

AIRCRAFT INCIDENT REPORT

**Report by the Swedish Accident Investigation Board into
the incident between aircraft LN-RON and TF-FIP in the
airspace above Stockholm/ Arlanda airport, AB County,
Sweden on 25 January 2002**



The aim of aircraft accident investigation is solely to identify mistakes and/or deficiencies capable of undermining flight safety, whether contributing factors or not to the accident in question, and to prevent further occurrences of similar cause(s). It is not up to the investigation authority to determine or divide blame or responsibility. This report shall not be used for purposes other than preventive ones.

(Law on Aircraft Accident Investigation, No 59/1996, para 1 and para 14.)

2003-01-27

L-007/02

Swedish Civil Aviation Administration

601 79 NORRKÖPING

Report RL 2003:01e

The Board of Accident Investigation (Statens haverikommission, SHK) has investigated an incident that occurred on the 25th of January 2002 in the airspace above Stockholm/Arlanda airport, AB County, Sweden, between two aircraft with registrations LN-RON and TF-FIP.

In accordance with section 14 of The Ordinance on the Investigation of Accidents (1990:717), The Board herewith submits a final report on the investigation.

Carin Hellner

Monica J. Wismar

Contents

ABBREVIATIONS

Summary	5
1 FACTUAL INFORMATION	7
1.1 History of the flight	7
1.2 Injuries to persons	8
1.3 Damage to aircraft	8
1.4 Other damage	8
1.5 Personnel information	8
1.5.1 <i>The pilots on board SAS 1551</i>	8
1.5.2 <i>The pilots on board ICE 306</i>	8
1.5.3 <i>The air traffic controller</i>	8
1.5.4 <i>The pilots' duty schedules (SAS 1551)</i>	9
1.5.5 <i>The air traffic controller's duty schedule</i>	9
1.6 Aircraft information	9
1.7 Meteorological information	9
1.8 Aids to navigation	10
1.9 Communications	10
1.10 Aerodrome information	11
1.10.1 <i>The airport</i>	11
1.10.2 <i>The air traffic control tower</i>	11
1.11 Flight and voice recorders	12
1.11.1 <i>Flight recorders (FDR, QAR)</i>	12
1.11.2 <i>Cockpit voice recorder (CVR)</i>	12
1.11.3 <i>Voice-recording equipment in the tower</i>	12
1.12 Incident site	13
1.13 Medical information	13
1.14 Fire	13
1.15 Survival aspects	14
1.16 Tests and research	14
1.17 The airlines' operational conditions and practice	14
1.17.1 <i>Flight operational conditions and practice</i>	14
1.17.2 <i>Instructions and practice for air traffic controllers at Stockholm/Arlanda airport</i>	14
1.18 Additional information	15
1.18.1 <i>Previous violations of minimum separation at Stockholm/Arlanda airport which were investigated by SHK</i>	15
1.18.2 <i>The Civil Aviation Administration's investigation of the occurrence in question</i>	16
1.18.3 <i>Incident at Oslo/Gardemoen airport on 8 March 2000</i>	17
1.18.4 <i>Acute warning messages</i>	17
2 ANALYSIS	17
2.1 The near-miss incident	17
2.2 The radio communication	18
2.3 The runway combination – takeoff runway 01L/ landing runway 26	19

3	CONCLUSIONS	19
3.1	Findings	19
3.2	Causes of the incident	20

4	RECOMMENDATIONS	20
----------	------------------------	-----------

APPENDIX

1	Extracts from Register of Licenses regarding the pilots and the air traffic controller (to the Swedish Civil Aviation Administration only)	
----------	--	--

Abbreviations

ANS	National agency for air traffic services in Sweden with headquarters in Norrköping	MUST	Military Intelligence & Security Service (Swedish)
ATPL (A)	Airline Transport Pilot License Aeroplane	NAV	Navigation/Navigator
ATIS	Automatic Terminal Information Service	NM	Nautical mile (1852 m)
ATC	Air traffic control	OFA	Management order that is given at a local ATS
BFT	Air Traffic Control Regulations	PC	Proficiency check
°C	Degrees Celsius	PIC	Pilot in Command
COM	Communication	PF	Pilot flying
CPL (A)	Commercial Pilot License Aeroplane	PNF	Pilot not flying
CRM	Crew Resource Management	PNT	Point of No Take-off
CTR	Control Zone	QAR	Quick Access Recorder
CVR	Cockpit Voice Recorder	QNH	Atmospheric pressure at Mean Sea Level
ESSA	ICAO code for Stockholm/Arlanda airport	RPU	Radar Presentation Equipment
FDR	Flight Data Recorder	s	Second
FOM	Flight Operations Manual	SAS	Scandinavian Airline System
hPa	Hectopascal	SMHI	Institute of Meteorology & Hydrology (Swedish)
IAL chart	Instrument Approach and Landing chart	TCAS	Traffic Alert and Collision Avoidance System Advisory does not cause any action except to localize the traffic, weather permitting and continued surveillance of the situation
IAS	Indicated Air Speed	TWR	Air Traffic Control Tower (E , east, W , west)
ICAO	International Civil Aviation Organisation	UTC	Universal Time Co-ordinated
ICE	Iceland Air	VHF	Very High Frequency
IFR	Instrument Flight Rules	VMC	Visual Meteorological Conditions
ILS	Instrument Landing System		
IMC	Instrument Meteorological Conditions		
IOR	Recording and registration of radar data		
JAA	Joint Aviation Authority		
km	Kilometer		
LFV	Civil Aviation Administration (Swedish)		
m	Meter		

Report RL 2003:01e

L-007/02

Report finalized 2003-01-27

<i>Aircraft; registration, type</i>	A. LN-RON, McDonell Douglas MD-81 B. TF-FIP, Boeing 757-200
<i>Class, airworthiness</i>	Normal, valid certificate of airworthiness
<i>Owner/Operator</i>	A. Commercial Aviation Leasing Ltd/SAS B. Hekla Ltd/Iceland air
<i>Date and time</i>	25 January 2002, 12:07 hours in daylight <i>Note:</i> All times in this report refer to Swedish Standard Time (UTC + 1 hour)
<i>Place of occurrence</i>	In the airspace above Stockholm/Arlanda airport, AB County, Sweden, (pos. 5939N 01755E; between 300 and 570 meters above sea level)
<i>Type of flight</i>	Scheduled traffic
<i>Weather</i>	According to SMHI's analysis at 12:07 hours: wind 300°/18 knots, visibility > 10 km, scattered clouds at 2,000 feet and broken clouds at 20,000 feet, temp./dew point -6/-9° C, QNH 989 hPa. Light to moderate turbulence had been reported earlier from another aircraft.
<i>Persons on board: crew</i>	A. Pilots, 2 Cabincrew, 4 B. Pilots, 2 Cabincrew, 6
<i>passengers</i>	A. 94 B. 41
<i>Injuries to persons</i>	None
<i>Damage to aircraft</i>	None
<i>Other damage</i>	None
<i>Age, sex, certificate, total flying time, flying hours previous 90 days:</i>	
<i>Aircraft A:</i>	
<i>Aircraft commander:</i>	37 yrs., male, ATPL (A), 8,331 hours, 112 hours, all on the type
<i>First officer:</i>	39 yrs., female, CPL (A), 3,800 hours, 141 hours, all on the type
<i>Aircraft B:</i>	
<i>Aircraft commander:</i>	61 yrs., male, ATPL (A), 16,749 hours, 50.4 hours, all on the type
<i>First officer:</i>	38 yrs., male, CPL (A), 5,093 hours, 112 hours, all on the type
<i>Air traffic controller</i>	36 years old, male, FL certificate since 1989

The Board of Accident Investigation (SHK) was notified on the 28th of January 2002 that an infraction of minimum separation had taken place between two aircraft with the registrations LN-RON and TF-FIP respectively, at Stockholm/Arlanda airport, AB County, Sweden, on the 25th of January 2002, at 12:07 hours.

The incident has been investigated by SHK represented by Carin Hellner, Chairman, and Monica J. Wismar, Chief Investigator Flight Operations.

Rickard Jörgensen has assisted SHK as Air Traffic Control expert.

The investigation has been followed by The Swedish Civil Aviation Administration, through Max Danielsson and Lars Hedblom.

Summary

During the morning of the 25th of January 2002 at Stockholm/Arlanda airport, runway 01L was being used for departing aircraft and runway 26 for landing traffic.

Aircraft A, an MD-81 with flight number SAS 1551, had received clearance to line-up on runway 01L to begin a flight to Amsterdam.

At the same time, aircraft B, a B-757 with flight number ICE 306, had initiated the approach to runway 26.

When aircraft B had passed the runway threshold and was at a height of a few meters over the runway, the crew initiated a missed approach due to the fact that the wind in combination with the runway conditions did not fulfill the requirements for a safe landing.

When the tower controller at position TWR-W observed that ICE 306 had passed over the threshold of runway 26, he judged that the aircraft would land and issued takeoff clearance to SAS 1551. Immediately thereafter he observed that ICE 306 had initiated a missed approach. The air traffic controller instructed SAS 1551 to stop immediately.

The pilots on board SAS 1551 did not hear the stop message¹, but continued the takeoff and lifted-off from the runway. When the aircraft commander leaned forward in order to reach the landing gear handle, he saw the climbing ICE 306 on the right side of the aircraft. He then assumed control of the aircraft and decreased the climb rate so that they passed beneath ICE 306. Subsequent to the near miss, the flight continued normally.

According to calculations accomplished by MUST, the minimum distance between the aircraft was 75-100 meters horizontally and about 300 meters vertically.

The investigation has revealed that SAS 1551 had received takeoff clearance and ICE 306 had received landing clearance and that the air traffic controllers handled the aircraft concerned according to applicable routines. However, the pilots on board SAS 1551 did not hear the stop message issued by the traffic controller. It has not been possible to determine in retrospect if the stop message was audible in the aircraft's loud speaker system.

The investigation also shows that, among other things, deficiencies exist in the working methodology during the use of the runway combination with departures from runway 01L and arrivals on runway 26.

The incident was caused by takeoff clearance being issued, according to existing practice, to SAS 1551 simultaneously as ICE 306 initiated a missed approach and that the attempt to stop SAS 1551 was not apprehended by the crew in that aircraft.

¹ Stop message (stop immediately) – The phrase is used during the sudden appearance of danger after an aircraft has initiated its takeoff roll, if the air traffic controller deems that the aircraft is able to stop on the remaining runway. The aircraft commander however, has full responsibility for the decision whether to abort or continue the takeoff. (BFT section 11-Chapter 2)

Recommendations

The Civil Aviation Administration is recommended to

- develop methods for air traffic controllers to judge when an aircraft can safely be considered to have landed (*RL 2003:01e R1*) (*previously rendered recommendation from SHK in report C1998:6*)
- develop terminology to be used in emergency situations that has the greatest possibility of being apprehended by pilots working under high stress (*RL 2003:01e R2*), and
- consider if additional operational procedures and improvements should be introduced during the use of the runway combination 01L and 26 in order to decrease the risk that a collision incident should arise (*RL 2003:01e R3*).

1 FACTUAL INFORMATION

1.1 History of the flight

During the morning of the 25th of January 2002 at Stockholm/Arlanda airport, runway 01L was being used for departing aircraft and runway 26 for landing traffic. The new air traffic control tower was in operation and a tower controller was present at position TWR-W for departing traffic, another at position TWR-E for arriving traffic. The visibility was good with scattered clouds at 2,000 feet. Air turbulence in the area had been reported by arriving aircraft and an approach had been discontinued earlier that morning due to strong gusty winds. 50% of the surface of runway 26 was covered by approximately 1 mm of ice.

Aircraft A, an MD-81 with flight number SAS 1551, had received clearance to line-up on runway 01L to begin a flight to Amsterdam.

At the same time, aircraft B, a B-757 with flight number ICE 306, had initiated the approach to runway 26. The aircraft commander has stated that the approach proceeded normally but that the wind was unstable. They received landing clearance from the tower controller and at the same time received instructions that in the event of a missed approach, they were to maintain runway heading and climb to 1,500 feet.

When the aircraft had passed the runway threshold and was at a height of a few meters over the runway, the crew initiated a missed approach due to the fact that the wind in combination with the runway conditions had such values that they no longer satisfied the airline's minimum limits for a safe landing. Thereafter they followed the missed approach instructions they had received from the tower controller. When they had climbed to between 1,000 and 1,500 feet they received a TCAS-warning (advisory). Thereafter they received radar vectoring for a new approach to runway 26.

When the tower controller at position TWR-W observed that ICE 306 had passed over the threshold of runway 26, he judged that the aircraft would land and issued takeoff clearance to SAS 1551. Immediately thereafter he observed that ICE 306 had initiated a missed approach and then transmitted the following instruction to SAS 1551 "Scandi 1551 stop immediately, I say again stop immediately". When he saw that the aircraft did not slow down he inquired "1551 did you get that?", but did not receive any answer from the crew.

The pilots on board SAS 1551 did not hear the message to reject the takeoff roll, but continued the takeoff and lifted-off from the runway. When the aircraft commander, who was the PNF, leaned forward in order to reach the landing gear handle, he saw the climbing ICE 306 on the right side of the aircraft. He then assumed control of the aircraft and decreased the climb rate so that they passed beneath ICE 306. Simultaneously they received traffic information from the air traffic controller in the form of "1551, you have the traffic 12 o'clock now from right to left?". The first officer answered "Yeah we have traffic passerat Scandinavian 1551". Subsequent to the near miss, the flight continued normally.

The incident took place at position 5939N 01755E; between 300 and 570 meters above sea level.

1.2 Injuries to persons

	<i>Crew</i>	<i>Passengers</i>	<i>Other</i>	<i>Total</i>
Fatal	–	–	–	–
Seriously injured	–	–	–	–
Slightly injured	–	–	–	–
No injuries	14	135	–	149
Total	14	135	–	149

1.3 Damage to aircraft

None.

1.4 Other damage

None.

1.5 Personnel information

1.5.1 *The pilots on board SAS 1551*

The aircraft commander was 37 years old, male and held a valid ATPL (A) license.

Total flying time: 8,331 hours.

Flying hours previous 90 days: 112.

Latest PC carried-out on 18 October 2001.

The first officer was 39 years old, female and held a valid CPL (A) license with an instrument rating.

Total flying time: 3,800 hours.

Flying hours previous 90 days: 141.

Latest PC carried-out on 28 October 2001.

1.5.2 *The pilots on board ICE 306*

The aircraft commander was 61 years old, male and held a valid ATPL (A) license.

Total flying time: 16,749 hours.

Flying hours previous 90 days: 50,4.

Latest PC carried-out on 3 December 2001.

The first officer was 38 years old, male and held a valid CPL (A) license with an instrument rating.

Total flying time: 5,093 hours.

Flying hours previous 90 days: 112.

Latest PC carried-out on 22 January 2002.

1.5.3 *The air traffic controller*

The air traffic controller at position TWR-W was 36 years old, and was qualified for the duties in question. He has held such qualification since 1989.

1.5.4 The pilots' duty schedules (SAS 1551)

During the week prior to the occurrence the pilots had had the following duty schedules:

	<i>Aircraft commander</i>	<i>Number of flights</i>	<i>First Officer</i>	<i>Number of flights</i>
2002-01-18	13:20-21:55	3	06:30-13:45	3
2002-01-19	Free		07:35-18:00	4
2002-01-20	Free		Free	
2002-01-21	Free		Free	
2002-01-22	Free		Free	
2002-01-23	Free		Free	
2002-01-24	Free		Free	
2002-01-25	07:00-	1	07:00-	1

1.5.5 The air traffic controller's duty schedule

During the week prior to the occurrence the air traffic controller had had the following duty schedule:

	<i>Duty time</i>
2002-01-18	Free
2002-01-19	Free
2002-01-20	Free
2002-01-21	13:30-22:30
2002-01-22	13:30-22:30
2002-01-23	Free
2002-01-24	13:30-22:30
2002-01-25	06:00-14:30

1.6 Aircraft information

Both aircraft had a valid Certificate of Airworthiness.

1.7 Meteorological information

It had snowed during the morning hours and patches of ice had formed on runway 26. A runway braking action of 0.35 had been reported.

According to SMHI's analysis at 12:07 hours: wind 300°/18 knots, visibility > 10 km, scattered clouds at 2,000 feet and broken clouds at 20,000 feet, temp./dew point -6/-9° C, QNH 989 hPa.

Light to moderate turbulence had been reported from an aircraft of type Dash 8 during approach to runway 26 at 11:59 hours.

The winds that were measured from Arlanda at time 12:10 were 300°/12 knots at a height of 50 meters (165 feet) and 330°/17 knots at a height of 100 meters (330 feet). The wind at a height of 1000 feet has been estimated to have been 310°/30 knots.

1.8 Aids to navigation

According to the IAL chart for Stockholm/Arlanda airport. The ILS to runway 26 was in use.

1.9 Communications

Radio communication (in some parts) between the air traffic controller at position TWR-W and the crew on board SAS 1551:

UTC Time (+ 1 hr. = local time)	From	Information
11:03:24	SK1551	Tower good afternoon, Scandinavian 1551. [female voice]
11:03:27	TWR-W	Scandi 1551 in sequence line up runway 01 left.
11:03:31	SK1551	In sequence line up runway 01 left, Scandinavian 1551.
11:06:21	TWR-W	Scandinavian 1551, cleared for takeoff runway 01 left.
11:06:24	SK1551	Cleared takeoff Scandinavian 1551. [male voice]
11:06:37	TWR-W	Scandi 1551 stop immediately, I say again stop immediately!
11:06:43	TWR-W	1551 did you get that? [High pitch tone in background].
11:06:59	?	[Short transmission, duration 0,3 seconds]
11:07:03	TWR-W	1551 you have the traffic 12 o'clock now from right to left?
11:07:11	SK1551	<i>(Yea we have traffic passerat)</i> Scandinavian 1551 [female voice].

During a meeting with SHK a few months after the occurrence, the pilots from SAS 1551 listened to the tape recording from the TWR-W position. At that time they were unable to recollect that they had heard the stop message from the air traffic controller. Some weeks after this meeting, the first officer recalled that she had reacted to the fact that someone had said, "did you get that?" on the radio and that she had commented this on to the aircraft commander, "Did who get what?". As she subsequently did not hear anything further, she came to the conclusion that it was directed to someone else.

The aircraft that departed prior to SAS 1551 had received clearance to change frequency to radar control and the next takeoff after SAS 1551 took place about 10 minutes later.

1.10 Aerodrome information

1.10.1 The airport

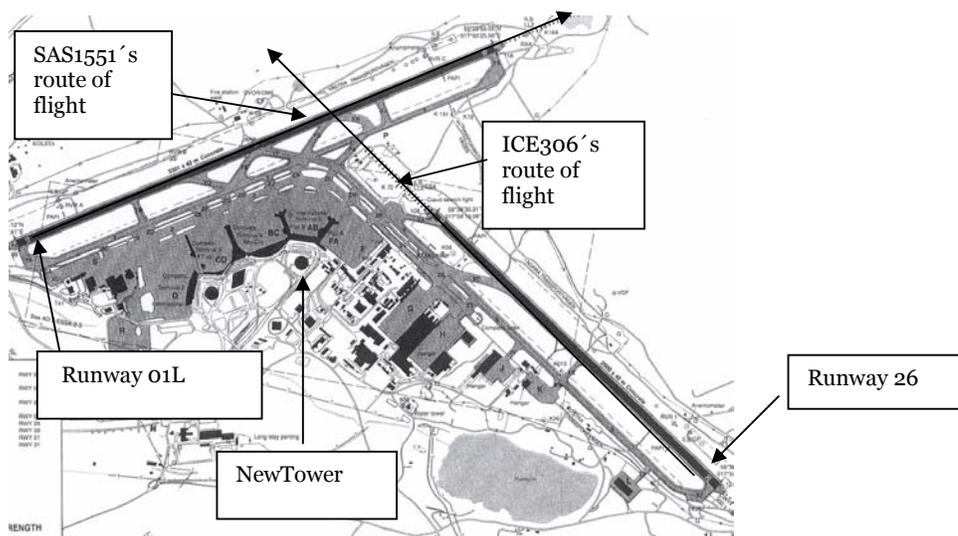


Image : Survey image, Arlanda airport (Source: LfV 2002-1843-002)

Stockholm/Arlanda airport has a third runway, designated 01R/19L, which was not operational when the incident took place and is not shown on the above image.

1.10.2 The air traffic control tower

Arlanda's new air traffic control tower became operational in December of 2001. The tower controller at duty position TWR-W was responsible for flight control service on runway 01L-19R, including the adjoining entrances and exits thereto, and for the western portion of Arlanda CTR. The tower controller at duty position TWR-E was responsible in a corresponding manner for service on runway 08-26 and for the eastern portion of Arlanda CTR.

The duty position chairs in the tower are adjustable in height. At the time of the incident the controller at position TWR-W was standing in order to observe landing aircraft on runway 26. The tower controller in position TWR-E was seated at his position and from there he was not able to see departing traffic from runway 01L, which however is not a requirement.

The communication between aircraft and air traffic control took place on different frequencies. This meant that departing aircraft had been assigned one frequency and landing aircraft had been assigned another and that these two groups of aircraft were not able to hear each other.

TWR-W was to visually determine when landing was accomplished on runway 26 in order to be able to issue takeoff clearance for departures from runway 01L. TWR-W did not have the possibility to monitor the radio communication between landing aircraft and TWR-E. To attract attention when an aircraft discontinues a landing, there is warning signal, audible within the tower, which the controller is to activate. The tower controller in position TWR-E activated the alarm at the same time that the controller in position TWR-W instructed SAS 1551 to reject the takeoff.

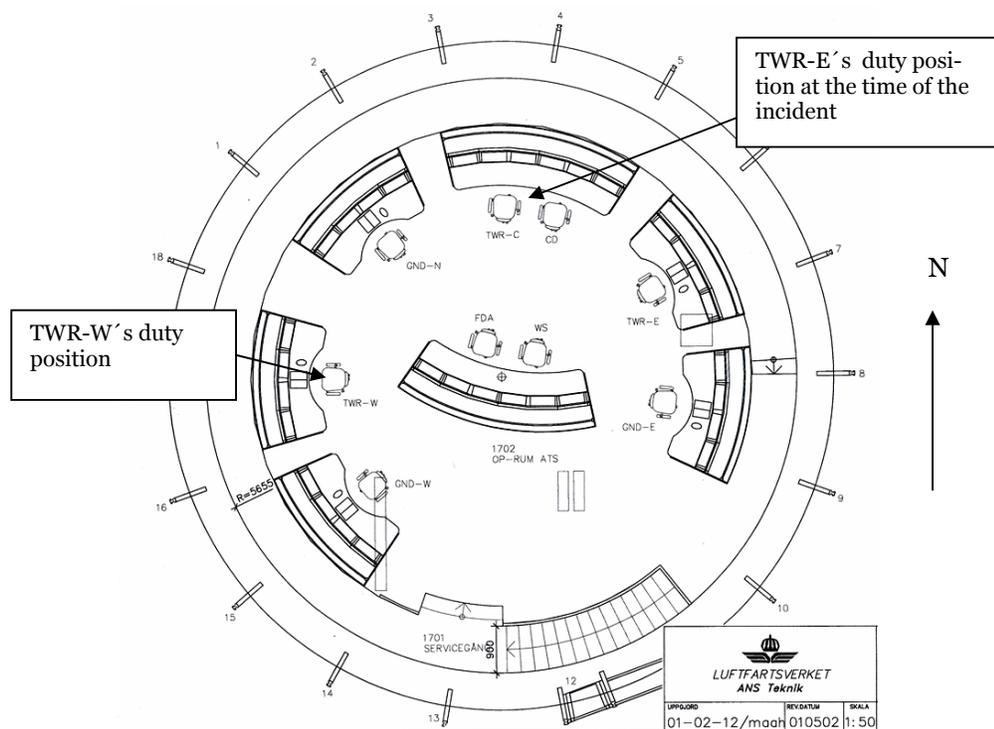


Image: Depicts duty position placement when runway three is in use. At the time of the actual occurrence TWR-E was working from TWR-C's duty position, see arrow. (Source: LFV 2002-1843-002)

1.11 Flight and voice recorders

1.11.1 Flight recorders (FDR, QAR)

The flight recorder equipment, QAR in the SAS 1551 aircraft, has been transcribed and data from the time of the incident has been delivered to SHK in printout form. The transcription shows that the takeoff proceeded normally. When the air traffic controller ordered SAS 1551 to reject the takeoff, the indicated airspeed of the aircraft was about 35 to 40 knots, and at the time of the inquiry "1551 did you get that?", the indicated airspeed was around 60 to 70 knots.

The flight recorder installed on board ICE 306 has not been transcribed, because the radar data from the time of the occurrence adequately depicts the aircraft's position.

1.11.2 Cockpit voice recorder (CVR)

The aircraft's voice recorder continuously records sound in the cockpit. The sound is registered on a continuous tape loop 30 minutes in length. The flight was about two hours in length and therefore the sound information from the time of the incident was lost in the re-recording.

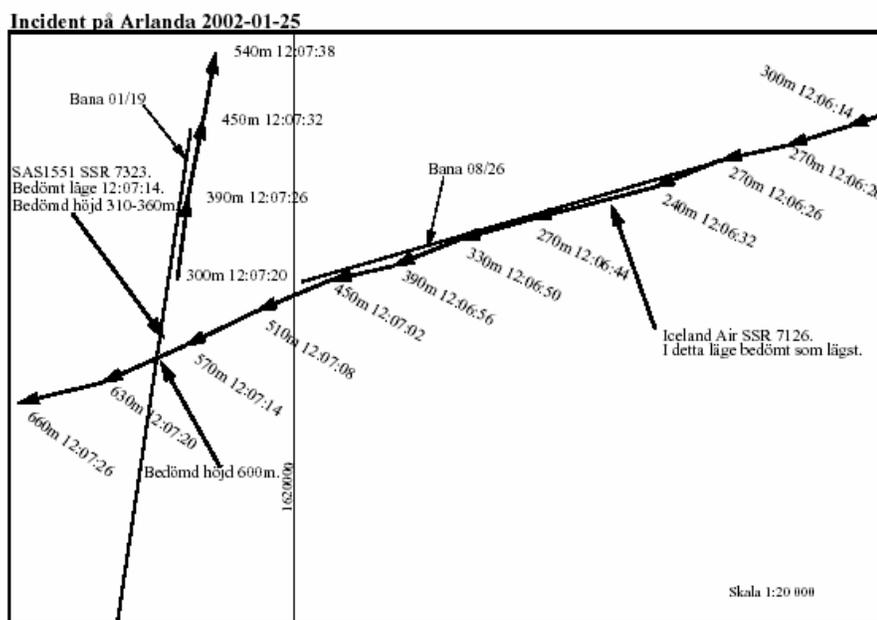
1.11.3 Voice-recording equipment in the tower

The equipment in the new tower records radio-transmitted conversation and conversation between tower controllers at the different positions. The recording only takes place via the microphone and it is therefore not possi-

ble to establish what portion of that which is said by the controller, that is actually transmitted over the radio.

1.12 Incident site

The route of flight of both aircraft has been registered by MUST and presented according to the diagrams below. From the registration, it has been calculated that the minimum distance between the aircraft horizontally was 75-100 meters and vertically about 300 meters. This took place at time 12:07:14. (See below)



A transcription of the route of flight and altitudes of both aircraft has been accomplished from the Civil Aviation Administration's radar data recording (IOR).

Update number	Horizontal range (NM)	Altitude difference(ft)
1	0.39	1,100
2	0.84	900
3	1.32	700
4	1.78	300

Note: ICE 306 had already passed overhead SAS 1551's departure path when SAS is seen for the first time on IOR (update nr 1).

1.13 Medical information

No medical investigation has been accomplished.

1.14 Fire

Not applicable.

1.15 Survival aspects

Not applicable.

1.16 Tests and research

Not applicable.

1.17 The airlines' operational conditions and practice

1.17.1 *Flight operational conditions and practice*

According to the SAS FOM 3.2.13 Operation of COM, NAV Systems & Data-link, section 1.1, it is generally applicable that "Monitoring of ATS channels in terminal areas should primarily be made using headset. Loudspeaker may be used when the quality of sound is such that undisturbed reception is available on the loudspeaker system."

Within SAS a "Safety Inspection of Flight Deck Crew environment on SAS MD80 Aircraft" has been conducted. In this report from 1991 it was concluded that the aircraft type has a low level of noise. It was decided not to establish any general requirement for the use of headsets on the MD80. The reasoning behind this is that, among other things, the company wants to stress the importance of being able to optimize pilot communication during an eventual critical situation and that they can more easily perceive abnormal sounds from, for example engines and landing gear.

Differing opinions prevail among pilots concerning the merits of headsets in aircraft with low noise levels. Many SAS pilots who fly the MD-80 feel that they can better supervise the situation when they do not use headsets. The reason for this is, among other things, that the present type of headset with a microphone, which is in use in the aircraft type, requires the use of the transmission button during internal communication.

All SAS pilots undergo rejected takeoff training twice each year during their proficiency check (PC) in the flight simulator. The cause may be engine failure, technical faults, foreign objects or vehicles on the runway or an order from ATC. According to flight simulator instructor reports, it happens seldom, if ever, that a message to reject is not heard when this is practiced in the simulator. It should be observed that all communication in the flight simulator is concentrated on the crew.

1.17.2 *Instructions and practice for air traffic controllers at Stockholm/Arlanda airport*

Within the instructions that were applicable at the time of the occurrence, there was no denunciation of the earliest point in time when the tower controller (TWR-W) was allowed to issue takeoff clearance from runway 01, taking into consideration that landing traffic runway 26 should indeed complete their landing. This assessment was left up to the traffic controller himself. The customary practice that is utilized for this assessment has been that landing aircraft must have passed overhead the threshold of runway 26 before takeoff clearance is issued on runway 01L.

1.18 Additional information

1.18.1 *Previous violations of minimum separation at Stockholm/Arlanda airport which were investigated by SHK*

On the 30th of April 1997 a minimum separation violation occurred at Stockholm/Arlanda airport when an aircraft in takeoff position on runway 01 received takeoff clearance. The air traffic controller judged that an aircraft on approach to runway 26 would complete its landing. As the departing aircraft initiated its takeoff, the other aircraft aborted the landing and followed the procedure for missed approach, which meant that it began to climb straight ahead to 1,500 feet. The resulting minimum separation between the two aircraft was 465 meters horizontally, with an minimum altitude difference of 213 meters.

SHK's investigation showed that the air traffic controller had made the incorrect judgement that the aircraft on approach to runway 26 would be able to land. Contributory to the occurrence was that the method that was used by air traffic control during a missed approach was not sufficiently developed.

SHK's recommendation to the Civil Aviation Administration was to develop unambiguous methods for air traffic controllers to assess when an aircraft can safely be considered to have landed. (Report C 1998:6)

The Civil Aviation Administration decided to introduce instructions into the regulations in accordance with SHK's recommendation. The result was that takeoff clearance from runway 01L could not be issued in the event that an aircraft during an approach to runway 26 had passed a "Point of No Take-off (PNT)", which was determined to be 3.5 NM from the touchdown point on runway 26 during instrument meteorological conditions. During visual weather conditions reduced separation was to be applied. However there was no method developed to facilitate the judgement of when an aircraft can be considered to have landed.

Subsequent to the occurrence of 30 April 1997 the missed approach procedure for runway 26 was changed. This meant that at the "MAPt" (Missed Approach Point = height of 500 feet, approx. 1 NM from threshold), pilots were to turn right as soon as practicable to a course of 300 degrees and climb to 1,500 feet.

On the 29th of June 2000 another violation of minimum separation occurred at Stockholm/Arlanda airport when runway 01L was in use for takeoff and runway 26 for landing. In this case, the aircraft, which was on approach to runway 26, discontinued the approach prior to 2,000 feet and before reaching the MAPt. The aircraft turned right to 300 degrees and climbed to 2,500 feet. At the same time, another aircraft had received takeoff clearance from runway 01L and had received departure clearance to climb on a course of 030 degrees to 5,000 feet. This departure profile resulted in the two aircraft coming into conflict with each other.

SHK came to the conclusion that the execution of the published procedure could easily be misunderstood and therefore did not satisfy the safety demands for separation to other traffic.

SHK recommended the Civil Aviation Administration to revise the missed approach procedure for runway 26 so the risk of misunderstanding was minimized and that the separation to other traffic at the airport was assured. (Report RL 2000:44)

The result of the recommendation was that Arlanda air traffic control introduced a minimum distance of 5.5 NM between landing aircraft on runway 26, regardless of weather conditions. A clarification was also introduced insofar as the procedure for missed approach was to be initiated at the decision height/MAPt, that is to say at a distance of approximately 1 NM from the threshold of runway 26.

1.18.2 *The Civil Aviation Administration's investigation of the occurrence in question*

Subsequent to the incidents of the 30th of April 1997 and the 29th of June 2000, Arlanda's air traffic control has labored continuously with a working method to meet the increasing demand for availability, while maintaining flight safety. To the greatest extent possible, the runway combination with departures from runway 01L and arrivals on runway 26 is avoided, as long as the winds allow for other takeoff and landing directions.

During the occasions when the use of the runway 01L/26 was mandatory, the rule in force was that TWR-W was allowed to issue takeoff clearance to departing traffic from runway 01L, at the latest, when arriving traffic to runway 26 was 3 NM from the touchdown point on the runway.

It is stated in the Civil Aviation Administration's investigation (LFV 2002-1843-002) of the occurrence of 25 January 2002 that:

- *ATS ESSA, after each and every one of the occurrences... (accounted for in 1.18.1 SHK's annotation) ... took measures in order to enhance safety during missed approach but that these measures, with the exception of the requirement for VMC and the ban on visual approaches, had not become permanent.*
- *The PNT has been relocated forward 0.5 NM with reference to the criteria for separation during VMC.*
- *Two considerations that have emerged during previous events have not been paid attention to, namely:*
 1. *The annotation in the ANS investigation of the occurrence of 30 April 1997, that avoidance of the acute risk of collision 'must be based upon procedures which are not dependent upon visual contact between aircraft or orders of 'evasive turns' on the part of ATS.'*
 2. *SHK's recommendation subsequent to the same occurrence to 'introduce clear-cut methods for air traffic controllers to safely judge when an aircraft can be considered to have landed.'*

The investigation's suggestion for measures to reduce the risk of recurrence were the following:

- 1 *Reestablishment of the PNT to 3.5 NM from touchdown point in accordance with the working team's suggestion after the occurrence of 30 April 1997. If the criteria for separation during VMC conditions can be confirmed and approved by the Civil Aviation Administration Inspectorate, 3.0 NM may be accepted.*
- 2 *The responsibility to insure that landing aircraft complete their landing is assigned to TWR E, who thereafter informs TWR W, in a suitable*
- 3 *manner, that there is no risk for missed approach. Accordingly, TWR W is not required to divide his attention between his own area of responsibility (RWY01L-19R), visual monitoring of RWY26 and control of the PNT at the RPU prior to takeoff clearance being issued. The fact that TWR E is completely focused upon landing traffic should entail a certain benefit to safety and/or timesaving compared with the present method.*

- 4 *The introduction of unambiguous methods for the traffic controller to judge when an aircraft can safely be considered to have landed in accordance with the recommendation in SHK's report C 1998:6.*

1.18.3 *Incident at Oslo/Gardemoen airport on 8 March 2000*

The Norwegian Board of Accident Investigation (HSL) has investigated an incident at Oslo/Gardemoen airport on the 8th of March 2000 where three SAS aircraft were involved in a minimum separation violation. In the final report (Report 6/2001) an account is given of how a landing aircraft was unable to exit the runway at the assigned position but passed the runway exit due to the slippery runway. Therefore the pilots chose, when they had brought the aircraft to a stop, to make a 180-degree turn on the runway and taxi back to the exit. Simultaneously the air traffic controller had issued takeoff clearance on the same runway to aircraft number two. When the traffic controller became aware that aircraft number one was still on the runway, he issued an order to aircraft number two to hold its' position; "Okay, SAS 327 hold position, hold position". The crew in aircraft number two did not hear this and continued their takeoff. They lifted-off at about 300 to 400 meters from aircraft number one and passed overhead it at a height of approximately 150 to 200 feet, according to the crew's assessment. Aircraft number three, which was on approach to the runway, was forced to perform a missed approach.

Aircraft number two was an MD-82 and the crew were not using any headsets during radio communications. It had not been considered necessary to use headsets, as the sound insulation in this model aircraft was good. The crew never heard when the crew of aircraft number one reported that they were backtracking on the runway.

HSL was of the opinion that the use of "headset" can be an important safety factor and recommended the airline to perform a reassessment of their routines.

1.18.4 *Acute warning messages*

SHK has not found any instructions within the current regulations for ATC personnel concerning a specific phraseology that shall be used in a situation when it becomes extra important to get the immediate attention of the pilots.

The crew was not wearing headsets at the time of the occurrence and did not feel that this was necessary because the noise level in the cockpit is low and the cockpit duties are deemed to be easier, when they are not required to communicate via the intercom system.

Also, the crew has conveyed that the phrase "Abort takeoff" might have got their attention as this phrase can only be directed to an aircraft on the takeoff roll.

2 ANALYSIS

2.1 The near-miss incident

The prevailing weather conditions at Stockholm/Arlanda airport were such that the tower controller who was responsible for departures on runway 01L had good visual contact with both SAS 1551 which was lined-up in take-off position and with ICE 306 on final approach to runway 26. When ICE 306 had passed overhead the threshold to runway 26 and everything looked

normal, he made the judgement that ICE 306 would complete the landing. He then issued takeoff clearance to SAS 1551. When he looked back towards runway 26 he observed that ICE 306 had initiated a go-around. He acted promptly and issued the stop message according to existing regulations before TWR-E had the time to trigger the warning signal. The air traffic controller acted in complete accordance with existing regulations and practice. The tower controller for runway 26 arrivals acted according to the regulations as well, when he warned that the landing had been aborted.

The crew on board SAS 1551 received takeoff clearance and initiated their takeoff. The cause for them not reacting to the stop message and thus carrying-out their takeoff is discussed below. When the aircraft lifted-off from the runway the aircraft commander observed the converging course of ICE 306 from the right side of the aircraft. Through his immediate takeover of aircraft control and reduction of aircraft climb rate, he was able to avoid the two aircraft coming any closer to each other. According to MUST's assessment, the minimum separation between the aircraft was 75-100 meters horizontally and about 300 meters vertically. In the absence of this maneuver the separation would have been less and the incident more serious.

2.2 The radio communication

The crew on board SAS 1551 did not hear the stop message from the air traffic controller. It has not been possible to establish with certainty that the transmission from the tower controller reached the cockpit speaker system on SAS 1551, as the information recorded on the aircraft's CVR during the takeoff was erased during re-recording as the flight continued. Furthermore, it is not possible to determine what was transmitted from the tower by means of the equipment at Arlanda due to the fact that the recording does not take place via the transmitter. It can be considered as probable that the transmission was heard in the cockpit because the crew heard the radio communication prior to the stop message and the first officer heard and answered the subsequent radio communication. There was most likely no other aircraft on the frequency at the time, which could have blocked the transmission.

The probable cause of the crew not noticing the stop message was that it came during a stage of the takeoff when their attention was completely directed at steering the aircraft, monitoring engine instruments and giving and responding to checklist items. Even when the air traffic controller attempted to get the stop message confirmed by transmitting "1551 did you get that", the pilots unconsciously prioritized other cockpit duties. Also, they probably did not notice anything abnormal that could have caused them to be more aware of instructions from the air traffic controller, which would have got them to reject the takeoff. When rejected takeoff is practiced in the simulator the pilots are prepared to stop. This expectation causes one to react immediately to the stop order. In contrast to reality, the environment in a simulator is free from outside disturbances.

When the aircraft commander leaned forward in order to move the landing gear handle, he observed ICE 306 and became occupied with taking-over control of the aircraft. The first officer understood a portion of the message but interpreted it as directed to someone else. Earlier in the day the crew had performed another flight with another numerical callsign. It is therefore possible that a radio call stating the word "Scandinavian" might have captured the crew's attention better than one using only the flight number, which is often changed for each flight.

Due to prescribed terminology the complete callsign "Scandinavian stop immediately" shall be repeated. The air traffic controller used, for the most

part, prescribed terminology, “Scandi stop immediately”, in his message that the takeoff was to be discontinued. Despite this the message was not perceived. SHK draws from this the conclusion that the conventional terminology is insufficient to be apprehended by the crew in a situation entailing high working stress.

It can be questioned if the phrase “stop immediately” is suitable to be used in order to stop aircraft on takeoff roll; as it can even be used for other traffic on the airport area.

The Norwegian investigation accounted for above dealt with a situation when a departing aircraft did not hear or become aware that there was another aircraft on the runway and that they were to hold their position. SHK concurs with the opinion of the Norwegian Accident Investigation Board that the use of headsets can increase awareness of what it said on the radio. In the incident under investigation, it was probably more a case of total focus on the takeoff procedure.

As the risk that a conflict can arise is greater at airports that operate with converging runways, there is reason for pilots on such occasions, as far as it is practicably possible, to be especially aware of the other traffic and mentally prepared for possible unexpected directives from air traffic control.

2.3 The runway combination—takeoff runway 01L/ landing runway 26

Operational problems that may arise in connection with the use of runways with converging directions are well known. This is also why the air traffic control service at Stockholm/Arlanda airport attempts, to the greatest possible extent, to avoid the use of the runway combination with departures on runway 01L and arrivals on runway 26. During certain wind conditions however, one is forced to use this combination so as not to inhibit the flow of air traffic. The occurrence shows that those measures that have been taken as a result of earlier incidents are not sufficient.

Even if the use of this runway combination is expected to decrease in connection with the third runway becoming operational, there will however even in the future be situations when it will become necessary to utilize the runway combination 01L and 26. It should therefore be considered whether additional operational procedures and improvements should be introduced during the use of the runway combination 01L and 26, in order to reduce the risk of a collision incident occurring. Further, additional methods should be developed that shall simplify the air traffic controller’s ability to judge when an aircraft can safely be considered to have landed.

3 CONCLUSIONS

3.1 Findings

- a) The pilots were qualified to perform the flight.
- b) The aircraft had valid certificates of airworthiness.
- c) SAS 1551 had received takeoff clearance.
- d) ICE 306 had received landing clearance.
- e) The air traffic controllers handled the aircraft referred to according to applicable routines.
- f) The pilots on board SAS 1551 did not hear the stop order from the air traffic controller.
- g) It has not been possible to determine in retrospect if the stop order was audible in the aircraft loudspeaker system.

- h) The closest distance between the two aircraft was, according to MUST, 75-100 meters laterally and about 300 meters vertically.
- i) Shortcomings exist in the working methods utilized during the use of the runway combination with takeoff from runway 01L and landing runway 26.

3.2 Causes of the incident

The incident was caused by takeoff clearance being issued, according to existing practice, to SAS 1551 simultaneously as ICE 306 initiated a missed approach and that the attempt to stop SAS 1551 was not apprehended by the crew of that aircraft.

4 RECOMMENDATIONS

The Civil Aviation Administration is recommended to

- develop methods for air traffic controllers to judge when an aircraft can safely be considered to have landed (*RL 2003:01e R1*) (*previously rendered recommendation from SHK in report C1998:6*),
- develop terminology to be used in emergency situations that has the greatest possibility of being apprehended by pilots working under high stress (*RL 2003:01e R2*) and
- consider if additional operational procedures and improvements should be introduced during the use of the runway combination 01L and 26 in order to decrease the risk that a collision incident should arise (*RL 2003:01e R3*).