerbaijan.

The airplane's payload according to the flight manifest was 19,800 kg, its take-off weight 140,414 kg (maximum permissible – 150,000 kg), center-of-gravity position – 25.5% (the range of permissible center-of-gravity positions for take-off is 18 - 32%).

The A-310 F-OGYP airplane (serial number 442) was manufactured at the Airbus Industry plant (France) on June 11, 1987, and was owned by Wilmington Trust Company, acting as the holder of fiduciary rights (USA). The initial type certificate no. 145 was issued by DGAC France on May 27, 1987. The airplane also had a type certificate no. 15-310 of Oct. 25, 1991, issued by USSR Gosaviaregistr, with amendment on Oct. 1, 1993 issued by IAC Aviaregistr.

The airplane had airplane registration license no. B23968 dated June 2, 1995 and current Airworthiness License no. 25076047462 dated Mar. 22, 2006 issued by DGAC France.

The A-310 F-OGYP airplane began to fly commercial flights on July 18, 2004 based on a sub-leasing agreement dated May 7, 2004 between OAO Aviakompania Sibir and Airbus Leasing II, Inc.

Before Sibir started to operate this airplane, the passenger cabin was converted from a three-class configuration with 185 seats into two classes with 205 seats (section 1.6).

The F-OGYP airplane had no breathing equipment on board for the two flight attendants responsible for the emergency exits in the middle part of the cabin. The breathing equipment for the flight attendants in the tail section of the cabin was located on the wall at the side of the passenger cabin. This did not allow flight attendants to quickly fetch it if the need arose.

Note: *Another* Sibir *airplane (serial number 453, reg. F-OGYQ), which had the same cabin configuration, had breathing equipment on board for 6 flight attendants.*

The availability of this equipment on board an airplane was regulated by clause 5.8.5.3 AAS-3, by which the A-310 was certified in the USSR. This clause states that "...Flight attendants to whom the flight manual assigns the duties of providing assistance to passengers when smoke appears in the cabin should be *supplied with additional smoke masks. The device with the smoke mask attached to it should meet the requirements of 5.8.4.2.4 and should be installed in a place that is easily accessible by the flight attendants".*

According to the information received from EASA the certification basis for A-310-300 (FAR-25 amendment 1 through 45) and particularly item 25.1439 amendment 38 do not require the presence of smoke masks for each cabin crew member.

Sibir was authorized to operate an A-310 type airplane based on Decision no. 157/007 of the Flight Inspection Administration (FIA) of FTOA on June 28, 2004. However, the Agreement on continued airworthiness between the State of Operator (Russia) and the State of Registry (France), as described by Article 33 of the Air Code of the Russian Federation, was not signed. The previous Agreements on the operation of French-registered A-310 airplanes at Aeroflot and Saxa-Avia airlines had run their course by the time these airlines had stopped operating this type of airplane.

Note: *French Civil Aviation legislation does not require this kind of agreement to be signed.*

The airplane has flown 59,865 hours since the start of operations and has made 12,550 landings, which do not exceed the established and assigned resource (80,000 h/35,000 landings).

All types of maintenance prescribed by regulations were carried out by the due dates and in full. Before the last flight, operational types of maintenance were carried out on the airplane at Domodedovo airport: "DLY check" and "PF" (daily and pre-flight maintenance checks). The maintenance personnel who took direct part in the technical servicing of the airplane had valid licenses authorizing them to work. The level of professional training of the maintenance personnel met the requirements of the State of Registry and Operator of the airplane.

Note: *As a result of a study of the airplane's maintenance records and an analysis of evidence given by specialists of OOO S7 ENGINEERING, it was established that 6 malfunctions and failures on the airplane had not been rectified at the time of take-off. According to the standard documentation (MMEL) of the designer and manufacturer of the airplane - Airbus Industry, as well as the current* Sibir *"Minimum Equipment List" (MEL) approved by the Federal Transport Oversight Authority on June 7, 2006, with subsequent Revision no. 1 on June*

20, 2006, flights with recognized malfunctions and failures may be carried out during the time corresponding to each malfunction and fault.

Special attention among the above-mentioned malfunctions and failures is focused on the deactivation in the last flight of the system for ***reverse thrust of the left engine****, which is related to the failure of the thrust reverser during a prior landing at Irkutsk airport that was recorded by* the Captain*. It should be noted that the prior flight along the route Domodedovo - Irkutsk - Domodedovo was carried out by* the Captain *with a deactivated thrust reverser on the* ***right engine*** *because of the malfunction of the flexible drive shaft. After the non-rectification of the failure of the thrust reverser on the* ***left engine****, this thrust* ***reverser was deactivated****, and the flexible shaft from it was installed on the reverser on the right engine, which was used to* ***bring the right thrust reverser into working order (activated)****.*

Apart from the above-mentioned deactivated condition of the reverser of engine no. 1, at the time of take-off the ***presence of 5 more non-rectified failures*** *was recorded in the flight log.* ***Among these were the following failures: auto-pilot no. 2 and system no. 2 on the flap control[11].***

In the first six months of 2006, 86 extensions of deferred defects (expired dates beyond those prescribed in the MEL) on A-310 airplane were documented with the permission of the Airworthiness Support Administration of the FTOA. A study of the history of the operation of the airplane that was involved in the accident also shows the presence of repeated failures (for example, in the auto-pilot system) which, in conjunction with the large number of extensions of deferred defects, attests to the shortcomings in the maintenance of A-310 type airplane at Sibir.

It should be noted that the presence on an airplane of such a number of authorized deferred defects or their combination does not have any standardized limitations, which allows airplane to fly even with a whole series of failures and malfunctions, which may significantly complicate the flight operation of an airplane and have a negative effect on the

[11] This failures did not contribute to the accident

psychophysiological condition of the crew.

All aircraft and engine systems, with the exception of the defects deferred as per the MEL, were operational upon take-off from Moscow. The commission also did not discover any signs of failure of any aircraft or engine system during the last flight, with the exception of the destruction during the landing run of the tread of one tire (after the crew fully depressed the brake pedals) on the right main landing gear bogie, which did not influence the effectiveness of the airplane's deceleration (see below).

On the day of take-off on July 8, after arriving at Domodedovo airport, airplane captain the Captain and the co-pilot, following Sibir airline regulations, initiated pre-flight preparation at 15:15 by undergoing a medical checkup 2 hours before the planned time of take-off. The crew had been created and consolidated by Order no. 34 of the ADD on June 2, 2006. The crew in its present form had flown ***12 flights***. The crew's preliminary training was conducted on Apr. 24, 2006 when they went through their spring-summer navigational training.

The members of the crew had current pilots' licenses with the corresponding qualification marks. The professional training of the crew members was conducted by the "AK Sibir" aviation training center on the basis of the flight personnel training course developed by the airline and approved by the aviation authorities of the Russian Federation.

The A-310 flight personnel training course at Sibir allows airplane captain commissioning of pilots who have solo flight experience as captains on class 1 Russian airplane without undergoing the co-pilot training course and without flight operations experience in this position. About 20 A-310 airplane captains, including the Captain, went through this commissioning course. Analysis showed that out of 62 A-310 airplane captains who worked at Sibir from the middle of 2004 to August 2006, only 20 pilots went through the training cycle including: co-pilot training, commissioning as co-pilot, flight operations experience in this position for up to one year, conversion training on the airplane captains' training course and commissioning as airplane captain.

The standard flight experience under the Sibir FPTP for those undergoing conversion training from the position of airplane captain of Russian airplane is 30 flights (up to 150 hours); and for pilots who have no solo flight experience as airplane captain - 300 hours. However, according to Aeroflot's FPTP, the totals are 500-1000 hours, which is 3-5 times more than what is prescribed.

Note: *There is no unified course in the Russian Federation for flight crew advanced training that focuses on learning the characteristics of crew resource management (CRM) when undergoing conversion training from Russian airplane with three or more crew members to airplane with a two-man flight crew.*

The total flight experience of the Captain on the A-310 airplane was ***1,056 hours***, of these ***1,013*** were solo as a captain (approved on June 1, 2005 by

Order no. 836), this means his flight experience as a trainee until he was approved for the airplane captain’s position was ***43 hours*** over three weeks. ***He had no flight operations experience as a co-pilot on the A-310.*** Before undergoing conversion training for the position of captain of An-24 and Tu-154 airplane, the Captain had flight operations experience as co-pilot on these types of airplane, totaling 2,445 hours (from 1983 to 1987) and 2,930 hours (from 1991 to 2000), respectively.

Note: *In 2005 the airplane captain was tested by an airline psychologist and was recommended for conversion training to the A-310. However, the independent expert evaluation (section 1.18.4) of materials from the psychological examinations revealed a series of personality features of* the Captain *that were not mentioned in the airline psychologist’s conclusion. In particular, it was noticed that “in terms of prognosis,* the Captain *is more effective in secondary roles.” The training of pilots with similar personality features requires: "the drilling of a maximum possible number of irregular situations, which brings them out of the league of the irregular and stressful category into of the normal, familiar and controllable category.” and "longer skill learning and training until they become automatic".*

The total flight experience of the co-pilot on the A-310 was ***158 hours***, of which ***92 hours*** were solo. The co-pilot was appointed to the position of co-pilot on May 5, 2006 by Order no. 1218, that is, his flight operations experience in this position was about 2 months.

Therefore, the commission believes the Captain’s personality features as well as the actual level of training and flight experience of the crew members on the A-310, may have influenced the outcome of the flight significantly.

During pre-flight preparation the crew received full meteorological support for the take-off airport, the flight route, the destination airport of Irkutsk and the diversion airport of Bratsk. The forecasted and actual weather did not hinder the decision to take off according to version 3 "Duration of flight to destination airport calculated at more than 5 hours" of Table 1, clause 5.5.11.1 of CAFOM-85, given the presence of the diversion airport at Bratsk.

During the pre-flight preparation the crew was given a provisional estimate of the flight, which estimated the duration of flight to Irkutsk at 5 hours 25 minutes, and a fuel load of 33,110 kg. Based on an analysis of the meteorological conditions, the Captain decided to increase the fuel load to 37,200 kg.

At the end of the pre-flight preparation, the airplane captain took the justified decision to fly.

During the pre-start preparation there were no deviations from the established requirements discovered on the basis of the available information.

On board the airplane were 195 passengers (of these 2 were service personnel), 2 flight crew members and 6 cabin crew members (flight attendants).

Take-off from Domodedovo was at 17:17 from runway 32 (right) in the following configuration: slats/flaps - 15/15 degrees, stabilizer set at position +1.4 degrees, with engines at "flexible" mode.

Take-off, climb and the flight along the route occurred without deviations. Auto-pilot no. 1 was used during the flight (auto-pilot no. 2 was not used because of its malfunction).

Note: *According to technical records, the defect of auto-pilot no. 2 was discovered on June 23, 2006. Replacement of the rudder servo did not eliminate the defect, which was discovered again on July 4, 2006. The defect was entered in the list of deferred malfunctions with a rectification deadline, in accordance with the MEL, of no later than July 14, 2006. During a prior flight on the same airplane (Irkutsk - Moscow), according to his report,* the Captain*, deactivated auto-pilot no. 1 after take-off because of a malfunction. The entire flight was carried out in manual mode. The defect was not confirmed during maintenance done at Domodedovo on July 7, 2006. There were no failures of auto-pilot no. 1 recorded during the last flight.*

Initially, at 17:32 the airplane was taken to 8,100 m. During the flight and as the flying weight decreased, the crew occupied higher altitudes of up to 11,100 m.

At cruising altitude the crew used the AFS "profile speed" mode during horizontal flight. Once it hit a zone of turbulence at 21:54, the crew activated control mode M for 4 minutes.

Before entering the Irkutsk ATC area, the crew obtained Lima ATIS information for 22:00 on the weather conditions at the airport: "surface wind - 280 degrees 4 m/s, visibility 3500, weak showers, complete cumulonimbus clouds 170, temperature +11, pressure 707 mmhg or 943 gPa. Condition of runway: wet, 100%, 2 mm, friction 0.5".

For the airplane's landing weight of ~114,000 kg, the calculated required landing distance on a wet runway using automatic wheel braking in LOW mode and without using the engines' thrust reversers is 1,850 m (FCOM 2.15.30). The landing distance available on runway 30, given the shifted entry threshold, was 2,425 m. Therefore, the landing weight and calculated landing center-of-gravity of the airplane (29.8% CAX) did not exceed the established limitations of the assumed landing conditions.

Note: *The required landing distance for the actual landing weight, with the automatic brake system in LOW mode, without using the thrust reverser on the right engine and for a runway "covered with water" (depth up to 6.3mm), was 2000 meters. Use of the thrust reverser on the right engine reduced the required landing distance by 75 meters for a runway condition of "wet" and by 125 meters for a runway "covered with water".*

The following radio equipment for landing approach was operational at the airport with a landing heading of 295º: outer and middle markers, VOR+DME beacon, localizer beacon of the ILS 295 system (the glidepath beacon was taken out of service because of the offset of the runway threshold, about which there is a corresponding NOTAM). A control radar was used to monitor the trajectory of the airplane's movements.

Given the above-mentioned list of conditions, the Captain chose the landing approach system "LSE with fixed glidepath entry point" where the required weather conditions should not be worse than the following: visibility 2500 m and cloud base 105 m. The chosen system of approach ensured the safe execution of landing in the actual weather conditions.

At 21:46 at 11,100 m and a speed of 490 kph (265 knots), when overflying the Lonka compulsory reporting point (CRP), on a frequency of 124.7 MHz, the crew informed the controller of Irkutsk regional center of their estimated time of arrival at Irkutsk airport as 22:40, confirmed the diversion airport (Bratsk) and received the instruction from the controller to maintain 11,100 m until the estimated time of starting their descent to the Razdolye CRP at 5,700 m.

At 22:16 the airplane was taken to the calculated point of starting their descent, which the crew reported to the controller, first on the emergency frequency and then on the frequency of 124.7 MHz, and received permission to descend to the Razdolye beacon at 5,700 m.

The co-pilot explained his error in using the emergency frequency: "…I didn't switch it over. …It's night, and we're not getting enough sleep", which was recorded by the CVR.

Note:

1. *The conversations recorded by the CVR were intact from 22:14.*
2. *One USW radio set on board the airplane is always tuned to the emergency frequency.*

At 22:16:40 the crew switched the profile speed AFS over to profile descent and initiated descent. The profile descent and vertical speed AFS modes were then used for the descent. Descent to 5,700 m was carried out at an average vertical speed of 12 m/s.

During descent at 9,100 m the anti-icing system (AIS) for the engines was switched on at the airplane captain's order and remained on until the end of the recording.

At 22:25 the crew reported passing over the Razdolye CRP at 5,700 m, the receipt of Lima ATIS information (for arrival) and switched over to communication with "Irkutsk approach" on a frequency of 125.2 MHz.

The approach controller confirmed to the crew the location of the airplane and permitted descent to 2,100 m.

During the descent at 4,200 m the wing AIS was switched on for 3 min at the airplane captain's order.

At 22:32 min the crew listened to the Mike ATIS information (for arrival), which indicated that there were minor changes in the direction of surface wind from 280º to 270º, and that the height of the cloud base had increased from 170 m to 190 m. The remaining parameters remained unchanged: wind speed 4 m/s, visibility 3500 m, weak showers and 8 octants of cumulonimbus clouds.

Note: *According to data from the KRAMS visibility detectors mounted at the threshold and in the middle of runway 30, visibility was 4400 m - 5600 m from 22:30 until the moment of the accident.*

After listening to the ATIS information, the crew reported receipt of the Mike information, their altitude as 2,100 m and requested an approach by non-directional beacons.

Note: *The friction coefficient measured in accordance with 1994 RF CAOG for the runway (0.5) and the deceleration conditions on the wet runway reported by the airport services on the basis of this measurement (braking action good) were reported to the crew via MIKE information. The simulation carried out and results of prior flight tests shows that the actual characteristics of braking corresponded to the conditions for a runway "covered with water".*

The distribution of crew duties during landing approach, according to data from the decrypted conversations inside the cockpit, was as follows: active piloting (PF) – airplane captain, control of piloting and communication (PNF) – co-pilot.

In passing through transition level H=1,800 m the crew set the pressure to 943 gPa and went through the Approach Check List in accordance with SOP's. After informing the controller of the airport pressure setting and descending to 900 m on the base leg, the crew received permission to continue their approach.

Approximately 5 miles from the base leg at a speed of 413 kph (223 knots) and at a height of 940 m, the co-pilot extended the slats to 15º at the airplane captain's order. At a speed of 367 kph (198 knots) and at 940 m the flaps were also extended to 15º.

At 22:36:46 the co-pilot reported to the controller that they were in the area of the base leg at 900 m and received information that the cloud base was at 190 m, and received permission to descend to 850 m on the final leg.

After turning at the base leg using the auto-pilot, at a speed of 325 kph (175 knots) and at 920 m, the co-pilot increased the flap angle to 20º at the airplane captain's order. The AFS mode was switched over to the control mode for set heading and vertical speed.

At 22:38:12 the co-pilot reported the completion of the final leg at 850 m, whereupon he received instructions to work with the tower on a frequency of 118.1 MHz.

After exiting the final leg and before starting the pre-landing descent, the crew turned on the wing AIS. This remained on until touchdown.

The Irkutsk tower controller permitted the crew to continue landing approach on runway 30. 2.9 nautical miles before the glidepath entry point, at a speed of 275 kph (149 knots), at a height of 860 m and on a heading of 313º, the co-pilot at the airplane captain's order released the landing gear and armed the spoiler handle, and 1 mile before the glidepath entry point brought the following parts to their corresponding final positions: slats 30º, flaps 40º, after which the crew went through the Landing Check List in accordance with SOP's.

At 22:40 the tower controller notified the crew: "Sibir 778, distance 15, on course, approach glidepath".

One mile before the fixed start-of-descent point, the co-pilot informed the airplane captain of their approaching the start-of-descent point. In accordance with the crew work procedure, the airplane captain increased the set approach height by 1 point and prepared the "vertical speed" mode for use in the longitudinal channel.

Descent to the final approach leg was carried out using the airplane captain's navigational display in VOR mode, and that of the co-pilot in ILS mode, to control the airplane's position relative to the course using indications from the localizer beacon.

The airplane captain steered by auto-pilot using the side channel of the heading selection handle and the vertical speed selector in the longitudinal channel.

On the final approach leg, the auto-throttle of the engine worked normally, using the set speed of 255 kph (138 knots). The position of the throttle control levers for both engines changed at the same time and stayed within the range of 45º - 48º[12] (9-12° TLA), while the thrust of both engines was 1.04 – 1.06 by

[12] Hereinafter the TRA values of deviations of the TCL and RTL are taken from the FDR. Conversion of FDR indicators into TLA values follows this formula (TCL_{FDR}-36.6)*1.16

EPR. The ground speed on the final approach leg was an average of 240 kph and the vertical speed of descent was 3.3 m/s.

At 22:40:18 the co-pilot reported: "Sibir 7-7-8 descending, landing gear down, ready for landing", whereupon he received the controller's permission to land.

At 22:42:40 at 240 m (according to the approach procedure - 245 m) and a speed of 257 kph (139 knots) the outer marker was passed, which the co-pilot reported to the controller.

At 22:42:43, according to conversations inside the cockpit, it was noticed that the nose landing lights were switched on.

At 22:42:45 the crew switched on the windshield wipers. The noise made by the wipers can be heard on the CVR recording.

The co-pilot notified the airplane captain about the decision height (DH) 100 feet before approaching it.

At 22:43:13 at a distance of 1500 meters from the offset threshold of runway 30 and 105 m above it, the crew disengaged auto-pilot no. 1, and switched off the auto-throttle 2 seconds afterwards. The TCL was steered manually from then on. After the auto-throttle was disengaged, there were no more steering commands from the thrust control computer (TCC) recorded on the FDR. Couplings connecting the auto-throttle to the engine control cable were disengaged and were no longer connected to the control cable. This is also confirmed by data from the FDR.

At 22:43:19 the middle marker was passed at 92 m according to the radio altimeter and at 260 kph (140 knots) (according to procedure, the height for passing over the middle marker is 96 m).

On the final approach leg the crew adjusted the position of the airplane in relation to the set the descent trajectory by comparing with the current one and set their height according to the distance. The crew corrected their vertical and lateral deviations from the set trajectory correctly and in due time.

Consequently, upon emerging from the cloud cover the airplane was at the set altitude with a minor deviation to the right. In switching over to visual piloting, the airplane captain made a small elevator deflection to pitch down which led momentarily to an increase in vertical speed and activation at 22:43:30, at 30 meters according to the radio altimeter, of the "SINK RATE" ground proximity warning.

Based on the FDR data (0º – 18º - TLA), the Captain moved both thrust levers from 51.6º to 36.6º (idle before touchdown) to control the speed of the airplane. At 22:43:40.5 the airplane captain landed the airplane at a speed of 244 kph (132 knots) with a vertical G of 1.2, without banking, at a distance of about 200-300 meters from the offset threshold of runway 30.

The landing weight and center-of-gravity settings were 113,572 kg and 29.8% respectively. These values did not exceed the established limits.

Note: *The crew did not fully complete the actions* *prescribed by Sibir A-310 SOP for pre-landing planning and landing operation. Thus, in accordance with clause 3.1.7 of the SOP, when carrying out an approach landing based on an inaccurate system, the crew ought to have announced (by speaking aloud) the changes in the FMA modes and passing control points during their pre-landing descent. These operations were not fully carried out.*

The co-pilot did not make the call-out when reaching the decision height. The captain did not announce the decision to land or the command to set the landing course on the FCU.

These shortcomings did not affect the landing operation, but they attest to insufficient precision in the crew's observance of the established work procedures.

Immediately after touchdown (main strut compression), with the spoiler handle armed, all spoiler sections were automatically released (seven sections of each wing surface).

1.5 seconds after touchdown the reverse thrust lever (RTL) of the right engine was moved to idle by the captain, and 3 seconds after that, after the reverser doors were in their working position, switched to maximum reverse thrust. Engine reverse thrust then started to increase. In violation of SOP's, the co-pilot did not call out the completion of reverser door movement to the working position (**Rev Green**). The crew did not activate the reverse thrust lever for the left engine.

Note: *In operating the A-310 airplane with P&W 4000 engines, it is not recommended to use the reverse thrust lever of an engine whose thrust reverser has been deactivated. This fact rules out the possibility of applying a uniform procedure for controlling reverse for various airplane modifications and in case of any asymmetric use of the reverse. There are no physical or electrical blockages against any erroneous displacement in the direction of forward thrust of the throttle control lever for an engine whose thrust reverser has been deactivated.*

Section TR 02-78 of the Master MEL and the corresponding section of Sibir's MEL, defining the features of operating an airplane with a deactivated thrust reverser, contain a warning that the pilot flying the airplane must hold the thrust lever in the idle position during a landing run to prevent any inadvertent *movement of the thrust lever in a forward direction.*

Sibir's FPTP does not provide for any training to learn this skill.

Afterwards the airplane captain began to shift the RTL of the right engine to reduce reverse thrust. Simultaneously with moving the RTL of the right engine, the FDR records a change in position of the TCL of the left engine, which in 3 steps, over 16 seconds, increased from 36.6º (idle, 0º - TLA) to 59º (~60% of the full rated takeoff thrust, 26º - TLA). It should be noted that the direction and periods of movement of the RTL of engine no. 2 to reduce the reverse thrust and the TCL of engine no. 1 to increase forward thrust coincide.

Analysis of data from the flight data recorder and the results of the investigations showed that:

- no failures of airplane and engine systems, including FADEC and TCC, which could have led to the inadvertent movement of the TCL, were discovered;
- after deactivation of the auto-throttle and before the airplane's touchdown, the airplane captain initiated regular control of engine thrust in order to maintain flight speed by means of the synchronous displacement of both TCLs;
- the TCL and RTL movement signal was sent to the on-board parameter recorder from the FADEC which, in turn, received signals from the sensor unit (resolver) that was mechanically connected to the throttle control levers (RTL and TCL) via 2 actuating rods and 3 arms. Signals from the resolver to the FADEC arrived in electronic form. FADEC did not have any feedback coupling with the mechanical portion of the engine control cable. After the accident one actuating rod of the mechanical portion of the left engine control cable, directly adjacent to the TCL, was found. Connections on it were fastened and secure. Based on all available data and a schematic analysis of the engine control system, the engineering sub-commission came to the conclusion that any malfunction of the mechanical portion of the control cable or failure (kinematic destruction) of the airplane's engine control system was extremely improbable;
- the thrust on both engines, recorded by the FDR as the airplane was on its landing run along the runway, corresponded to the calculation of the recorded position of the TCL/RTL and the actual conditions at Irkutsk airport.
- the functioning of the limit switches responsible for the automatic retraction of the spoilers and blocking of the reverser activation, which actually serve as auxiliary and independent TCL position sensors, occurred in the recorded positions of the TCL for the left

engine corresponding to the marked (theoretical) positions (10 and 22 degrees TLA, accordingly);

- the recorded deceleration loads were insufficient for any self-movement of the TCL forward, even if the friction coupling applying additional forces on the TCL failed completely;
- over the entire history of operation there was no case of failure or malfunction that would have led to the mutual mechanical meshing of the engine control cables. The penetration of foreign objects that could create a "semirigid connection" working only in one direction between the control cables of the two engines was practically impossible because of the principles inherent in the TCL design. All prior failures of the mechanical portion of the engine control cable were related to jamming (impossibility to move) of the cable for various reasons.

Thus, the movement of the left engine TCL, as recorded on the FDR, where the thrust reverser had been deactivated, to increase forward thrust, really occurred and was a consequence of the involuntary and uncontrolled actions by the airplane captain during his efforts to control the thrust reverser on the right engine on the run after landing.

Results of experiments conducted on A-310 airplane with P&W engines (section 1.16.4) showed that, because of a weakening of the friction coupling's pull, the forces needed to move the throttle control lever can be greatly reduced during operation, up to ~400 g, which is practically 3 times less than the minimum permissible amount indicated in the AMM (1.17 kg) and corresponds to the control cable's own friction forces, without any additional forces coming from the friction coupling.

Note: *Existing technical maintenance documentation (MPD) of the A-310 airplane did not provide for the periodic inspection and adjustment of the forces. This work is carried out at irregular intervals at the request of flight crews whenever they feel uncomfortable in controlling the throttles. There was no such record found in the log book of the accident airplane.*

Considering the fact that the age and number of flight hours of this airplane exceeded those of airplane that took part in the experiment and, bearing in mind the effect of the deceleration loads with an average amount of 0.17 g, which additionally reduces the forces needed to move the TCL forward, one can assume that the forces needed to move the TCL during the accident flight were relatively small. The presence of shakes and vibrations that were typical of the runway at Irkutsk airport could have made the uncontrolled forward movement of the TCL even more unnoticeable by the airplane captain.

While the reverse thrust program of the right engine was in progress and maximum value of the reverse thrust level of 1.218 as per EPR was reached at 22:43:54, the average level of longitudinal deceleration was ~-0.17 unit, without the crew pressing the brake pedals. This attests to the working condition of the automatic brake system in LOW mode (ensuring deceleration with continuous slowdown -1.7 m/s^2).

Note: *According to the results of a simulation, it was established that the thrust of both engines as recorded by the FDR during the airplane's landing run on the runway corresponds to that calculated for the recorded position of the TCL/RTL and the actual conditions at Irkutsk airport. The airplane's progress along the runway was fully determined by movements of the TCL and the flight surface controls, as well as the engine operation modes selected by the crew. The airplane's aerodynamic and thrust parameters matched those of the airplane type. There was no influence on the airplane by any hazardous external factors (wind displacement etc).*

Any movement of the TCL for the left engine to a position greater than 10º, in accordance with work-inherent logic, caused the automatic retraction of the spoilers, which coincided with the time maximum thrust was reached by the thrust reverser on the right engine. Retraction of the spoilers led to the deactivation of the automatic braking mode.

Note: *In violation of SOP's, the co-pilot failed to report the deactivation of the automatic braking mode.*

At this time the speed was about 180 kph (98 knots) and, on account of the large asymmetry of engine thrust, the airplane started to turn to the right, which the airplane captain counteracted by depressing the left pedal from the 0º position to -30º (limit) and forcibly applying the brakes. The CVR recorded twice, at 22:43:55 and at 22:44:00, information from the airplane captain about his forcible braking of the wheels. The depression of the brake pedals was 14°, which was the structural limit. Analysis of prior flights has shown that the average depression of brake pedals during a landing run was 3°-5°. Deactivation of the automatic brake mode, retraction of the spoilers and the increase in the work mode of the left engine to forward thrust decreased the deceleration rate to 1 m/s^2.

After the accident pieces of rubber from the destroyed wheel tire protector on the right landing gear bogie were found on the right side of the runway, at a distance of 1340 - 1860 m from the offset threshold of runway 30. The location of the pieces of rubber corresponds to the stage at which the crew applied the brakes, using the pedals, at a speed of 170-165 kph (92-89 knots).

Note: *Investigations have shown that the destruction of one tire protector on the right main landing gear bogie did not affect the braking effectiveness of the bogie as a whole. It should also be noted that the MMEL (section 01-32) permits the take-off of an airplane even if the brake of one wheel on each landing gear bogie is not functioning.*

It was not possible to establish the exact cause of the destruction of the tire protector. Investigation revealed that the anti-skid system worked properly during the landing run.

At 22:44:01 the thrust reverser doors of engine no. 2 were in the intermediate position for 2 seconds, after which they switched over to the deactivated position, and they remained in this position until the end of the recording.

Starting from 22:44:05 and for 10 seconds the position of the TCL of the left engine decreased from 26º to 22º TLA. The thrust changed from 1.211 units to 1.16 - 1.17 units and was constant up to the end of the recording.

The minimum air speed during the landing run from 22:44:00 – 22:44:05 was 165 kph (89 knots), after which it started to increase. From that moment the crew had to start the active work to diagnose the situation when the role of the co-pilot in monitoring the engine speed and work parameters is paramount.

Note: *Sibir's A-310 SOP stipulated that the co-pilot must continuously monitor the engine parameters (EGT, N1) as well as the speed of movement of the airplane during a landing run.*
An analysis of the work of crew members shows that, at least before 22:44:15, the airplane captain's right hand was on the engine control module, that is, only the co-pilot could have manipulated the ECAM control panel and, until then, he could not have seen the position of the TCL for the left engine, as it was covered by the airplane captain's hand.

Therefore, the crew members, particularly the co-pilot, failed to exercise appropriate control over the working parameters of the engines and the airplane's speed during the landing run.

By depressing the brake pedals practically all the way to the limit, and because of the significant forward thrust of the left engine and deactivation of reverse thrust of the right engine, the braking force came to equal the total thrust of the engines. Speed stabilized and was about 180 kph (98 knots).

Note: *Simulation has shown that the actual coefficient of friction on the runway segment where the crew forcibly (non-automatically) applied the brake (over the last 2000 m) corresponded to the standard values for a runway "covered with water". It was impossible to determine the condition of the initial third of the runway (wet or covered with water) because of the use at this stage of automatic brakes at LOW mode where an airplane is slowed down at a given rate under any condition of the runway. If the coefficient of friction corresponded to a "wet" runway condition, the airplane would have stopped within the limit of the runway, even given the actual forward thrust of the left engine, which was caused by the significantly larger magnitude (about 3 times) of the friction coefficient for the "wet" runway condition compared to a runway "covered with water" at speeds of about 150-180 kph, at which the forcible braking of the airplane was initiated on its landing run on the accident flight. Thus, the actual state of the runway was one of the factors that influenced the deceleration rate and speed value at the runway excursion moment.*

The existing procedure for estimating the state of the runway does not make it possible to accurately determine the braking conditions for water covered runways at speeds that are significantly greater than the measurements taken.

At 22:44:05 after the left TCL reached the 22º position TLA, the emergency signal for wrong take-off configuration was initiated, accompanied by the CRC audible warning and the MASTER WARNING light.

In accordance with the logic of the flight warning computer (FWC), the functioning of this signal should be blocked during the run after landing (stage 10). However, on this flight, because of the retraction of the thrust reverser, the location of the airplane on the ground at a speed of more than 70 knots and the position of the TCL of the left engine at more than 22 degrees TLA, the FWC shifted over normally to stage 4 (take-off) and issued a warning to the left ECAM display about the non-takeoff position of the flaps, slats and stabilizers, as well as the automatic copy of the ENG page on the right ECAM display.

In general, SOP and FCOM A-310 prescribe that, when the ECAM signal is initiated, the piloting crew member should give the command to the non-piloting member to take the necessary action and follow what is on the ECAM display (ECAM actions). The pilot not flying determines the type of signal, reads the messages on the screen and confirms whether the failure is actual or not. According to data from the recorded conversations in the cockpit, the captain of the airplane and the co-pilot did not audibly refer to any such actions when the emergency signal was activated. The average time needed to read out the text information that appeared on the ECAM display in this instance ("Flaps not in t.o. config, slats not in t.o. config, pitch trim not in t.o. range") is 7-8 seconds (according to results of tests with A-310 pilots at different stages of training).

In the case in question, the ECAM did not offer the crew any concrete actions in respect of their intention to perform a full landing. In fact, because of the crew's actions in moving one TCL to a position greater than 22°TLA, the ECAM indications referred to a non-take off configuration. On the other hand, one of the necessary conditions for the functioning of this signal is the position of the TCL of any engine at a position higher than 22 degrees TLA, which could have served as a clue to the crew.

Note: *FCOM A-310 1.9.50 contains the information that this warning appears if at least one engine has take off power without specifying the exact numerical criteria for take off power mode.*
SOP's and the A-310 FCOM do not specify any crew actions when this type of signal is actuated during a landing run.

While this emergency signal was sounding and continued to function until the end of the recording, the co-pilot reported completion of landing at the third attempt to the controller[13]. It should be noted that the SOP of Russian airlines during domestic flights provide for a "landing" report to the controller after deceleration to taxi speed. In this case the airplane's speed was well above taxi speed and the co-pilot's report could have hampered his performance to the detriment of the monitoring of instruments and landing-run parameters during a period of high workload, because of the necessity to determine the reason for the emergency warning being given.

At this moment the *psychological factor called the "phenomenon of mistrust"*, when the pilot does not trust the functioning of the emergency signal because of the improbability, in the pilot's opinion, of its functioning under the given flight conditions or because of its improper functioning, could have appeared and played a significant role. It is probable that this *phenomenon of*

[13] The fact that the report to the controller was done at the third attempt and "any old way" may also testify that the co-pilot was subject to the premature mental demobilization conditions described above.

mistrust was the reason for the inadequate reaction of the crew to the "*wrong take-off configuration*" signal. Instead of clarifying the reason for the functioning of the signal, the crew made long enough inputs to clear the ECAM screen by depressing the CLR and RCL buttons. This was confirmed by the disappearance and repeated reappearance on the FDR of the on-off command "Non-takeoff configuration". The crew's actions could have also distracted them from monitoring the instrument indicators for the engine and the airplane speed and, consequently, could have affected the time needed to diagnose the irregular situation.

Only after the report to the controller about the landing, when the airplane was at the 5th taxiway (850-800 m before the end of the concrete portion of the runway), the co-pilot, in response to the captain's "What's wrong?", answered "RPMs increasing", whereupon the "Reverse once again" command was given.

At 22:44:21 the crew (most probably the co-pilot) tried once again to deploy the thrust reverser on the right engine, for which he moved the RTL of the engine over to maximum reverse thrust but, per design, the location of the TCL for the left engine in a mode higher than 22° TLA (more than 55° on the FDR) prevented the operation, and the thrust reverser doors failed to unlock. The right engine remained at idle forward thrust.

The crew failed to determine the reason for the lack of braking effectiveness on the landing run after attempts to re-activate the thrust reverser on the right engine. This is confirmed by conversations of the crew immediately before the airplane overran the runway: "Why?" - "I don't know".

After this attempt to deploy the thrust reverser, the airplane started to swerve to the left. The crew depressed the right pedal to the 15° angle, which reduced the left lateral depression, and the airplane started to drift to the right. Full depression of the left pedal did not prevent the airplane from swerving to the right. The right main bogie exited the runway at a speed of 182 kph (98 knots), and the nose landing gear and the left main bogie moved along the reinforced concrete portion of the runway. The nose landing gear and the left main bogie exited on to the ground at the end of the reinforced concrete runway at 22:44:36.

Afterwards, until the airplane collided with the concrete barrier and the garages, it traveled over clay soil with a grassy cover. At a distance of 210 m from the threshold of runway 12, the left engine destroyed part of the antenna and the wooden fence of the localizer beacon system. At a distance of 250 m from the threshold of runway 12, the airplane crossed an asphalt bypass road.

The tracks made by the airplane's landing gear on the ground attest to its virtually straight trajectory until the collision with the artificial barriers. There is a difference between the airplane's travel vector and its construction line, which was approximately 6° - 9°.

The airplane stopped at 22:44:40 after colliding with a reinforced concrete airport perimeter fence and with brick structures (garages) behind it. The reinforced concrete fence was 2.8 m high. The place where the airplane stopped

(52° 16' 29.35 north, 104° 21' 59.71 east) was located at a distance of 310 m from the threshold of runway 12 and 30 m north of the heading line of runway 12. The magnetic heading of the construction line of the airplane was 270°. The airplane broke apart during the collision and burst into flames. The parts of the airplane's structure that remained intact after the fire were the left and right wing surfaces, the rear part of the fuselage and the tail unit. The airplane wreckage was not scattered.

Results of a study of FADEC engine control computers and the nature of the engines show that, in spite of the command by the airplane captain: "Shut down the engines" given at 22:44:33 (7 seconds before the collision), the engines were not shut down. At the moment of collision with the barriers, the left engine was working at higher rpm than the right engine.

The Captain who was the pilot flying the airplane should have shut down the engines himself or given more precise instructions to the co-pilot. It is probable that, having been under stress because of insufficient training on type, both pilots experienced the transferring of habits from a previous airplane type (Tu-154) where the flight engineer is the crew member who controls the throttles. That is, although the Captain gave the command but did not address it to any particular person, he assumed that it would be carried out by the flight engineer, while the co-pilot also failed to perceive that this command was addressed to him.

Thus, the analysis conducted showed that the development of the abnormal situation and its escalation into a catastrophic situation happened because of the crew's lack of teamwork as well as the co-pilot's inadequate degree of professional training in terms of monitoring the working parameters of the engines and the airplane's speed while on the landing run, which did not facilitate a timely and complete diagnosis of the situation or prevent the accident. The crew had enough time and information for the timely recognition of the situation. The aural and visual warnings were unexpected to the crew in relation to their intention of carrying out a complete landing and may have hampered their recognition of the situation. On the other hand, one of the necessary conditions for the functioning of this warning is the position of the TCL of any engine at a position higher than 22 degrees TLA, which could have served as a clue to the crew.

Simulation results showed that, if the crew had moved the TCL of the left engine from idle and again applied the thrust reverser after the co-pilot reported that "RPMs are increasing" (in this case the spoilers would also have been released automatically), then the overrun speed would have been around 70 kph. If the above-mentioned actions had been accomplished before 22:44:16 the airplane would have stopped before the end of the runway, that is, the crew had more then 25 seconds to perceive the irregular situation (from the moment the throttle control lever of the left engine started to move).

Analysis of incidents with a similar scenario involving the onset of an abnormal situation (section 1.18.3) showed that crews on average took 30-35 seconds from the time the TCL started to move forward to recognize the situation. After recognizing the situation, in all cases, what followed was the retarding of the TCLs for both engines to idle. This prevented the airplane from overrunning the runway at high speed.

Analyzing the possible reasons that, in conjunction with the co-pilot's lack of adequate experience, could have prevented the crew in this instance from switching the TCL to idle (or deactivating the engine), after recognizing that the speed was increasing (at 22:44:19, the co-pilot reported: "Speed increasing"), we should turn to the results of the airplane captain's psychological tests that were carried out from 2003 to 2005 (sections 1.18.4 and 1.18.5). Thus, given the adequately high degree of development and functioning of his cognitive functions, a high degree of sensitivity to the effects of the environment and instability of emotional reactions was revealed. The personality features of the Captain that was highlighted by the results of psychological tests, in combination with elements of his conceptual thinking, could have had a significant effect on his behavior in a stressful situation. In particular, they could have caused disorganization. An emergency situation that suddenly appeared could have caused the Captain to have a rapid vegetative and psychoemotional reaction, under which only simple and highly automatic skills and actions could have been performed. Intellectual activity under such conditions is extremely difficult, behavior disorganized and chaotic, is not mediated by intellect, but resembles an inconsistent, disjointed and haphazard set of actions.

The FDR and CVR data confirm the conclusions of the psychologists. The highly automatic skills in maintaining the direction of an airplane's movement along the center line of the runway and the forcible braking of the wheels were carried out by the captain normally, whereas the actions to recognize and prevent the development of an abnormal situation (moving engines to idle or switching them off) were not taken.

To a certain degree, the condition of ***premature mental demobilization***, which the crew may have felt during the landing run after the long night flight crossing 5 time zones and normal landing at their "home" airport, could also have affected the outcome of the accident flight. Such a mental state is characterized by a decrease in pilot alertness (relaxation) and a decrease in the degree of nervous and emotional tension at the moment when the principal activity has not yet ended. The discrepancy between the degree of nervous and emotional tension and the requirements of the activity being performed, especially as flight conditions become more complicated, becomes the reason for the decrease in the professional reliability of pilots. The degree of conscious control over flight parameters and actions being performed decreases. The pilot assumes that the main stage of the flight has already ended. It is possible that, after the engine thrust reverser was deactivated and active deceleration started and upon sensing the usual noise and negative acceleration that are due to the thrust reverser and the start of deceleration, the crew fell into the above state of premature mental demobilization. As a result of the decrease in the degree of nervous and emotional tension and its incompatibility with the requirements of a flight situation that was becoming complicated, the crew was unable to act in a timely and adequate manner even after they realized the disparity of the flight parameters (engine rpm, speed) with the stage of the flight.

As a result of the destruction of the airplane after colliding with the barriers, a surface fire broke out. The first fire truck arrived on the scene of the accident 75 seconds after the collision at a distance from the CRS of 1,557 meters. After 20 seconds, and in intervals of 5 seconds, 3 more trucks arrived and started to extinguish the fire. The efficiency and effectiveness of fire suppression was reduced because of the inability of the vehicles to approach the accident site directly (the fence and garages obstructed the way) and because of the insufficient power of the master stream nozzles and, consequently, the need to unroll the hose lines to ensure the supply of the fire-extinguishing mixture.

At the time of the airplane's collision with the barriers, all flight attendants were in their seats with their seat belts fastened. Evacuation of passengers after the collision was initially carried out only through the right middle door and left rear door. The inflatable chute of the left rear door was released and inflated but was damaged by sharp metal objects on the ground and lost its load-bearing capacity. The inflatable chute of the right middle door did not inflate since the door handle was in the DISARMED position. The right rear door was blocked from the inside by food containers wrenched from their places as a result of the airplane's collision with the barriers, and was opened from the outside by arriving rescuers. It was impossible to use the forward doors and left middle door for evacuation because of the nature of the airplane's destruction and the seats of fire that broke out. As a result of the emergency rescue work, 78 individuals were evacuated, including three members of the cabin crew.

Of the 3 flight attendants who died, only one was identified at the time of completion of the investigation. Forensic medical experts concluded that she died from acute carbon monoxide poisoning. The concentration of carboxyhemoglobin in her blood was 85%. The three unidentified men died of acute carbon monoxide poisoning.

Based on the results of forensic medical examinations presented to the commission, of the 120 passengers who died, 119 died as a result of acute carbon monoxide poisoning in conjunction with oxygen insufficiency in the inhaled air (in one case, the poisoning was accompanied by trauma to the skull and brain) and one female passenger died from severe trauma combined with burns to the body.

As already mentioned above (chapter 1.6), the airplane had no protective breathing equipment for the flight attendants responsible for the emergency exits in the middle part of the cabin. Smoke control equipment for flight attendants in the tail section of the cabin was located on the wall on the side of the passenger cabin. This did not allow flight attendants to quickly fetch it if the need arises. Analyzing the possible influence of this fact on the effectiveness of actions of the flight attendants in evacuating passengers after the accident when the passenger cabin filled with smoke and, consequently, as regards the severity of the consequences, it should be noted that the existing equipment is used for in-flight firefighting only. there are no procedures or requirements to use it during an emergency evacuation. The corresponding cabin crew training does not exist. According to the DOT/FAA/AR-TN99/29 report, the PBE donning time for cabin attendant ranges from 30 to 60 seconds with an average of 50 seconds. After donning the PBE, the effective guidance of passengers' evacuation by cabin crew becomes more difficult, which may increase the time for smoke and/or other toxic fumes to affect the passengers. The vision capability and voice communication may be hampered with PBE on. On the other hand, if there is no open fire, the use of PBE allows the cabin crew to stay for a longer time in a smoke-filled compartment (the actual duration of the emergency evacuation on the accident flight was estimated to be 60-70 seconds) and afford help to any passengers that are weakened by carbon monoxide or other toxic fumes. Thus, it was impossible to determine for sure the possible influence of the absence of PBE equipment on the effectiveness of cabin crew's actions or the severity of the consequences. The Commission has drafted a safety recommendation on the necessity of providing protective equipment to passengers and crew members for use during an emergency evacuation in smoke-filled conditions.

3. Findings and Conclusion

3.1. The ATC service provided met the requirements of the applicable standard documents.

3.2. The meteorological service provided met the requirements of the applicable standard documents. At the time of the accident, the weather conditions did not hamper the safety of carrying out a landing on runway 30 at Irkutsk airport.

3.3. The available landing distance on runway 30 at Irkutsk airport amounted to 2425 m and ensured the safe landing of the A-310 airplane under the actual conditions.

The friction coefficient of the runway measured by the airport authorities in accordance with civilian airport operations guideline RF-94 and the braking characteristics on a runway declared on this basis (braking action good), were given to the crew via ATIS Mike. The investigations carried out show that the actual braking conditions at Irkutsk airport for at least the last 2/3 of the runway corresponded to the conditions for a runway “covered with water” and was one of the factors that influenced the deceleration rate and speed value at the runway excursion moment, given the actual crew actions and airplane movement parameters.

3.4. On its last flight on July 8, 2006, the airplane was released with 6 defects as per MEL, including the deactivated state of the ***left engine*** thrust reverser. The previous two flights had been carried out with a deactivated ***right engine*** thrust reverser.

A comparison of the applications for consumable materials and spare parts for A-310 aircraft with their actual availability in Sibir’s warehouses showed that the reserve stock held in storage satisfied 25%-30% of the demand. The difficulties involved in the customs clearance of spare parts imported from abroad in circumstances requiring the urgent correction of faults (within 10 days) resulted in the universal practice of operating flights with defects being deferred for long periods. There was no effective monitoring of the dynamics of using the MEL. There were no trends towards any reduction in the recurrence of such negative factors. In the first half of 2006, there were 86 extensions of deferred defects on A-310 airplane (over and above the periods laid down in the MEL), which, together with the recurring breakdowns, testify to substantial shortcomings in the maintenance of A-310 airplane at Sibir.

3.5. All airplane and engine systems aboard the A-310 F-OGYP, apart from the defects deferred according to the MEL, were in working order on departure from Moscow. According to the results of the investigations carried out, the Commission did not detect any signs of any breakdowns of any aircraft or engine systems on the last flight until the time of collision with the barriers on the ground, apart from the destruction of the tread of one of the airplane's tires on the right main bogie while on the landing run (after the crew had depressed the brake pedals fully), but which had no effect on the airplane's braking effectiveness.

The current technical maintenance documentation (MPD) for an A-310 with P&W 4000 engines do not envision any periodic check or adjustment of the effort required to move the throttle control lever. This work is carried out irregularly at the request of flight crews whenever they feel uncomfortable in controlling throttles. There was no such record found in the log books of the accident airplane. Analysis showed that, during operations, because of the loosening of the friction unit the forces needed to move the throttle may be reduced by a factor of 3 times as regards the regulation periodic maintenance guides.

In operating the A-310 airplane with P&W 4000 engines, it is not recommended to use the reverse thrust lever of an engine whose thrust reverser has been deactivated. This fact rules out any uniform procedure for controlling reverse in different circumstances (e.g. with both thrust reversers working or with one deactivated thrust reverser). There are no physical or electrical blockages against any erroneous displacement in the direction of forward thrust of a throttle control lever for an engine whose thrust reverser has been deactivated.

Section TR 02-78 of the Master MEL and the corresponding section of Sibir's MEL, which defines the features of operating an airplane with a deactivated thrust reverser, contain a warning that the pilot flying the airplane must hold the thrust lever in the idle position during a landing run to prevent any inadvertent movement of the thrust lever in a forward thrust direction.

3.6. The crew had valid pilots' licenses. The airplane captain's flight experience on the A-310 airplane amounted to 1056 hours, 1013 of which were solo as an airplane captain (confirmed on 01 June 2005, order no. 836). His experience as a trainee before being confirmed as an airplane captain amounted to 43 hours over three weeks. He had no previous experience as a co-pilot of an A-310.

The co-pilot's total flight experience on the A-310 amounted to 158 hours, 92 of which were solo. He was appointed as a co-pilot on 05

May 2006, order no. 1218, and had been flying in this capacity for about 2 months.

The conversion training and preparation of crew members were carried out on the basis of the flight personnel training course (ATC-A310) drawn up by Sibir and confirmed by the aviation authorities of the Russian Federation.

During the investigation, the Commission detected a series of deficiencies in the system for preparing and supporting the professional standards of the flight crew at Sibir:

- The Sibir A-310 FPTP allowed those pilots to become airplane captains who have solo experience on 1st class Russian airplane but have not been trained as co-pilots and have no flight operations experience on type as co-pilots. Some twenty A-310 airplane captains underwent such training, including the Captain. Analysis showed that, of the 62 A-310 airplane captains who worked for Sibir from mid-2004 to August 2006, only 20 pilots completed the cycle of preparation including: co-pilot training, commissioning as co-pilot, flight operations experience in this position for up to one year, conversion training on the airplane captains' training course and commissioning as an airplane captain. At the same time, the standard flight experience on Sibir FPTP for those undergoing conversion training from the position of airplane captain of Russian airplane was 30 flights; and for those pilots who had no solo flying experience as an airplane captain, it was 300 hours. This is 3-5 times less than what is prescribed by the Aeroflot FPTP for the same type of airplane;

Note: *There are no unified courses in the Russian Federation for flight personnel advanced training that focus on learning the characteristics of crew resource management (CRM) when undergoing conversion training from Russian airplane with three or more crew members to airplane with a two-person flight crew.*

- Sibir has not compiled a course for the initial training of instructors. Staff instructors undergo appropriate training in foreign training establishments in accordance with their own courses.

- Despite the volume of objective information processing achieved (90% of flights) within Sibir, the use of such information did not fully comply with the requirements of the 1987 FOM. Analyses of flights (for example, the overshooting of an A-310 at Domodedovo airport on 29.06.05) were simply reduced to a statement of fact, without any detailed analysis of the flight parameters or the actions of the crew.

3.7. Analysis of the actions of the crew from the onset and in the development of an emergency situation revealed shortcomings in the professional training of both the airplane captain and the co-pilot, which have led to:

- the airplane captain erroneously moving the throttle control lever for the left engine, whose thrust reverser has been deactivated, to forward thrust when controlling the reverse thrust of the right engine without making the necessary check on the position of the throttle control lever for the left engine, as required by the MEL.

Note: *The Sibir A-310 FPTP does not provide for any training to learn this skill.*

- in the absence of the required monitoring by the co-pilot of the performance of the engines and the specified flight parameters.

During the landing approach and landing run, the following deviations from SOP were also established:

- during the non-precision approach the co-pilot did not report any changes in FMA parameters or the overflight of any check points while on the pre-landing descent;
- the co-pilot did not report reaching decision height, as well as the airplane captain did not speak aloud the decision to land, and did not give the command to set the landing course on the FCU;
- the co-pilot did not announce that right thrust reverser was deployed and that autobrake was disengaged;

which is probably associated with the inadequate crew training on the CRM course as well as with short experience on type of the co-pilot.

3.8. Medical aspects.

During the evaluation, analysis and interpretation by Sibir's psychologist of the data received as a result of the psychological testing of the airplane captain, the test data "Comparison of concepts" and "Sondi modified methods" were inadequately expertly analyzed and taken into account. The details of Kettell's test and "Luscher's eight-color test" were correctly analyzed but not taken into account in the final interpretation and conclusions. Accordingly, the psychologist's recommendation to admit airplane captain to the A-310 conversion training course was given without adequate grounds .

The personality traits of the airplane captain which were identified from the results of analyzing the psychological tests, together with the features of his conceptual thinking, may have had a profound effect on his behavior in a stressful situation, and, particularly, may have caused disorganization.

3.9. The autopilot and thrust controller were switched off by the crew at a height of 100m and could not have any effect on the landing and landing run. The couplings linking the thrust controller to the engine control linkage were uncoupled and were not connected to the linkage any more. No steering commands given by the thrust controller computer were recorded. The results of the investigation of the electronic guidance and engine control system (FADEC) testify to the efficiency of the system right up to when the airplane collided with the barriers.

The airplane landed in the touchdown zone at Irkutsk airport at 22.43.40 in wheel control mode with engines running at idle. After landing, the spoilers were automatically deployed and the automatic braking system (ABS) was automatically switched on in LOW mode.

1.5 seconds after touchdown, the airplane captain set the reverse thrust lever for the right engine to the reverse mode. The right engine correctly went into reverse thrust mode. The reverse thrust lever for the left engine was not applied.

Consequently, during the time the reverse thrust lever for the right engine was being moved forward (to reduce the reverse thrust), the airplane captain unintentionally and uncontrollably moved the throttle control lever for the left engine forward (increasing forward thrust). The reverse thrust of the right engine was reduced by the pilot gradually up to the stowed position and remained in that position until the time of colliding with the barriers. The throttle control lever for the left engine was in the position corresponding to the forward thrust setting of ~60% of its full rated takeoff thrust, and remained in that position until the FDR stopped recording. The crew did not notice the left engine's increase in forward thrust.

The simultaneous congruence of the following factors contributed to the moving of the TCL that went unnoticed by the airplane captain:

- presence of shakes and vibrations typical for runway at Irkutsk airport;
- presence of negative acceleration during the normal run after landing with an activated right engine reverser and automatic wheel braking in LOW mode (until 22:44:00);
- possibly small friction force needed to move the TCL, which makes any inadvertent movement of the throttle control lever easier.

After the throttle control lever for the left engine moved forward, in accordance with the work logic involved, the spoilers were automatically retracted, which led to the automatic braking being switched off. The resultant asymmetry of thrust was countered by the crew with the use of the rudder. At the same time, the crew fully depressed the brake pedals and switched to the manual braking mode for the undercarriage wheels.

The minimum indicated speed, up to which the airplane decelerated in 20 seconds after touchdown, was approximately 165 kph. The increased mode of the left engine resulted in the airplane's accelerating up to 180 kph and balancing at that speed up to the moment when the airplane left the runway.

In these conditions, the co-pilot did not perform the necessary monitoring of the engine performance and airplane speed, and it was only 30 seconds after the emergency situation started to develop when he reported an increase in engine revolutions ….“RPMs is increasing”….

Approximately 800m remained up to the end of the concrete part of the runway. Analysis showed that, if the necessary action had been taken (setting the throttle control lever for the left engine to idle), the speed could have been effectively reduced. The crew did not take this action. The airplane captain's order to switch off the engines, which was given immediately prior to overshooting the runway, was not carried out. With its engines still running, the airplane overshot the concrete runway and ran on to the soil at a significant speed (180 kph), which predetermined its collision with the barriers at the airport boundary.

3.10. As a result of the accident, 125 people died. According to the conclusion of the forensic experts, the cause of death in the majority of cases was carbon monoxide (CO) gas poisoning, in conjunction with a lack of oxygen in the air inhaled. The emergency rescue work carried out by the cabin crew and the ground services was in accordance with current regulations. As a result of their work, 78 people were evacuated.

The F-OGYP airplane had no protective breathing equipment for the flight attendants responsible for the emergency exits in the middle part of the cabin. Smoke protection equipment for flight attendants in the tail section of the cabin was located on the wall at the side of the passenger cabin. This did not allow flight attendants to reach it quickly if the need arose.

The existing equipment was used for in-flight firefighting only. There were no procedures or requirements to use it during an emergency evacuation. The corresponding cabin crew training did not exist. It was impossible to determine for sure the possible effect of the lack of PBE equipment on the effectiveness of the cabin crew's actions or the severity of the consequences.

Conclusion

The cause of Sibir A-310 F-OGYP accident was the erroneous and uncontrolled actions by the crew during rollout after landing in a configuration with one engine reverser deactivated. After touchdown, the Captain, while acting on the reverse thrust lever of the right engine, inadvertently and uncontrollably moved the throttle lever for the left engine, whose thrust reverser was deactivated, from the "idle" to the significant forward thrust position. Inadequate monitoring and call-outs of airplane speed and engine parameters by the Co-pilot made it impossible for the crew to perform the necessary actions, either by moving the left throttle back to idle or shutting down the engines. The crew had enough time to recognize the situation.

The airplane went off the runway at the high speed of ~180 km/h, hit the concrete fence and buildings, crashed and caught fire.

125 people died as a result of the accident.

4 Shortcomings Identified in the Course of the Investigation

4.1. There was no agreement between the air authorities of Russia and France on the continued airworthiness of A-310 aircraft of French registration operated by Sibir provided for in article 33 of the Air Code of the Russian Federation.

4.2. Aircraft operations were accompanied by a significant number of defects that had been postponed, according to the MEL. Its last flight was carried out with 6 postponed defects authorized, including the deactivated thrust reverser on the left engine, a fault in the no. 2 system for raising and lowering flaps and a fault in the no. 2 autopilot, which, together with the overall number of extensions to the delayed faults in the A-310 airplane being operated during the first half of 2006 (86) and the presence of recurring defects, testify to substantial shortcomings in organizing the technical maintenance of A-310 airplane within Sibir.

4.3. The difficulties involved in the customs clearance of spare parts imported from abroad in circumstances requiring the urgent correction of faults (within 10 days) resulted in the universal practice of operating flights with defects being postponed for long periods.

4.4. The current Guide to the technical operation of the A-310 airplane does not envision any periodic check or adjustment of the effort required to move the throttle control lever, as a result of which, in the process of prolonged use, the efforts made can drop to levels that were considerably lower than the minimum permitted level specified by the airplane maintenance guide.

4.5. The reverse thrust control procedure of A-310 airplane with P&W 4000 engines recommends not to use the thrust reverse lever for an engine whose thrust reverser has been deactivated, which prevents the same procedures from being used by the crew to select reverse thrust in various situations.

4.6. The design of the throttle and reverse levers does not prevent pilots inadvertently moving the throttle lever forward of an engine whose thrust reverser has been deactivated when operating the thrust reverser on the other engine per the manufacturer's recommended procedure.

4.7. During the rollout after landing, the on-board "wrong take-off configuration" audio and light warning system was triggered as per design as a result of the actual crew actions. According to the FCOM, this warning is inhibited during the rollout phase of the flight.

4.8. The investigation of the air incident involving the A-310 airplane UK-31001 that occurred on 3 March 1999 at Sheremetovo airport was not thoroughly carried out. The airplane and engine developers were not invited to participate in the investigation. According to the results of the investigation, the Commission did not draft any specific recommendations for the flight crew or the developers of the engine control system aimed at preventing any similar occurrences in the future.

4.9. In the Russian Federation, there is no universal course for improving the qualifications of flight crew that is aimed at studying the features of crew resources management (CRM), when converting from Russian aircraft with three or more crew members to aircraft with a two-man flight crew.

4.10. The Sibir A-310 FPTP allowed the commissioning as A-310 airplane captains of pilots who have no experience on two-crew member aircraft without undergoing the co-pilot training course and without flight operations experience on type as co-pilot.

4.11. The practice of allowing flights with **extended** "deferred" defects without any form of control procedure exercised by the Russian aviation authorities in each specific instance had taken root in Sibir.

4.12. The appropriate training to support flights using the MEL was absent from the airline crew training system.

4.13. Sibir did not draw up any course for the basic training of instructors.

4.14. Investigations of most air incidents within Sibir were reduced to mere statements of fact, without any detailed analysis of the parameters of the flight or the actions of the crew.

4.15. Sibir's psychologist's recommendation to admit the Captain to the A-310 conversion training course on the basis of a non-objective assessment of the pilot's personal qualities appears to be without adequate foundation.

4.16. The section entitled "Guide to ensuring the psychological selection, training and professional activity of civil aviation flight crew and air traffic control staff in the Russian Federation" does not ensure the psychologists' standardized rules of selection for conversion to new aircraft and requires substantial additional work.

4.17. Order no. NA-30-r of the Ministry of Transport of the Russian Federation dated 24.01.01, on providing friction coefficient measuring vehicles (ATT-2) in Irkutsk airport (and a number of other airports) with modern devices for measuring and processing results to replace existing visual recording equipment, has not been carried out.

4.18. The friction coefficient on the runway measured by the authorities of Irkutsk airport and the resultant statement on the braking conditions given to the crew in the ATIS information “MIKE” (“braking action good”), actually turned out to be much worse and corresponded to the braking conditions on “a runway covered in water”. The existing procedure for estimating the state of the runway did not make it possible to determine accurately the braking conditions for water covered runways at speeds that were significantly greater than the measurements speed .

4.19. After the accident, no sketches were made and no tracks of the airplane’s progress along the runway were described.

4.20. At the Irkutsk airport weather station, the qualifications of its technical observers had not been improved, in violation of the terms of the licensing requirements imposed on the autonomous non-commercial organization, the “Irkutsk Meteorological Agency”.

4.21. The wording set out in the warning section of TR 02-78 of the MMEL AIRBUS (CAUTION), in which the use of a thrust reverse lever is not recommended for an engine whose thrust reverser was deactivated, and the need to check the position of the relevant throttle control lever in the “idle” setting while on the landing run is prescribed, is partially incorrect in its use of the singular and plural number for some nouns and verbs, which, in conjunction with its position on the page (at the end of a section), does not exclude any ambiguous understanding of the essence of caution. The caution is also incorrect in terms of stating that the forward thrust will increase in cases of using the reverse thrust lever for an engine whose thrust reverser has been deactivated.

The wording of a similar warning in Sibir’s MEL (edition 5), confirmed by the aviation authorities of Russia on 1 August 2006, does not correspond to the sense incorporated in the aircraft manufacturer’s document and essentially excludes any correct understanding by its crews.

4.22. This airplane’s set of equipment did not anticipate the provision of any smoke-protection equipment for the flight attendants being placed in the central part of the fuselage. Smoke protection equipment for flight attendants in the tail section of the cabin was located on the wall at the side of the passenger cabin. This did not allow flight attendants to quickly fetch it if the need arose.

4.23. When compiling the loading chart and the centre-of-gravity diagram, neither was the weight of the containers and pallets taken into consideration, nor was the incorrect number of crew members shown (two service passengers were not taken into account).

4.24. During the registration of the air tickets, on numerous coupons, the columns for indicating the presence of passengers' hold luggage and hand luggage were not filled in.

4.25. When recording the hazardous freight, freight invoice no. 421-0867902 was corrected by hand to no. 421-0867961, but the correction was not confirmed with a stamp and signature.

4.26. On the fuselage of the F-OGYP airplane, there was no emergency and rescue layout diagram for the ground emergency and rescue services.

4.27. The fire and rescue service staff of Irkutsk airport and the Irkutsk Civil Aviation Regional Search and Rescue base were not allowed to use their normal individual smoke-protection equipment when carrying out rescue work in the conditions of the severely smoke-filled airplane cabin because of the lack of the necessary time for their preparation for use.

4.28. The range of delivering a fire-extinguishing compound from the fire-engine gun-carriage barrels when it was impossible to deploy the fire engines close to a burning airplane did not ensure the delivery of the fire-extinguishing compound to the seat of the fire, as a result of which it became necessary to lay hose pipes from the fire engines to the airplane and deliver the fire-extinguishing compound through them, which excluded immediate fire-extinguishing operations from being carried out.

4.29. The normal means of communication did not ensure the effective management of the rescue teams in carrying out their rescue work on the airplane. The existing portable radio sets reduced the effectiveness of the fire-extinguishing operations because of the need to constantly divert attention to manually handle them.

4.30. The rescue workers' special clothing did not allow them to carry out their work near to the seats of open fires when there was any danger of their catching fire if any flammable substances (including airplane fuel) fell on them.

4.31. The actual numerical strength of the airport's departmental fire brigade (VPO SOASOP) did not correspond to the official schedule.

5 Safety Recommendations

5.1. To the Aviation Authorities of Russia:

5.1.1. To carry out a comparative analysis of the specificities of operating airplanes of Russian and Western manufacturers;

5.1.2. Until the necessary changes have been made by the developer of the A-310 airplane that are aimed at unifying the procedures for using the engines' reverse thrust in various situations, to exclude the use (apart from special or emergency situations) of reverse thrust on one engine if the other is deactivated. To take into account this fact when calculating the necessary take-off and landing distances;

5.1.3. In accordance with article 33 of the Air Code of the Russian Federation and article 83bis of the Convention on International Civil Aviation, to accomplish the mandatory conclusion of Agreements on continued airworthiness when allowing airlines of the Russian Federation to operate aircraft of foreign registration. To complete work on the said Agreement with the aviation authorities of France as regards the A-310 airplane being operated by Sibir;

5.1.4. When allowing airlines of the Russian Federation to operate aircraft, including aircraft of foreign registration, to ensure that a check is made on their compliance with the standard construction on which the Certificate has been issued. To exclude permission to operate any aircraft that do not meet this requirement;

5.1.5. To examine the question of unifying training and conversion training courses for flight crew on each type of aircraft and to put them into effect as a single basic document for all airlines operating similar airplanes, with the aim of raising the standards of training personnel and excluding any occurrences of oversimplification in this task;

5.1.6. To examine the questions on creating unified training courses for flight attendants on each type of aircraft, stipulating therein the optimization of a precise series of actions by members of the cabin crew and their use of protective, emergency and rescue equipment when carrying out an emergency evacuation of passengers in various conditions (fire, smoke etc);

5.1.7. To develop and implement a universal course for improving the qualifications of flight crew specializing in crew resources management (CRM) on airplanes with two-man crews. To ensure that crews undertake it obligatorily at conversion from aircraft with three or more crew members. To cease the practice of immediately having the captain of an aircraft with a crew of three or more members conversion to captain of an aircraft with a two-man crew without gaining any experience of operational flights as a co-pilot of an aircraft with a two-man crew;

5.1.8. To amend the procedure of confirming the airlines' MEL, excluding the possibility of confirming any "softer" variations than the developer's MASTER MEL;

5.1.9. To cease the practice of granting permits to carry out flights with a prolonged period for correcting faults without a detailed analysis of each specific occurrence;

5.1.10. Together with the Federal customs service, to examine the question of accelerating the customs formalities for importing spare parts for aircraft of foreign manufacture;

5.1.11. To carry out a one-time check of all aircraft for the actual availability of emergency and rescue equipment provided by type design, as well as for the availability of layout diagrams of the external emergency and rescue markings;

5.1.12. To develop and incorporate the new edition of the section on the psychological and physiological selection of candidates for conversion to new aircraft and promotion to the airplane's captain position into the "Guide to ensuring the psychological selection, training and professional activity of civil aviation flight crew and air traffic control staff in the Russian Federation" 2001 edition. During the period of developing the new edition of the section to prolong the effectiveness of the previous rules of selection, as confirmed by the Minister of Civil Aviation in the "Guide to professional, psychological and physiological selection in civil aviation" (1986);

5.1.13. When selecting candidates for conversion to new airplane, to oblige physical evaluation board and airline psychologists to pay particular attention to any candidates' personal qualities affecting the processes of emotional reaction and behavior in non-standard conditions (increased tension and stress), and, when identifying any unfavorable signs, to approach more severely the resolution of any question of their suitability for conversion training and/or the need for an individual approach in conversion training;

5.1.14. To ensure the high-quality and thorough investigation of air incidents according to ICAO Annex 13 and the development of specific recommendations on preventing similar occurrences in the future;

5.1.15. To equip at least two devices at Irkutsk airport with modern units for measuring, processing and recording the results of measuring the friction coefficient to replace the visual recording equipment being used. To check the availability and, if need be, to reequip other airports, a list of which is given in Order no. NA-30-r of the Ministry of Transport of the Russian Federation dated 24.01.01, with the appropriate measuring equipment.

5.1.16. Together with the scientific research organizations, to develop a method of objective, multiple and quantitative assessment of the state of the runway in accordance with any parameters affecting the take-off and landing characteristics of aircraft of all types, as well as the introduction of the corresponding forms of information of crew members. In order to improve the braking characteristics of civil aircraft on a runway covered in precipitation, to carry out investigations of possibilities to perfect runway surfaces (surface cleaning, corrugation etc);

5.1.17. To develop and implement regulations to exclude the possibility of civil airports accepting any aircraft of a category higher than the level of fire protection of the airport (UTPZ);

5.1.18. To develop and implement changes to the List of Flight Search and Rescue (SPASOP) equipment for airports and regional search and rescue bases (RPSB) in the section dealing with the obligatory provision of special helmets that can be rapidly donned for firefighters and rescue workers equipped with devices for radio communication and the protection of the respiratory organs;

5.1.19. To develop and implement requirements for an increase in at least one UTPZ category of any airports where take-offs and landings are carried out above structures (buildings and erections), with a guaranteed time for the arrival of the first airport fire engine of no longer than two minutes, and a guaranteed range of delivering fire-extinguishing compound at medium and high frequency of at least 70 meters;

5.1.20. Together with the scientific research organizations, to conduct investigations and prepare recommendations on extinguishing combined fires on aircraft;

5.1.21. To consider the possibility to develop and provide special clothing for rescue workers when working close to centre of open fire;

5.1.22. To complete the number of departmental search and rescue fire brigades in accordance with the prescribed standards.

5.2. To Sibir:

5.2.1. To include questions on the use of the MEL in conversion training courses and periodic training courses and to stipulate specific actions by the flight crew. To ensure that the crew’s operating procedure is in compliance with the manufacturer's recommendations while flying with defects deferred as per the MEL;

5.2.2. To cease the practice of training captains of aircraft of Western manufacture with two-man crews without passing through co-pilot training courses and gaining experience on operational flights in this capacity;

5.2.3. To devise a course for the initial training of airline instructors;

5.2.4. To ensure the constant monitoring of the use of the MEL. In the event of the ambiguous interpretation of any provisions, to ask for relevant explanations from the aircraft developer;

5.2.5. When selecting candidates for conversion to new aircraft, to oblige airline psychologists to pay particular attention to any candidates' personal qualities affecting the processes of emotional reaction and behavior in non-standard conditions (increased tension and stress), and, when identifying any unfavorable signs, to approach more severely the resolution of any question of their suitability for conversion training;

5.2.6. To develop and implement remedial measures targeted at maintaining a high level of flight safety in conditions of intensified air traffic during familiarization with new aircraft types;

5.2.7. To develop and implement the emergency layout diagram of the A-310 airplane for the airport emergency and rescue services;

5.2.8. To exclude a perfunctory approach in debriefing flight crews in relation to the results of analysis of the circumstances of accidents and incidents, as well as any other events that have affected or may affect the level of flight safety;

5.2.9. To issue tickets for all the crew members flying as passengers without adding them to the flight task list;

5.2.10. To correct any other faults that have been revealed in the course of this investigation as well as during the audit conducted by Airbus in April 2006.

5.3. To the Airbus Group:

5.3.1. Together with the engine developers, to investigate the possibility of having and developing a unified procedure for engaging reverse thrust, irrespective of the engine type or the presence of a deactivated thrust reverser;

5.3.2. To investigate the possibility of changing the algorithm for the activation of the "wrong take-off configuration" warning in order to prevent its activation during any irrelevant stages of a flight or to insert the relevant caution in the FCOM about the possibility of activation of this warning during a landing run, as well as the appropriate crew actions in this situation;

5.3.3. To reword the caution in the TR 02-78 A-310 MMEL chapter in order to remove any incorrect or ambiguous information to ensure precise understanding of the caution.

5.4. To EASA and other Certifying Authorities together with the Manufacturers of Large Transport Aircraft

5.4.1. to review the human factors issues associated with the dispatch conditions and the operational procedures in case of one thrust reverser being inoperative, in order to avoid inadvertent forward thrust application;

5.4.2. to review the design and maintenance requirements for all FADEC controlled airplanes to ensure that throttle lever breakout forces remain at the acceptable lever and that they are checked on a periodic basis;

5.4.3. to evaluate the usefulness of cabin crew smoke hood devices in assisting the evacuation of airplanes; to evaluate the possibility of equipping large transport airplanes with devices for passengers and/or flight attendants to be used in case of an emergency evacuation without suffering from the effects of smoke and toxic fumes.

5.5. To IATA

5.5.1. The investigation showed that other events occurred on different types of aircraft, involving inadequate monitoring and erroneous activations of the reverse thrust levers during a landing run in a configuration with one engine reverser deactivated. The Interstate Aviation Committee recommends drawing the attention of operators to the risks of erroneous movement of the thrust levers in these conditions and their non-detection.

5.6. To "Domodedovo" Airport:

5.6.1. To the staff engaged in the registration of passengers, to enter on air tickets the actual weight of hold luggage and hand luggage, and to enter all required details in the registration information;

5.6.2. To require loading and centre-of-gravity supervisors to enter information carefully and in good time and to make corrections to the airplane's centre-of-gravity diagram and loading chart in accordance with the actual information available;

5.6.3. To require loading agents to strictly comply with the rules for completing carriage documentation, including whenever inserting any corrections in air cargo manifests for the carriage of hazardous cargoes.

5.7. To the International Civil Aviation Organization (ICAO):

5.7.1. To examine the question of urgently introducing the video recording of any situation in the cockpit as an ICAO standard at least for aircraft with a maximum take-off weight of more than 27,000 kg.

5.8. To the Aviation Authorities of Russia and the Countries participating in the Agreement on Civil Aviation and the Use of Airspace:

5.8.1. Along with flight crews and cabin crews (flight attendants), as well as air traffic controllers and technical engineering staff, to carry out special analyses to study the circumstances of and reasons for an accident;

5.8.2. To draft national (state standard) air rules for the operation and safety of flights in accordance with international standards, using the Air Rules devised within the context of the ICAO-IAC project on Air Rules, as approved by the Council of the states participating in the Agreement and the ICAO Air Navigation Bureau;

5.8.3. To determine the procedure for regulating the operation of aircraft of foreign registration in any states participating in the Agreement and to engage in work on perfecting the existing standard basis. When operating any aircraft of foreign registration in any states participating in the Agreement, to ensure the concluding of agreements in accordance with article 83bis of the Chicago Convention between the state of the operator and the state of registration, including any aircraft of non-commercial organizations registered in a “private” category, for the purposes of a clear division of responsibility for maintaining operational airworthiness;

5.8.4. To amend in the national suitability standards for airports the full list of requirements for flight safety at an airport, including the requirements for:

- the physical characteristics of an airport;
- the restriction and assessment of any obstacles;
- any visual flight safety equipment;
- the radio equipment and air traffic control towers;

- the meteorological equipment;
- the electrical power supply and equipment;
- the emergency and rescue equipment;
- safety control at the airport;
- air navigation information;
- equipment and methods of measuring the friction coefficient on a runway.

5.8.5. To examine the question of introducing additional restrictions on residential and other buildings in the vicinity of the airport and its surrounding territory and any structures (gas pipes, fuel distribution points etc) near the runways into the legal standards documentation. To insert amendments in the existing building standards and rules for the purposes of introducing new technical and technological decisions (modern software products) in the planning, construction and acceptance of newly built (or reconstructed) airports;

5.8.6. To implement the Federal Aviation Rules accepted by the Council of States participating in the Agreement on medical flight safety in civil aviation, and to organize the execution of work on the basis of a system of working time and rest periods for civil aviation flight crew and air traffic controllers, as well as the study of death rates among aviation specialists, and the drafting of preventative measures with a view to prolonging the life expectancy of flight personnel;

5.8.7. To regularly carry out an examination of and a check on executing the recommendations of commissions investigating accidents and incidents, and governmental commissions' recommended actions as well;

5.8.8. To resolve top-priority tasks to improve the quality of training aviation specialists, it is necessary:

- To introduce standards, norms, courses and requirements to regulate the process of training aviation specialists and the level of professional training;
- To carry out work on drawing up standard training plans to acquire professional training, as well as standard courses for conversion and improving qualifications. Particular attention should be paid to training staff instructors;

- To carry out work on preparing training courses and the requirements for the use of simulators and technical teaching methods for a detailed draft of the actions to be taken in special flight situations;

- To incorporate modern methods of training flight crews and air traffic controllers in English into the work of training establishments and airlines;

- To cease the practice of immediately training candidates from aircraft manned by 3 or more crew members as airplane captains (omitting the stage of flying as a co-pilot) for class 1-3 aircraft with a 2-man crew;

- To increase the minimum level required for conversion training to large types of aircraft and to ensure control thereof by observation as a supervisory service. To ban solving the problem of a shortage of flight crew by means of the oversimplified conversion training of other members of flight crews (navigators, air engineers).

5.8.9. To introduce modern information systems on incidents, accidents, breakdowns and faults in aviation equipment in use, for the purposes of taking corrective actions in good time to ensure flight safety;

5.8.10. To legally determine the position on the compulsory insurance covering the liability of the carrier/owner of an aircraft towards passengers and third parties, establishing the unified level of liability for domestic and international air transportation laid down by the 1929 Warsaw Convention and the Hague Protocol. To take steps to ratify the 1999 Montreal Convention;

5.8.11. To introduce the requirement for compliance with international (IOSA) quality standards for all operators by no later than 1 January 2008;

5.8.12. To ensure checks are made on the serviceability and proper maintenance of emergency and rescue equipment on all civil aviation aircraft.

5.8.13. To examine the question of organizing joint work on maintaining the airworthiness of aircraft of foreign registration taking into account the need to build up a database and analyze the reliability of the whole fleet and, in conjunction with the manufacturer, to process any recommendations for improving reliability and the level of flight safety;

5.8.14. To introduce the regular practice of holding technical flying conferences on generalizing the experience of operating aircraft of foreign registration and drafting proposals for their perfection.

Chairman of the Commission:

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Deputy Chairmen of the Commission:

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V.V. Chernyaev

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