



**Statens haverikommission**  
Swedish Accident Investigation Board

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## **Report RM 2003:01e**

***Accident involving a JA37 Viggen on the 20<sup>th</sup> of June 2002, at Upplands Wing/ F 16, Uppsala, C County***

Case M-002/02

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2003-06-03

M-002/02

Swedish Armed Forces

107 85 Stockholm

## **Report RM 2003:01e**

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The Swedish Accident Investigation Board (Statens haverikommission, SHK) has investigated an accident that occurred on the 20<sup>th</sup> of June 2002 within the Wing confines at Upplands Wing/ F16, Uppsala, C County, involving a JA37 Viggen (37411) with the call sign Petter Eleven (P 11).

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

SHK gratefully awaits notice before the 15<sup>th</sup> of December 2003 of the measures that the Swedish Armed Forces undertake on account of the recommendations made in this report.

Carin Hellner

Carl R. Hellström

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## ABBREVIATIONS

<b>ANS-DA</b>	Operational disturbance report for Air Navigation Services (Swedish CAA report)
<b>ATS</b>	Air Traffic Services
<b>CAA</b>	Civil Aviation Administration
<b>CAVOK</b>	Ceiling and visibility OK
<b>CVR</b>	Cockpit voice recorder
<b>DA</b>	Operational disturbance reporting
	<ul style="list-style-type: none"> <li>• DA FLYG concerns operational disturbances that occur in connection with flight duty, as well as with simulator and centrifuge training.</li> <li>• DA BAS concerns operational disturbances that occur in connection with airfield and base duties, as well as flight maintenance duties.</li> <li>• DA STRIL concerns operational disturbances that occur in connection with combat control and air defence duties.</li> <li>• DA SIS concerns operational disturbances that occur in connection with liason and information systems services.</li> <li>• DA VÄD concerns operational disturbances that occur in connection with meteorological services.</li> </ul>
<b>DIDAS</b>	An operations computer system
<b>DVD-RAM</b>	Digital storage medium
<b>AB</b>	Afterburner
<b>FFSU</b>	Continuation flight type training
<b>FLI</b>	Flight position indicator
<b>FMV:VoVC</b>	Swedish Defence Materiel Administration: Validating and Verification Centre
<b>GFSU</b>	Basic flight type training
<b>GFUF</b>	Basic flight training
<b>hPa</b>	hectopascal, a unit for measurement of pressure
<b>JA 37</b>	Fighter version of SAAB 37 VIGGEN
<b>Mil AIP</b>	Military Aeronautical Information Publication
<b>PST</b>	Periodic simulator training
<b>RHM</b>	Radar altimeter
<b>RML</b>	Regulations for military aircraft
<b>RUF</b>	Equipment for registration maintenance and flight safety
<b>SFI</b>	Special pilot instruction
<b>SI</b>	Sight line indicator
<b>TIS</b>	Aircraft type training phase
<b>TRAB</b>	Technical Report / Work Order
<b>UTB</b>	Equipment for evaluating training
<b>QFE</b>	Atmospheric pressure at airfield elevation
<b>QNH</b>	Atmospheric pressure at mean sea level

## Report RM 2003:01e

M-002/02

Report finalized 2003-06-03

Aircraft; registration, type	P 11, SAAB JA37 (37411)
Owner/operator	Swedish Armed Forces/Upplands Wing/ F 16
Time of occurrence	2002-06-20, 09:03 hours in daylight <i>Note: All times are given in Swedish Daylight Savings Time (UTC + 2 hours)</i>
Place of occurrence	Upplands Wing/ F 16, Uppsala, C County 59°53'41N 17°34'12E, 20.6 m above mean sea level
Type of flight	Military exercise flight
Weather	Wind from 240° at 18 km/h, visibility 40 km, CAVOK, temperature/ dew point +18°/+11°C, QNH 1018 hPa
Persons on board	1
Injuries to persons	8 persons on the ground received injuries of varying degrees of severity.
Damage to aircraft	None
Other damage	None
The pilot: Sex, age Total flying time Flying time previous 90 days	Male, 27 years old 810 hours, of which 522 hour on the type 33 hours, of which 33 hours on the type

The Swedish Accident Investigation Board (SHK) was notified on the 20<sup>th</sup> of June 2002 that an accident with a JA37 Viggen, with call sign "Petter eleven" (P 11) occurred on the same day at 09:03 hours within the Wing confines at Upplands Wing/ F 16, Uppsala, C County.

The accident has been investigated by SHK represented by Carin Hellner, Chairperson, Rune Lundin, Chief Investigator Flight Operations until 2002-11-30, and Carl R. Hellström, Chief Investigator Flight Operations from 2003-02-01.

SHK was assisted in the investigation by Thomas Niclason, flight operations expert, Tommy Åkerblom, flight medicine expert, Kristina Pollack, flight psychology expert, and Fredrik Holmbom, flight technical expert.

The investigation was followed by Göran Mattsson representing the Swedish Armed Forces. Mikael Grev has been the safety representative from F 16.

## Summary

In conjunction with an informal study visit to F 16 on the 20<sup>th</sup> of June 2002, the pilot in a departing JA37 (P11) made an overflight of the visitors who stood on a hill to the side of the take off runway. The overflight was made at such a low altitude that eight persons on the ground were injured. Three persons were seriously injured.

In SHK's investigation, it was established that the pilot diverged from the set instructions for normal take off procedure.

Calculations indicate that the overflight occurred at a couple of meters altitude and that the aircraft's attitude was such that the jet exhaust plume was directed at an angle down towards the visitors.

The technical investigation has not been able to prove that there was a technical problem with the aircraft that could explain the low altitude of the flight.

During the investigation, it has come to light that take offs similar to the one during the accident had been made at least three times earlier at F 16. These occurrences had not been reported in the system for operational disturbance/operational divergence. As well, the occurrences had not come to the knowledge of the Wing or Division command by any other means.

SHK is of the opinion that measures should be taken to ensure that behaviour that diverges from the flight instructions are reported.

The accident was caused by the fact that the pilot in conjunction with take off, with lit afterburner, diverged to the side of the take off runway and at a low altitude flew over the visitors while at the same time commencing a climb, whereby the aircraft achieved such an attitude that the visitors were injured by the aircraft's jet exhaust plume and pressure wave. The pilot's decision to do the overflight can have been effected by the fact that he had seen others carry out similar manoeuvres without receiving complaints.

## Recommendation

The Swedish Armed Forces should take measures to ensure that behaviour that diverges from the flight instructions is reported. (*RM 2003:01e R1*).

# 1 FACTUAL INFORMATION

## 1.1 History of the flight

### 1.1.1 *Background to the study visit*

Thursday the 20<sup>th</sup> of June 2002 an informal study visit was carried out at Upplands Wing/ F 16 in Uppsala. The visit consisted of two independent groups. One group was composed of three relatives to one of the Squadrons pilots and the other group consisted of a Swede, without connection to the Wing, and her boyfriend. The boyfriend is an airforce pilot in the Italian Airforce. The latter two had received permission to visit the Wing half a year earlier, but for various reasons the visit had been postponed. During the mid-summer week, the time for the visit shifted two times. The guide for the first named group was the pilot who was related to the visiting group, while a GFSU student was the guide for the second group. The visiting groups were to follow the ordinary flight duty at the fighter Squadron and no special arrangements had been made. One of the guides (the GFSU student) asked the leader of the formation (the pilot of P11), after the briefing, if he could make an overflight of the area beside the runway where the visiting groups intended to stand during the take off of the formation.

### 1.1.2 *The flight exercise*

The fighter Squadron at F 16 carried out normal flight duties with four JA37 aircraft and one SK60 aircraft. The flight duties with the JA37 comprised mainly of GFSU training with four students who began their training during the spring of 2002. The flight exercise consisted of basic air combat exercises (B3: 4) with the Squadron's entire seven relatively young instructors as leader of the formation and instructors. The SK60 was used for navigation flying with visual reference to the ground.

After the weather and flight briefing that was given before the flight, the guides gathered the visitors into two vehicles and drove to the end of the runway in use (runway 26) in order to watch the aircraft take off.

The visitors chose to stand on a hill, which was approximately 2 meters high and 10 meters in diameter. The hill was situated 97 meters south of runway 26.

### 1.1.3 *The flight*

At 09:00 hours the pair of planes, consisting of an instructor as the leader and a GFSU student as wingman, was cleared for take off. The formation received clearance to take off with a separation delay of 15 seconds between the elements of the formation.

The pilot of P 11 (the leader) carried out a take off with a lit AB (zone 3). After rotation and retraction of the landing gear, the pilot turned to the left, after passing the intersection of the runways, and flew over the grass infield at a very low altitude towards the hill on which the visitors stood. The pilot passed over the hill under a weak climb with such an aircraft attitude that three persons in the group were seriously injured due primarily to the AB flame and pressure wave. Several persons threw themselves out of the way or attempted to take cover. A woman was thrown 15 meters from her original position.

#### 1.1.4 *Eye- witness reports, etc.*

From the witness reports that SHK gathered from the visitors on the hill and from two air traffic controllers in the tower as well as the leader of the rescue team, it is clear that the aircraft's flight altitude at the passage was very low and clearly diverged from the normal procedure for take off.

When the aircraft passed over the hill, the air traffic controller saw a cloud of dust, which is why he asked the pilot if he had hit the hill. The pilot responded that he "went over" the hill with the aircraft. He then carried out the ordered flight together with the second aircraft according to plan. It was first after he had landed that he received information that several people had been injured due to the overflight.

The pilot has stated that he made a rolling take off with lit AB (zone 3). He lifted from the runway at a normal speed, raised the landing gear and turned slightly to the left. He intended to fly over the visitors at a safe altitude. He saw at a late stage that the visitors were standing on a hill, instead of on the ground at the runway level, which he had counted on. He pulled the control stick quickly backwards and noted a short high-alpha warning from the aircraft's warning system. He perceived that the aircraft did not climb as expected, but instead only changed its attitude and thereafter climbed slowly. He then passed the visitors at an altitude that he judged to be safe and subsequently climbed out towards the exercise area.

The pilot has for SHK stated that he had seen other pilots carry out corresponding types of overflights, and that he himself had made a similar overflight manoeuvre during the month of March 2002.

His explanation to the take off procedure was that he was requested to do an overflight and that he judged that it could be encompassed in the concept of a normal take off. The pilot has no explanation for the fact that the flight altitude over the visitors was lower than what he had intended, other than that he was surprised that the visitors stood on a hill. He had no personal relation to the visitors. However, he knew the pilot colleagues who were present on the hill.

## 1.2 Injuries to persons

	<i>Crew</i>	<i>Passengers</i>	<i>Persons on the ground</i>	<i>Total</i>
Fatal	–	–	–	–
Seriously injured	–	–	3	3
Minor injuries	–	–	5	5
No injuries	1	–	–	1
Total	1	–	8	9

## 1.3 Damage to the aircraft

None.

## 1.4 Other damage

Insignificant, only due to the AB flame, which scorched the grass at the side of the take off runway and on the hill where the visitors stood.



## 1.5 The crew

### 1.5.1 The pilot

The pilot, male, was 27 years old.

<i>Flying time (hours)</i>			
<i>Previous</i>	<i>24 hours</i>	<i>90 days</i>	<i>Total</i>
<i>All types</i>	–	33	810
<i>This type</i>	–	33	522

The pilot was accepted for training as an officer in flight duty with the Air-force in 1995 and has undergone the training without problems. After completed GFSU training in 2000, he has undergone the leadercourse for a pair of planes as well as the simulator instructor course. He has also served a short period with FMV-VoVC. He has consistently received good grades and judgement of his service. The GFSU-tour of duty was the pilot's second tour at F 16 as an instructor.

Judgment of the pilot has been positive and he has been perceived as a very capable flight instructor with good instructional methods and someone who has always been willing to help when it has been required.

The pilot's aircraft type training phase (TIS) was completed 1998-05-06.

From the medical investigation, it is clear that the pilot had undergone the prescribed medical examinations with approved results. Nothing indicates that the pilot's physical or mental condition was impaired at the time of the accident.

## 1.6 The aircraft

<i>THE AIRCRAFT</i>	
<i>Manufacturer</i>	SAAB
<i>Type</i>	JA 37
<i>Serial number</i>	37411
<i>Year of manufacture</i>	June 1986 the aircraft was delivered to F 21
<i>Total operating time</i>	1744 hours

<i>ENGINE</i>	
<i>Engine manufacturer</i>	Pratt-Whitney
<i>Engine model</i>	JT8D, number 9476
<i>Number of engines</i>	1
<i>Total operating time, hours</i>	1250

## 1.7 Meteorological information

According to the meteorologist's prognosis, communicated at the weather briefing before the flight: Wind from 240° at 18km/h, visibility 40 km, CAVOK, temperature/dew point +18°/+11°C, QNH 1018 hPa.

## 1.8 Aids to navigation

Not applicable.

## 1.9 Communications

Not applicable.

## 1.10 Aerodrome information

The airport had status according to Mil AIP.

## 1.11 Flight and audio recorders

### 1.11.1 Flight recorders (RUF, UTB)

Both of the tape recorders in the aircraft P 11 have recorded the whole course of events and RUF show that there did not exist any technical problem during the take off. The take off took place with lit AB (zone 3). Rotation occurred at 266 km/h (74 m/s), at a computer time of 1500. The second after there was indication of rotation coming from the nose gear. After an additional two seconds (1503), there was indication of rotation coming from the main gear and the second after (1504) the retraction of the landing gear was initiated. A course change of approximately ten degrees to the left was commenced at time 1505 and a weak correction to the right came after an additional few seconds (1508 – 1510). From time 1505 until 1513, the aircraft's flight path angle varied between  $+0.2^\circ$  and  $-0.6^\circ$ .

Between 1512 and 1513 a strong pull-up was initiated with a quick movement backwards with the control stick. The speed was at this instant 460 km/h (128 m/s). A high rate of change in the angle of  $20.6^\circ/\text{second}$  can be read during the middle of the time points from 1513 to 1514. An increase of the angle of attack with a high-alpha warning and G-loading was registered during the time point 1514. Even the flight path angle went from having been somewhat negative to becoming positive at this time point.

Thereafter the aircraft climbed on course straight ahead to 450 meters altitude and the AB was de-selected at 500 km/h.

The registrations in UTB show that its flight data agrees with RUF. In addition to this, during the take off sequence it could be read that rotation with the speed vector symbol took place to the presented horizontal line in the SI. Rotation, landing gear retraction, and the beginning of the turn to the left of the runway's course occurred one after the other in quick succession. During the turn and the following straight course as well as the during the course correction, the speed vector symbol in the SI laid on or slightly under the horizontal line. Shortly after the course correction to the right, there occurred a short, quick and strong pull-up. The climb angle was arrested at  $+10^\circ$  attitude. A few seconds later, the UTB recording ceased according to the instrument's design.

There was no radar-measured altitude above ground presented at this stage, nor was there any other altitude reference, which is why the flight in this phase only took place with visual references. Presentation of radar-measured altitude to the pilot occurs earliest 30 seconds after the take off mode is exited. However, radar-measured altitude information is registered in RUF.

Radar-measured altitude (RHM) in RUF has a scale factor of 1.5. In other words, the accuracy from RUF regarding RHM is 1.5 meters. From the computer data, values can be read that are not whole number multiples of the scale factor. This is due to the fact that the RHM was not properly calibrated.

According to the specification for the RHM, the accuracy for altitudes less than 20 meters is  $\pm 0.9$  meters. The RHM measures the nearest point in relation to the antennae within a cone having a cone angle of  $40^\circ$ . The transmitter and receiver antennae are placed under each nose wing. The distance between an antenna and the lowest point on the aircraft is 2 meters. No compensation for this condition is made in the presentation of the radar-measured altitude.

During the time between 1505 and 1512 the RHM registered an altitude of 3.7 meters. At the same time during this period the aircraft attitude varied between  $4.5^\circ$  and  $9^\circ$ . With support from the discussion in the previous section, this gives the lowest point on the aircraft during this period of time to be in the interval 0–3.5 meters above the ground.

The radar-measured altitude that was registered in RUF at time 1513 as 2.2 meters and the aircraft attitude was  $6^\circ$ . This indicates that the lowest point on the aircraft was in the interval 0–1.9 meters above the ground.

### 1.12 Location of the incident

The accident site is situated 97 meters south of runway 26 at F 16 Wing airport in a clearing area called Helge Väst (HV).

Position  $59^\circ 53' 41N$   $17^\circ 34' 12E$  and 20.6 meters above mean sea level.

The accident site consists of a hill that at the time of the accident was even and had the same texture (grass covered) as the surrounding area. There were no obstacles on the hill.

### 1.13 Medical information

Nothing has come to light that suggests that the pilot's physical or mental condition was impaired before or during the flight.

Seven of the eight individuals in the visit group sought medical care due to the burn injuries that they received from the aircraft's jet exhaust plume during the overflight. Some of them had thrown themselves out of the way or attempted to take cover. The most seriously injured persons were blown down from the hill. A seriously injured woman was found approximately 15 meters from her original position.

In the medical report of the accident it is stated that all of the visitors on the hill showed signs of having been exposed to high temperature. There were confirmed injuries that varied from very lightly singed hair and light redness of the skin to more widespread burn wounds that required intensive care.

*Person A:* Very lightly singed hair. Did not seek medical care.

*Person B:* Mild burn wounds in the back of head and on right wrist. Hospitalization not required.

*Person C:* Dressing on small burn wound. Hospitalization not required.

*Person D:* Burn wounds on face approximately 2 % of body area, contaminated with dirt and gravel. Hospitalized for four days.

*Person E:* Superficial second degree burns and wounds in the face, contaminated with soot and gravel particles. Light redness in the left eye. Hospitalized for five days.

*Person F:* Burn wounds on 46 % of body area, on the head, neck, torso and arms. Burn injuries on left cornea. Lung injuries and bleeding under one of

the soft cerebral membranes. Had a period with fever and treated with antibiotics. Hospitalized for 19 days. Continued medication after release from hospital.

*Person G:* Burn wounds on 45 % of body area, on the face, arms, torso, right thigh and left lower leg. Punctured lung on the right side, left elbow fracture, bleeding under one of the soft cerebral membranes, burst right eardrum, suspected inhalation of unburned jet fuel, superficial damage to cornea. Trachea opened for breathing support. Treated with antibiotics. Hospitalized in the intensive care section for four days, then the burn wound section for 12 days. Continued treatment and care.

*Person H:* Burn wounds on 24 % of body area, on the face, arms, torso, and left lower leg. Hospitalized for 14 days.

All of the persons A–H are born in the 1970's, and consist of three women and five men.

The injuries varied substantially depending on the clothing worn and where the individuals stood. The guides wore the defence's flame-resistant flight overalls, while several of the visitors wore very light clothing such as jeans, shorts, and T-shirts, as well as clothing made of synthetic material.

#### **1.14 Fire**

Not applicable.

#### **1.15 Rescue efforts**

Immediately after the accident the guides alarmed the air traffic controller via a portable aviation radio. The air traffic controller activated the Wing's crash alarm at the same time as he alarmed the civil ambulances via the SOS Alarm.

The Wing's rescue team and ambulance with a nurse was at the accident site within a few minutes and began taking care of the injured. When the civilian ambulances with medical personnel arrived, they took over the responsibility and six people were taken to the Academic Hospital in Uppsala. An individual with minor injuries sought care at the Wing's hospital.

During the rescue effort a municipal rescue team in support of the Wing was alarmed to assist with rescue readiness for the aircraft that were in the air during the time that the Wing's rescue team was engaged in the taking care of the injured.

#### **1.16 Tests and research**

Directly after landing, the aircraft P 11 was taken out of service in anticipation of SHK's investigation.

From the technical investigation it was clear that the aircraft was equipped with a filled extra fuel tank. The aircraft was otherwise not equipped with external equipment. All engine values during the take off were within allowed values. After the flight there were no complaints or external damage on the aircraft.

At the request of SHK, the engine manufacturer Volvo Flygmotor has submitted a report about the engine's exhaust temperatures. The report gives the exhaust temperature radially and axially behind the aircraft when

the AB is lit (zone 3). Axially behind the AB exhaust nozzle the temperature is 1100 °C. The same temperature is found out to a distance of approximately ten meters behind the aircraft with a radius of about 0.5 meters, after which the temperature drops drastically. At a radial distance of 1.5 meters from the centre of the jet exhaust plume, the temperature is essentially the same as the surrounding air temperature. At the time of the accident the aircraft was airworthy and had five TRAB, registered in DIDAS, as remaining complaints. These complaints are of such character that they could not have had an influence on the course of events.

## **1.17 The unit's organization and management**

It has been decided that F 16 shall be closed in 2003. This has resulted in the operation having personnel and economic limitations and that many employees have left their positions or been posted to other units or staffs.

The training at F 16 continues during 2003. Towards the end of the 1990's, there were some 30 serving pilots at two fighter Squadrons. After the decision to close the Wing there has been a successive downsizing of the operations. Lack of technical officers and fighter controllers has therefore affected the supply of aircraft and the production of flight time.

A consequence of this scarcity is that during 2001, in order to ensure that all GFSU students received the requisite flight time in the first course, the student group was split and some were repositioned to other units. During the fall of 2001, the pilots did relatively little flying. Incident readiness was the main priority.

The normal instructor manning level for a GFSU course is at least twice the number of students. Therefore there should have been eight instructors. At the time of the accident there were seven instructors at the fighter Squadron. The majority of these were young and inexperienced.

## **1.18 Additional information**

### **1.18.1 Normal take off procedure**

Instructions for take off with the JA37 are described in detail in SFI JA37 Part 2, Chapter II, section 11: Take Off, page 17-21.

SFI describes how a normal take off shall be carried out in terms of speed, aircraft attitude, and climb profile. After rotation and lift-off, a normal take off shall be carried out as a climb straight ahead to a safe altitude. These rules shall always be followed unless special airport or unit conduct requirements exist.

Sometimes there are objective reasons for diverging from the normal take off procedure. When more than three aircraft take off in formation, it can facilitate the take off for the following aircraft if the first aircraft fly out low so that disturbances from its wake vortexes and jet exhaust plumes do not lie in the flight path of the following aircraft. There were no such exceptional circumstances in the case of the accident.

According to SHK's review of the flight briefing and decisions about the flight, there did not exist any misunderstanding about how the take off should be carried out. The take off was to be carried out individually with 15 seconds separation between the leader and the wingman. The command personnel within the Squadron who ordered the flight in question were not aware that an overflight of the visitors was planned.

### 1.18.2 *Visits close to the runway in use*

Persons and vehicles may not come closer than 50 meters from the edge of the runway in use for take off. The visiting group stood on a hill that was 97 meters from the nearest edge of the runway and thus fulfilled the criteria for obstacle clearance.

### 1.18.3 *Previous occurrences*

SHK has gathered that take offs with the JA37, similar to the one under investigation, have been carried out at F 16 during at least three occasions prior to the accident.

From the recorded telephone and radio communications in the control tower at the time of the accident, it was clear that there was discussion of a similar occurrence at F 16 one week earlier. On that occasion, the aircraft flew so low that grass and soil were thrown up in the air and landed on the take off runway, which resulted in a clean up effort.

Apart from the air traffic controllers, other personnel at F 16 have also seen or heard about the previous occurrences. However, these occurrences have not been brought to the attention of the Wing or Squadron command.

### 1.18.4 *Reports of operational disturbance/operational divergence*

At the units of the Swedish Armed Forces where flight operations are carried out, there is a reporting system called Operational Disturbance Reporting (DA) with the aim of improving flight safety within the different areas of activity: DA Flight, DA Base, DA Stril, DA SIS, and DA Weather.

DA is a system for reporting faults in the functioning of personnel, material, or for reporting other occurrences that result in divergence from the ordered or planned activity, which have affected or could have affected flight safety or airworthiness. Gathering and registering of DA aims to give the Swedish Armed Forces flight safety command knowledge of events that occurred in order to be able to decide on measures that will prevent a reoccurrence. An operational disturbance shall be reported as DA Flight, DA Base, DA Stril, DA SIS or DA Weather. Instructions for the reporting of an operational disturbance are described in the document "Report directions Flight material service" (RAFT) for DA Flight and DA Base and in supplementary directives for the other DA.

At Swedish Armed Forces Wing airbases, air traffic is directed and controlled by air traffic controllers employed by the Swedish Civil Aviation Administration (CAA). In resemblance to that of the Swedish Armed Forces, the CAA has a reporting system called ANS-DA. According to the CAA service regulation (TF-ANS A: 2102, p. 3, point 2.1 ANS- DA, operational divergence), it is every individual's responsibility to report, as soon as possible, ATS and/or pilot based events that affect flight safety.

Reports of previously made overflights that were in contradiction to the valid instructions had not been made in either the DA system or in the ANS-DA system.

The accident in this investigation has been reported to the CAA via ANS-DA.

### 1.18.5 *ATS audio recordings*

Recording of the air traffic control tower's internal and external communications were made on newly acquired equipment that records several radio frequencies and telephone traffic digitally.

The communications are stored on a computer hard disk and then saved on DVD-RAM media. Time information for each message is stored together with the recorded communications.

The registered information supports the testimonies and other registrations that SHK have received.

## **2 ANALYSIS**

### **2.1 The overflight**

It can be established that the pilot had the intention to carry out an overflight of the visiting groups in conjunction with the take off. Such a flight manoeuvre diverges from the instructions laid down for normal take off procedures. SHK has established that SFI JA37 describes how a take off with a JA37 shall be carried out regarding speed and climb profile. There were no circumstances in the flight in question that justified departure from the instructions. The pilot judged, however, that the flight could be encompassed in the normal take off procedure and be carried out in a safe manner. He had seen other pilots make similar take offs and overflights and had also carried out such a take off a few months earlier.

When the pilot approached the visitors at a low altitude, he became aware that they stood on a hill. In order to pass over the visitors at a safe altitude, the pilot initiated a climb. At that point the jet exhaust plume and pressure wave hit and injured the individuals on the ground.

Flying a JA37 over objects or people on the ground immediately after take off involves several difficulties and thus risks. During the take off phase the forward visibility after rotation is somewhat limited. One way to improve the visibility is obviously to lower the nose, which, however, results in a decrease in flight altitude. In addition to this, it is difficult to judge the height, because the barometric altimeter does not display reliable readings for heights less than 20 meters. Nor is the radar altimeter information in the JA37 presented to the pilot during the first thirty seconds of flight. To use the change of angular velocity in relation to terrain under the aircraft for assessing altitude is made substantially more difficult by the fact that the aircraft during the take off is accelerating at a great rate and by the fact that the airfield's surface lacks details—cement and short cut grass.

The low altitude of the flight at the time of the accident has not been able to be explained due to a technical problem with the aircraft. However, it can be noted that the engine's thrust is dependent on the ambient temperature. Consequently the pilot's experience from the overflight in March is not completely applicable to the situation at the time of the accident due to the fact that at a higher ambient temperature the engine produces less thrust and has a slower acceleration.

It can be established that carrying out a manoeuvre such as the one in question, regardless of whether it is allowed or not, demands knowledge and experience as there exists a number of parameters to take into consideration for each particular occasion. This knowledge appears to have been insufficient, which can be explained by the fact that the pilot was young and inexperienced.

SHK establishes that several factors could have contributed to the pilot's decision to carry out an overflight of the visitors. The circumstances at the Squadron on the morning in question with a relatively large visiting group that in addition contained a pilot from the Italian Airforce could have influenced the pilot to say yes when he was asked to make an overflight of the

visitors. Furthermore, he could have experienced an acceptance for this type of manoeuvre outside the framework of the regulations when it had obviously been done earlier without complaints or serious consequences.

A contributing factor to the occurrence of this manoeuvre contrary to the regulations could have been that F 16 soon will be closed, which has meant a certain deficiency in experienced leaders and good models that can restrain tendencies of this type.

## **2.2 Reporting of operational disturbance/operational divergence**

Take offs similar to the one in this investigation have been carried out at F 16 during at least three occasions prior to the accident. Several persons serving at the Wing have seen or heard about these occurrences. No reporting in the DA- or ANS-DA-systems had been made. As well, the occurrences had not come to the knowledge of the Wing or Squadron command by any other means.

It is very important that flights that diverge from the instructions are reported so that correcting measures can be taken. SHK is of the opinion that measures should be taken to ensure the reporting of behaviour that diverges from the flight instructions.

# **3 CONCLUSIONS**

## **3.1 Findings**

- a) The pilot was not ordered to carry out an overflight of the visitors.
- b) The pilot diverged from instructions for the normal take off procedure for the JA37.
- c) It has not with certainty been possible to establish the height above the visitors that the overflight took place. Calculations of the jet exhaust plume and eye-witness accounts compared with the pattern of injuries to the visitors suggest that the overflight occurred at a couple of meters altitude and with such an attitude that the jet exhaust plume was directed at an angle down toward the visitors
- d) The technical investigation has not been able to prove that there was a technical problem with the aircraft that could explain the low altitude of the flight.
- e) Take offs similar to the one in this investigation have been carried out at F 16 during at least three occasions prior to the accident. No reporting in the DA- or ANS-DA-systems had been made. As well, the occurrences had not come to the knowledge of the Wing or Squadron command by any other means.

## **3.2 Causes of the incident**

The accident was caused by the fact that the pilot in conjunction with take off, with lit afterburner, diverged to the side of the take off runway and at a low altitude flew over the visitors while at the same time commencing a climb whereby the aircraft achieved such an attitude that the visitors were injured by the aircraft's jet exhaust plume and pressure wave. The pilot's



decision to do the overflight can have been effected by the fact that he had seen others carry out similar manoeuvres without receiving complaints.

#### **4 RECOMMENDATION**

SHK gives the following recommendation.

- The Swedish Armed Forces should take measures to ensure that behaviour that diverges from the flight instructions is reported.  
(*RM 2003:01e R1*).