ESTONIAN SAFETY INVESTIGATION BUREAU

# INVESTIGATION REPORT

## SE-FVP SERIOUS INCIDENT IN KÄRDLA ON 28.10.2013

TALLINN 2014

# Contents

## Abbreviations used in this report

AS – Public Limited Company (Estonian - *Aktsiaselts*);

CSU – Constant Speed Unit;

CVR – Cockpit Voice Recorder;

CVR – Cockpit Voice Recorder;

ESIB – Estonian Safety Investigation Bureau;

EU – European Union;

FDR – Flight Data Recorder;

ft – Feet;

GMT – Greenwich Mean Time;

HPa – Hectopascal;

ICAO – International Civil Aviation Organisation;

kt – Knots;

LH – Left Hand;

NA – Not Applicable;

QNH - Barometric Pressure Adjusted To Sea Level (Query: Nautical Height);

RH – Right Hand;

RPM – Revolutions Per minute.

| | |
|---|---|
| **Date and time:** | 28 October 2013 at 0625 hrs UTC |
| **Place of serious incident:** | Kärdla, Estonia |
| **Registered operator**: | Operator Avies AS |
| **Aircraft Type:** | British Aerospace Jetstream 31 |
| **State of registry:** | Sweden |
| **Registration no:** | SE-FVP |

## Synopsis

On October 28th 2013 at 08:25 local time, Jetstream 31 with registration SE-FVP started its take-off roll on runway 14 at Kärdla airport with 17 passengers and 2 crew members on board. Immediately after applying take off power the aircraft turned sharply to the right and exited the runway. The crew gained directional control over the aircraft on a grass strip between runway and apron, continued on to the apron where the passengers were disembarked.

There were no injuries to the persons and the aircraft was not damaged.

Estonian Safety Investigation Bureau opened an investigation to determine the causes of the serious incident. The investigation was conducted according to the ICAO Annex 13 and EU Regulation 996/2010.

The investigation determined as the cause of the incident being incorrect pilot action. Going through checklists before departure, pilots did not perform propeller start lock system disengagement procedure correctly, causing RH propeller to stay on starting locks. After applying take off power, the LH engine with the propeller unlocked and in the alpha range produced relatively more thrust than RH engine with the propeller locked in the beta range. This strong asymmetrical thrust caused the aircraft to sharply turn right on the starting roll and exit the runway.

# 1 Factual information

## 1.1 History of the flight

The aircraft had arrived from Tallinn (EETN) to Kärdla (EEKA), the flight was uneventful. After short turnover and passenger boarding the crew started up the engines for flight back to Tallinn. The pilot flying was the Captain. During preparation for the flight, the crew went through the before start-, and after start checklists. The checklists were read by the co-pilot. The last item on the *After Start* section of checklist was *Start Locks*, which refer to the propeller start lock disengagement. The Captain did not reply to that item.

During taxi from apron to the runway the crew did not notice any abnormalities. The preparation for takeoff was performed according to before takeoff checklist. Immediately after applying take off power the aircraft turned sharply to the right and the crew could not control the directional movement of the aircraft with nose wheel steering or rudder. The Captain retarded the power levers to idle, while the aircraft exited the runway. The crew gained directional control approximately 35 meters from the beginning of the roll, on a grass strip between runway and apron. The flight crew continued taxing over grass to the apron where the passengers were disembarked.

When passengers disembarked, the crew started up the engines again, taxied back to the runway and tested the aircraft engines, propellers and systems. No abnormalities were detected.

During an interview, the crew reported “strange noises” coming from the right engine on engine startup and starting locks disengagement.

### 1.2 Injuries to persons
No injuries.

### 1.3 Damage to aircraft
No damage.

### 1.4 Other damage
No damage.

### 1.5 Personnel information
Captain

Male, 56, holding ATPL(A) license and I class Medical Certificate. Last proficiency check 28.06.2013.

| Experience, hours: | Last 90 days | Total |
|---|---|---|
| On JS 31/32 | 80 | 530 |
| All types | 80 | 14,500 |

Co-pilot

Male, 49, holding ATPL(A) license and I class Medical Certificate. Last proficiency check 16.05.2013

| Experience, hours: | Last 90 days | Total |
|---|---|---|
| On JS 31/32 | 109 | 2,000 |
| All types | 109 | 2,500 |

The crew was well rested and the Flight and Duty Time requirements were met.

## 1.6 Aircraft information

British Aerospace Jetstream 31 is a twin-engine aircraft with turboprop engines. Its passenger capacity is 18 and it is normally manned with two pilots, no cabin attendants. The aircraft had a valid Certificate of Airworthiness and a valid Airworthiness Review Certificate.

| Aircraft SE-FVP | |
|---|---|
| TC-holder | BAe Systems (Operations) Ltd. |
| Type | Jetstream 3102 |
| Serial number | 719 |
| Year of manufacture | 1986 |
| Total flying time, hours | 20,118 |
| Flying time since latest inspection, hours | 20118 |
| Number of landings | 25,247 |
| Fuel on board before event | 630 kg Jet A1 |

| *Engine* | | |
|---|---|---|
| TC-holder | Honeywell International INC | |
| Type | TPE331-10UF-513H | |
| Number of engines | 2 | |
| Engine | Nr 1 | Nr 2 |
| Serial number | P-42149 | P42036C |
| Operating time since latest inspection, hours | 11.5 | 11.5 |
| *Propeller* | | |
| TC-holder | Dowty Propellers | |
| Type | R333/4-82-F/12 | |
| Propeller | Nr 1 | Nr 2 |
| Serial number | DAP0011 | DRG/1348/85 |
| Total operating time, hours | 11,721 | 25,767 |
| Operating time since latest overhaul, hours | 749 | 749 |

| | | |
|---|---|---|
| Number of cycles since latest overhaul | 1,236 | 1,236 |

The aircraft is powered by two Honeywell International INC. TPE331-10UF turbopropeller engines, each driving a four bladed Dowty-Rotol propeller. The engine has a two stage centrifugal compressor and a three stage axial flow turbine. The compressor and the turbine are both mounted on the same shaft.

The propeller has a single-acting pitch change mechanism, with a range between reverse and feather. Boosted engine oil pressure is used to drive the blades to fine, ultimately achieving reverse. To drive the blades to coarse pitch, finally achieving feather, spring pressure assisted with counterweights is used

After engine shut-down, the trapped oil in the fine pitch side of the pitch change cylinder of the propeller pitch change mechanism will leak through the CSU control valve. Feathering spring will start to push the blades towards feathering position. To prevent this from happening, in order to reduce the loads on the engine starter motor, the blades are held at zero pitch at engine start-up by starting locks. The locks are engaged automatically by spring pressure as a part of an engine shut-down procedure and disengaged by pilot action after engine start.

In order to disengage the starting lock system, sufficient centrifugal force and hydraulic pressure need to be generated. To overcome the spring force holding the latches in engaged position sufficient RPM must be applied to the engine and sufficient hydraulic pressure must be applied to the fine pitch side of the pitch change mechanism in order to reduce the friction forces between the mating faces of the latches and piston (Figure 1).

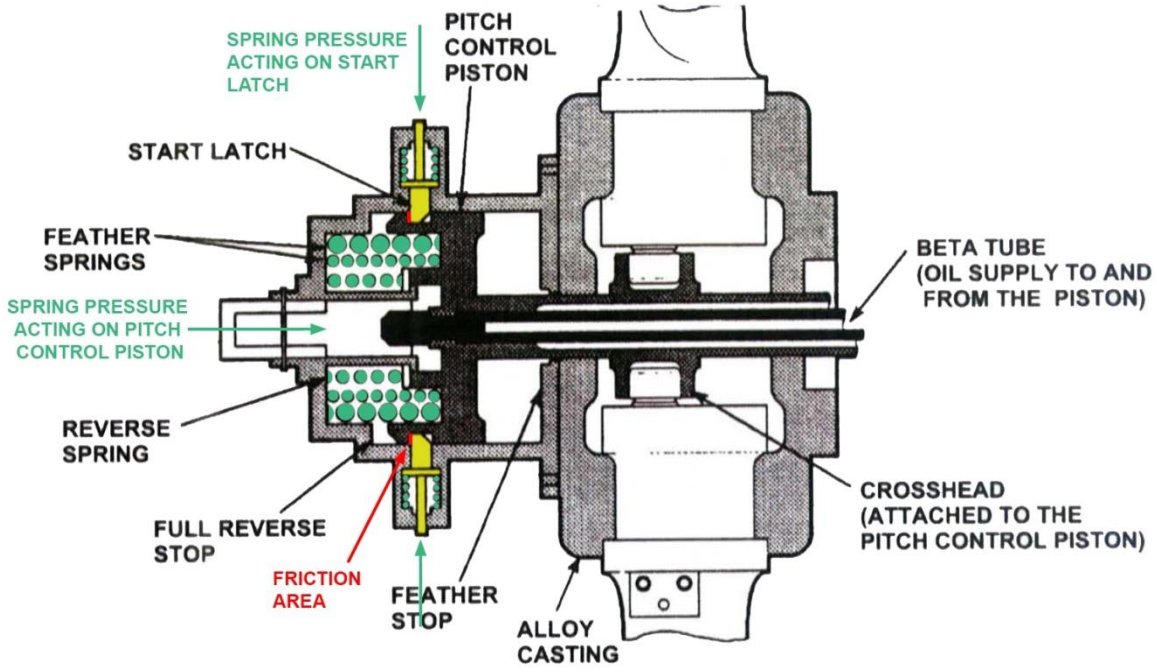


Figure 1. Single-acting pitch change mechanism with start lock system engaged on the start latches

Start locks on a Jetstream 31 aircraft will disengage by attaining engine RPM greater than 28% (450 rpm and above) overcoming the elastic forces of the springs and holding the latches in the "engaged" position. To reduce the frictional forces acting on the start latch and pitch control piston mating faces and to assist latch outward movement, hydraulic pressure needs to be applied to the fine side of the pitch control piston to move it forward. This is achieved by moving the power levers to REVERSE position until increase in torque and RPM is observed – indicating that propeller blade and control piston has moved to reverse position and the starting laches have been pushed fully to the disengaged position.

The starting locks are disengaged going through normal procedures as a part of the manufacturer`s and the operator`s "AFTER START" section of a checklist. Because there is no cockpit indicator for the position of the propellers relative to the start locks, the manufacturer`s normal procedures for taxing require "Take off torque" check to be performed verifying the position of starting locks. There is no procedure in the operator`s "TAXI" or "BEFORE TAKE-OFF" check list to determine or verify the position of the locks before take-off power is applied.

While taxing the aircraft, with TAXI selected on the RPM levers, the aircraft is able to move forward at all operating weights within the ground range (beta range – from fine pitch to reverse) of the propeller operation, with starting locks engaged.

## 1.7 Meteorological information

Wind at 023$^{o}$, 09G15 kt; visibility 10 kilometers; 992 QNH; 990,3 HPa; clouds 2/8 at 1100ft; air temperature 10$^{o}$C.

## 1.8 Aids to navigation

Not relevant.

## 1.9 Communications

Not relevant.

## 1.10 Aerodrome information

Asphalt runway of 1,520 meters (4,990 ft.) in length and 30 meters (98 ft.) width. The directions are 14 and 32.

## 1.11 Flight recorders

The aircraft was equipped with both FDR and CVR. The parameters recorded on FDR were not relevant for particular investigation. The CVR was secured and removed for readout.

The CVR (FA2100-1020-00, SN 568659) recordings were submitted to sound spectrum analysis. The examination revealed a 400Hz frequency erase tone with following 33 minutes of audio, referring to bulk erase that occurred after the incident took place.

Two hours of erased recordings were recovered from the CVR and sound spectrum analysis was performed. The CVR spectrum analysis reveal, that while the crew went through the *After Start* check list, the engines were running at approximately at 72% (76Hz). Just after co-pilot reads check-list item *„Start Locks"*, both engines were briefly brought to 81% (86Hz) and 80% (85Hz) one after the other

during the check (Figure 2 - two small peaks at 27:27). The peaks are better visible on 2nd and 3rd harmonic lines due to smaller sound wave abatement (Figure 2).

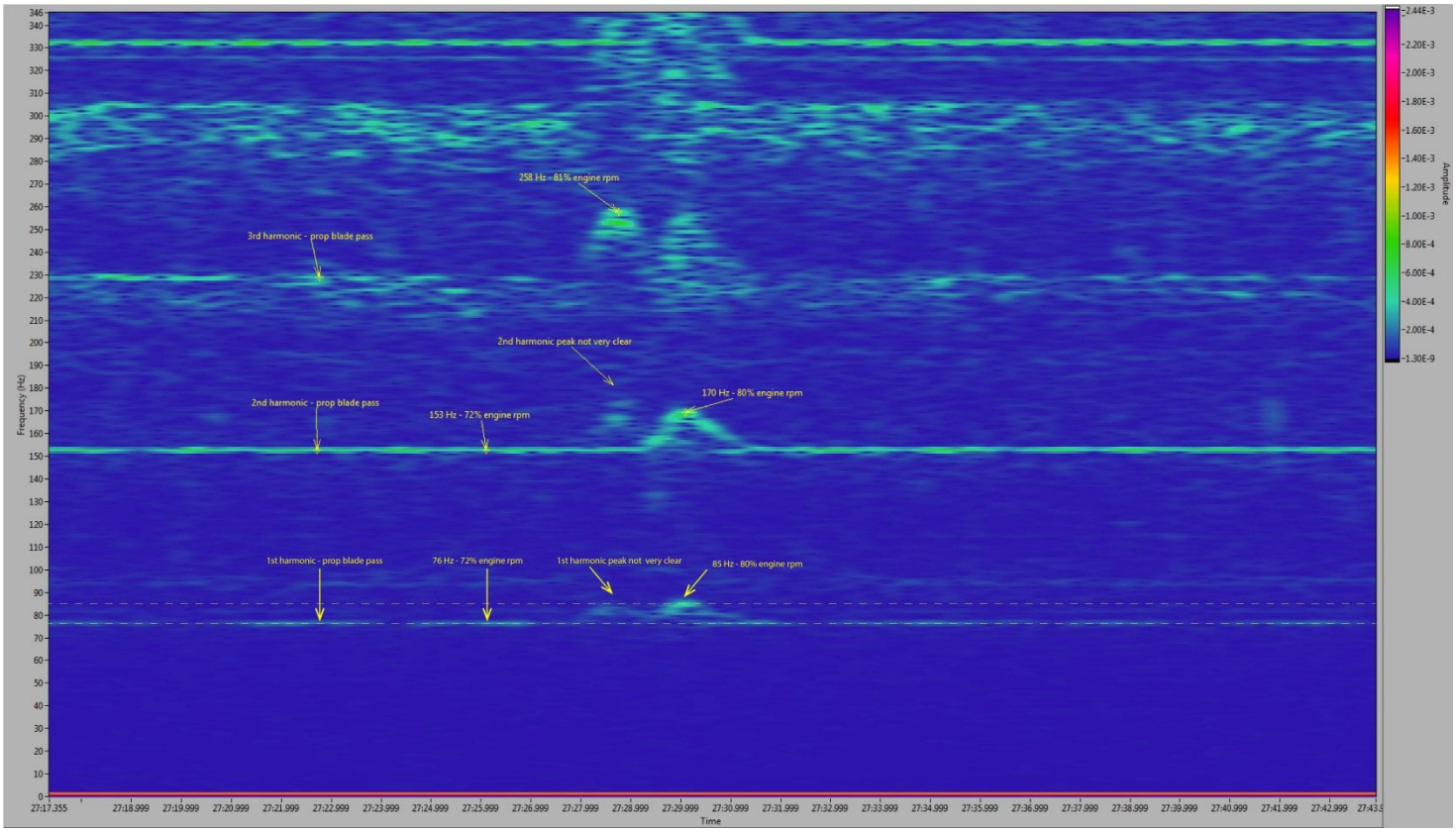


Figure 2. CVR spectrum analysis

## 1.12 Wreckage and impact information

Not relevant.

## 1.13 Medical and pathological information

Not relevant.

## 1.14 Fire

NA

## 1.15 Survival aspects

Not relevant.

## 1.16 Tests and research

Interviewing the flight crew, strange noise coming from the right engine on engine startup was reported. The ESIB undertook an investigation in order to determine the character of the noises heard and to obtain the normal acoustic pattern.

Multiple sound recordings from the aircraft cabin of the engine startup and starting lock disengagement were made in order to define a normal acoustic pattern on these procedures. Recorded patterns were compared with the CVR recordings and evaluated.

## 1.17 Organizational and management information

NA

# 2 Analysis

## 2.1 General

Evaluation of the incident site and meteorological conditions found no relevant abnormalities that could refer to technical, weather or any other conditions that could have caused or contributed to this incident.

Review of the aircraft technical log and maintenance records did not reveal any relevant issues or deferred defects. No evidence was found that would indicate that the aircraft had not been maintained in accordance with applicable regulations. The pilots did not report any technical problems in the flight log or in any radio transmissions.

After the incident, testing the aircraft normal operational procedures, no faults or abnormalities in operating the aircraft were detected. The functionality of the start locks, nose wheel steering and brakes was intact.

The analysis and comparison of the engine starting and starting lock disengagement sound recordings, made by ESIB, and the CVR recordings did not reveal any significant deviations that could refer to a technical related malfunction.

Therefore in analyzing the causes of this incident, the investigation focused on crew coordination and training aspects.

## 2.2 Crew coordination and training aspects

During preparation for the flight, the crew went through the checklists. The checklists were read by the co-pilot with Captain replying. The last item on the *After Start* checklist was "*Start Locks"*, which The Captain did not reply.

It is evident from figure 2 that even without the Captain replying, there has been some pilot action in order to disengage the start locks. The RPM applied has been enough to overcome the elastic forces of the start lock springs, what appears is, that the power levers were not being moved all the way to the REVERSE position, not waited for torque to increase, thus leaving the RH propeller on the starting locks. The fact that there is no indicator in the cockpit referring to the position of the start latches in the aircraft, the condition was left unnoticed for the flight crew during taxy and takeoff procedures.

According to the captain statements – the flight crew did not check the torque indication when disengaging the start locks and the crew was not familiar to the start lock system construction or mechanics.

After finishing the before takeoff checklist (at 29:50) pilots apply takeoff power (at 30:10). As the RPM increases, within two seconds (at 30:12) the aircraft banks sharply to the right due to the asymmetrical thrust that is produced by the engines and propellers. LH propeller unlocked from the starting latches and the pitch controllable in the flight range (alpha range), producing takeoff thrust. RH propeller locked on the starting latches in the ground mode (beta range), producing thrust required for ground operations.

The co-pilot calls “Stop-stop-stop” (at 30:13) while the pilots reduce power by pulling back the throttle lever and to control the aircraft push the rudder to the left. According to CVR recordings none of the pilots apply brakes.

Ultimately the crew gains directional control over the aircraft (at: 30:17) approximately 35 meters from the beginning of the roll on a grass strip between runway and apron. The crew decides to continue taxi over grass to the apron where the passengers (17) were disembarked (figure 3).

Figure 3. Aircraft parked on the apron and tracks on the grass strip

# 3 Conclusion

## (a) Findings

1. The pilots were properly licensed and qualified to conduct the flight.
2. No evidence was identified of a pre-existing technical defect.
3. The weather at Kärdla airport was suitable for departure.
4. The pilots did not perform propeller lock disengagement procedure correctly.
5. The crew did not try to stop the aircraft exiting the runway by applying the brakes.
6. The crew erased the CVR recordings after this serious incident.

### (b) Causal factors

The cause of this serious incident is incorrect pilot action on propeller lock disengagement procedure. Pilots did not pull the throttle levers fully to REVERSE position and waited for torque increase, leaving RH propeller starting latches in the engaged position. The condition was left unnoticed by the pilots, resulting in asymmetrical thrust production while applying takeoff power.

### (c) Contributory factors

1. None of the pilots tried to stop the aircraft exiting the runway by applying the brakes.
2. The fact that there is no indication in the cockpit with regards to the position of starting latches has caused pilots to develop and use multiple unofficial procedures to determine the condition of a propeller.

## 4 Safety Recommendations

To the operator Avies AS:

It is recommended to the operator that when operating aircraft with single acting propellers with starting lock systems, procedures to determine starting lock position and to stabilize the aircraft before applying take off power should be developed and implemented.

### 4.1 Actions taken so far

Since the incident, the operator has issued a flight safety bulletin (No: 004/13) to inform their pilots about the cause this incident, reminding to carefully follow the manufacturer (British Aerospace) procedures in releasing the starting locks.

The operator has organised a remedial training course for the pilots on the operation of the British Aerospace Jetstream 31 starting locks system, the faults that can happen and a live training on normal lock removal operations and abnormal situations, when locks fail to be removed.

# Appendixes

Manufacturer`s comments not accommodated in text:

“Page 7 indicates that you can taxi with the starting locks engaged. Whilst this is achievable with one engine in that state, this is not likely to be achievable with start locks for both engines engaged and that if it were achieved the engine instruments would be abnormal”.