Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accident Investigation

Investigation Report

Identification

Type of Occurrence:	Accident
Date:	9 August 2013
Location:	Leipzig/Halle Airport
Aircraft:	Cargo Airplane
Manufacturer / Model:	Antonov / An-12 BK
Injuries to Persons:	None
Damage:	Aircraft destroyed
Other Damage:	Cargo, apron surface
State File Number:	BFU AX002-13

Factual Information

On 9 August 2013 at 0230 hrs[1], the German Federal Bureau of Aircraft Accident Investigation (BFU) was notified by phone that a transport aircraft Antonov An-12 was on fire at Leipzig/Halle Airport. It was determined that during engine start-up the Auxiliary Power Unit (APU) had caught fire. The fire spread not only into the cargo compartment but also outside. The airplane was destroyed by the fire.

1 All times local, unless otherwise stated.

History of the Flight

On 8 August 2013 at 1914 hrs the airplane, arriving from Stockholm, Sweden, landed at Leipzig/Halle Airport. After the landing it taxied to apron 2 to stand 207. On board the airplane were the Pilot in Command (PIC), the co-pilot, one flight engineer, one navigator, one radio operator, and two flight mechanics.

The driver of the fuelling vehicle stated that the airplane was refuelled between 0058 and 0121 hrs with 22,809 l fuel. The flight engineer stated that approximately at the same time the loading had occurred and was completed at about 0140 hrs. Between 2330 and 0100 hrs the airplane was loaded with 48,960 one-day-old chickens. They had a total mass of 3,061 kg.

Take-off for the flight to Mineralye Vody, Russia, was planned for 0215 hrs. At 0201 hrs the engine start-up clearance was issued and the APU started. After the APU was running, engine No 1, outer left, was started. Once engine No 1 had reached idle speed the start-up for engine No 4, outer right, was begun. During engine start-up of engine No 4 the crew noticed a dull bang and the airplane jerked. The co-pilot, who monitored the APU instruments during engine start-up, had observed rotary speed oscillations and a temperature rise. A short time later the APU fire warning indication illuminated. The crew shut off the two already running engines and triggered the APU fire extinguisher system.

One photo (see Appendix) shows a glaring light on the left fuselage side. At this time propellers 1 and 4 were turning; propellers 2 and 3 stood still. Video recordings show fire in the area of the left main landing gear.

The co-pilot stated that the PIC had then opened the cockpit door. Flames were already visible in the cargo compartment.

The PIC stated that he sent one of the flight mechanics outside for a check. He left the aircraft through the emergency exit located in the floor of the cockpit. After he had left the airplane, he immediately reported that the APU was burning. Subsequently, the three fire extinguishers located in the cockpit were handed down. In addition, the flight engineer and the second flight mechanic left the airplane; they confirmed the fire. Together the three men tried to extinguish the fire with on-board fire extinguishers.

The PIC instructed the radio operator to report the situation to the tower. At 0207:45 hrs the radio operator reported the fire and requested the fire brigade.

Around 0208 hrs the fire was noticed by other witnesses. They stated that the area of the left main landing gear was burning and that in this area on the left side below the fuselage some liquid leaked on to the ground.

At 0208:01 hrs the tower alerted the fire station east. Half a minute later the fire station west was alerted. At 0209:00 hrs the tower announced the location of the fire. At 0212:06 hrs the first fire truck reached the airplane and undertook the first extinguishing attempt with foaming agent.

The crew members evacuated the airplane through the front emergency exit located in the floor of the cockpit. Then they left the danger zone and retreated to a grassy area about 50 m in front of the airplane.

Personnel Information

The 47-year-old Pilot in Command (PIC) held an Airline Transport Pilot's License (ATPL) issued by the Ukrainian aeronautical authority in accordance with ICAO with the commensurate class and type ratings. The pilot held a class 1 medical certificate. He had a total flying experience of 6,082 hours; 5,819 hours of which on the Antonov An-12.

The 46-year-old co-pilot held a Commercial Pilot's License (CPL) issued by the Ukrainian aeronautical authority in accordance with ICAO with the commensurate class and type ratings. The pilot held a class 1 medical certificate. He had a total flying experience of 4,268 hours; 4,229 hours of which were on type.

The 56-year-old flight engineer held a Flight Engineer's License (FEL) issued by the Ukrainian aeronautical authority in accordance with ICAO with the commensurate class and type ratings. He held a class 1 medical certificate. He had a total flying experience of 7,066 hours; 7,062 hours of which were on type.

Additional personnel on board: one navigator, one radio operator and two technicians.

Aircraft Information

The Antonov AN-12 BK is a high-wing cargo aircraft in all-metal construction with a retractable landing gear in nose wheel configuration. The aircraft was fitted with four

Motor Sich JSC Ai-20M turbo prop engines. Maximum take-off mass was 61,000 kg. Maximum landing mass was 58,000 kg. The aircraft with the manufacturer's serial number 9346904 was built in 1969.
The aircraft was registered in Ukraine and operated by a Ukrainian operator.

The last comprehensive maintenance was conducted between 24 April and 26 April 2013. Up until then the airplane had completed 5,319 flights and 10,948 flight hours. Until the day of the accident the airplane had completed 11,219 flight hours and 5,410 flights.
Until the day of the accident the engines were in service as follows:

Engine	1	2	3	4
Serial number	N2926212	N29226038	N2446041	N2846216
Total flight time (h)	11,872	3,401	10,845	10,525

The airplane was equipped with a TG-16 M APU, serial number OM 4502251 manufactured by JSC PPC Aviamotor. The APU was manufactured in 1975 and had a total operating time of 407 hours. According to the operator, a total of three overhauls were carried out in 1983, 1996, and in 2007. On 12 September 2012 the APU was installed in the accident airplane. There were no records of any technical malfunctions during APU operation.

With this aircraft type the APU is located behind the left main landing gear inside the fairing (see technical data in the Appendix).

The fuel tanks are located in the wings and the fuselage. The fuselage fuel tanks were located beneath the cargo floor (see technical data in the Appendix).

Meteorological Information

The Deutsche Wetterdienst (German meteorological service provider, DWD) stated that at the time of the accident visual meteorological conditions at night prevailed. Ground visibility was more than 10 km. The wind came from west with 5 - 6 kt.

Radio Communications

Radio communications with Leipzig/Halle Tower had been established. The recordings and the transcript of the radio communications were available to the BFU for evaluation purposes.

Aerodrome Information

Leipzig/Halle Airport has two asphalt runways. The runways are oriented 080°/260°. The north runway is 3,600 m long and 45 m wide. The south runway is 3,600 m long and 60 m wide. The five aprons and the taxiways have concrete pavements.

In accordance with ICAO Annex 14, the airport is classified with category 10 in regard to the required rescue and fire-fighting personnel. It had two category 10 fire brigades which are stationed in two fire stations (east and west).

Flight Recorder

From the wreckage a Flight Data Recorder (FDR) and two Cockpit Voice Recorders (CVR) were salvaged.

The MSRP-12 FDR, serial number 71222, was undamaged. At the BFU it was opened and the recording tape removed. The tape had been inserted the wrong way. The Ukrainian air accident investigation authority analysed the recording. The last recording on the tape was the landing at Leipzig/Halle Airport.

The two MS61 CVRs were undamaged. CVR No 1 had the serial number 16 and CVR No 2 the serial number 17. In CVR No 1 a wire recording reel was found. CVR No 2 was empty. On the reel found in CVR No 1 was a recording of about 11 minutes. From its content (take-off clearance on runway 18) it was clear it could not be Leipzig/Halle Airport.

Wreckage and Impact Information

The airplane had burned out (Image 2). The wings and the tail section had fallen down. The cockpit area had been severed from the fuselage and was lying on its right side. The cargo compartment had burnt and melted, respectively, to the ground. Several light metal alloy components, such as aluminium and magnesium, had either completely melted or burnt, except for a few debris pieces.

The emergency exit in the floor of the cockpit was open (Image 3).

When the BFU arrived at the site most of the wreckage was covered in foaming agent. The wing tanks still contained fuel. A disposal company pumped about 10 t of fuel from the wing tanks.

The gas turbine of the APU and gear wheels of the APU gearbox were salvaged from the wreckage and transported to the BFU for further examination (Image 4).

The Magnesium gearbox housing had burnt and melted, respectively, as had the light metal alloy compressor unit consisting of centrifugal compressor wheel and guide wheel.

Using construction plans the APU gearbox was reconstructed with the gear wheels salvaged from the wreckage (Images 5 and 6).

Image 7 depicts the two air intake grids. The cylindrical air intake grid faced the generator. In spite of the exposure it showed little damage and had mostly retained its original form. The conical air intake grid faced the centrifugal compressor. It was torn and bent. The compressor wheel and the guide wheel were missing. The bolts, which had connected the compressor with the combustion chamber, were almost completely preserved. On two bolts the bolt heads were missing (Image 8). Some areas of the combustion chamber of the gas turbine had burnt through. The turbine drive shaft and its bearing positions showed traces of fire. The turbine wheel was in the turbine housing and showed traces of fire. After dross and ash had been cleared from the exhaust, the turbine wheel could be moved somewhat but not turned.

Fire

Witnesses stated that the fire had started in the area of the left main landing gear and the APU, respectively. Initial attempts of the crew to extinguish the fire with the APU fire extinguisher system and the three fire extinguishers from the cockpit were not successful. The fire propagation was very fast and severe. The tower alarmed the airport fire brigade. The fire brigade could not prevent the fire from destroying the airplane.

The APU fire produced temperatures which were sufficient to melt some areas of the Magnesium gear box housing. The melting temperature of Magnesium is 650°C. The melting temperature of the alloy was higher. Due to the effects of the heat and the

molten mass the Magnesium and the alloy ignited. Burning Magnesium reaches temperatures of up to 3,000°C.

Because live animals were transported, the cargo door had been open. When the fire reached the cargo compartment it was fuelled by the good oxygen supply through the open door.

A police helicopter recorded the course of the fire and the airport fire brigade actions between 0214 and 0222 hrs, because it had approached the airport for refuelling. The video shows a burning liquid underneath the airplane spreading to the left.

The airport fire brigade used Aqueous Film Forming Foam (AFFF) and water. The foam suffocated and the water cooled the fire. Initially, there were chemical reactions (hydrogen gas) due to the high temperatures of the burning Magnesium. Eventually the massive use of water cooled the temperature below the reaction temperature of the Magnesium.

Survival Aspects

When the crew noticed the fire the regular exit through the cargo compartment was already impassable due to the fire. The crew evacuated the airplane through the emergency exit in the floor of the cockpit.

Organisations and their Procedures

ICAO Annex 14 (Fifth Edition, 19.11.2009) makes stipulations for the design and operation of airports. Chapter 9 Subsection 9.2 describes requirements for rescue and fire-fighting. In accordance with *Table 9.1 Aerodrome category for rescue and fire-fighting* Leipzig/Halle Airport is placed in category 10 due to the length of the airplanes being operated; category 10 is the highest. The aerodrome category determines the minimum required amount of extinguishing agent. Since Leipzig/Halle Airport uses a Level B extinguishing foam it must provide at least 32,300 l water. The required minimum discharge rate foam solution per minute was 11,200 l. The extinguishing foam consists of water, foaming agent (AFFF) and air. Three airport fire trucks transport the extinguishing foam. Due to the size the airport had six fire trucks. Three trucks each were stationed at the fire station east and the fire station west. All six fire trucks were deployed. Apron 2, where the Antonov was parked, was part of the sector of the fire station west.

ICAO Annex 14 Subsection 9.2.25 recommends: *The operational objective of the rescue and fire fighting service should be to achieve a response time not exceeding three minutes to any other part of the movement area, in optimum visibility and surface conditions.* Within this time span the fire brigade should reach every operating surface of the airport. *Response time is considered to be the time between the initial call to the rescue and fire fighting service, and the time when the first responding vehicle(s) is (are) in position to apply foam at a rate of at least 50 per cent of the discharge rate specified in Table 9-2.*

The tower notified the fire brigade by direct alert. In the working area of the air traffic controllers two buttons were installed; one for each fire station. The tower used a direct telephone to inform the fire department about the site of the fire. The fire brigade procedure stipulated that the information about the occurrence site should occur via the intercom system of the private mobile radio to the fire vehicles. On the day of the accident this did not happen, however. The fire brigade had to ask for the site of the occurrence.

Additional Information

Fire Brigade Operation

Chronological order of the fire brigade operation:

Time	Action
0207:45	The radio operator reported the fire.
0208:01	The tower notified the fire station east by direct alert
02:08:20	The tower used a direct telephone to inform the fire department about the site of the fire (“Feuer Südrampe AN 12“).
0208:32	The fire department acknowledged the information
0208:34	The tower notified the fire station west by direct alert
0209:00	Fire chief east asked about the site of the fire
0209:23	Fire truck No 7 of fire station west leaves the station as well as other fire trucks and rescue vehicles
0209:30	Fire trucks and rescue vehicles of fire station east leave the station

0209:39	The tower asked the fire department about the missing fire brigade
0209:43	Answer of the fire department, fire station west has left
0210:44	Fire station east called fire vehicle Florian 12 with the clearance request for Ramp 2
0210:44	Fire station west, fire vehicle Florian 15 reports from apron west
0211:56	Fire chief west reaches the site and sounds out the situation
0212:06	Fire truck No 7 reaches the site of the fire
0214:15	Fire trucks and rescue vehicles of fire station east reach the site of the fire
0230:00	The fire is under control
0247:00	The fire is extinguished

Based on the experiences during this occurrence the alerting system was changed. Now triggering the alarm also triggers the opening of a communications channel which allows all parties involved to communicate with each other without delay.

Antonov AN-12 BK

The Ukrainian civil aviation authority has transmitted the following information in regard to the history of the registration of the Anotonov An-12:

Ukraine CAA comments relatively airworthiness standards of Antonov-12 aircraft.

«Antonov-12 type aircraft was designed during 1955-1957 as a cargo version of Antonov-10 passenger aircraft, and the operation of Antonov-12 airplanes in the civil aviation of the USSR started in 1960.

Antonov-12 aircrafts and its modifications were released to operations in the civil aviation of the USSR in compliance with the effective (at that time) procedures on the ground of the recognition of the positive results of the state (military) tests. Later on, there was published Antonov-12 Aircraft Civil Operation Worthiness Certificate on 28.08.1985, which was approved by the Minister of Civil Aviation of the USSR and agreed with the Minister of Aviation Industry of the USSR, being considered equal to a Type Certificate.

After the establishment of the national aviation authority of Ukraine that Certificate was recognized as valid for Antonov-12 aircrafts and its modifications operation in the civil aviation of Ukraine. Taking into account that Antonov-12 aircrafts and its modifications have been under the jurisdiction of Ukraine, the State Aviation Administration of the Transport Ministry of Ukraine, as the national aviation authority, issued Type Certificate TL 0035, and Ukraine, as the State of Design, assumed a responsibility in compliance with the provisions of International Convention on Civil Aviation (Chicago Convention) and its Annexes. Type Certificate TL 0035 was issued on the ground of the USSR Civil Operation Certificate of Antonov-12 aircraft worthiness for operations in civil aviation with a consideration of its positive operational experience, without extra certification works.

Proceeding from the said above, it should be mentioned that the modern requirements of airworthiness to large aircrafts of Part-25, and in particular, p.25.1181 and p.25.1191, as it is pointed out in BFU Final Report draft, are not applied to Antonov-12 aircrafts and its modifications. Along with, it should be taken into consideration that, by the results of the state stand fire tests of Antonov-10 TG-16 turbo generator fire protection, which installation is structurally identical to Antonov-12 aircraft, have confirmed the effectiveness of that protection. These results, as well as the availability of the neutral gas system on the aircraft, would prove an enhancement of the equivalent safety level, which is determined by the requirements of Annex 8 to Chicago Convention, 4-th edition of 1957, which were effective at the time, when Antonov-10 and Antonov-12 aircrafts were designed».

The currently valid certification specifications (Part 25) show in Para FAR 25.1181 designated fire zones to which the APU chamber belongs. Para 25.1191 Firewalls stipulates: *(a) Each engine, auxiliary power unit, fuel-burning heater [...] must be isolated from the rest of the airplane by firewalls, shrouds or equivalent means. [...]*

Auxiliary Power Unit (APU)

According to the Interstate Aviation Committee (representing the Russian Federation, MAK) the APU manufacturer had stopped production and maintenance of the APU approximately in 2000.

MAK also stated that the manufacturer usually engraved the turbine blades during maintenance; no such engraving was found on this APU.

Analysis

Aircraft Fire

Witness statements and the degree of destruction of the area where the APU used to be show that the fire started there. Due to the high degree of destruction it was not possible to determine the exact cause of the fire. It is possible that the compressor wheel had burst. Proof for this assumption could be the disrupted air intake grid (Appendix, Image 7) and the two cut-off bolt heads (Image 8). Subsequently, flying fragments of the compressor wheel could have penetrated the APU chamber and severed fuel pipes. Due to the damages of the APU chamber a connection would have been created between APU and cargo compartment. It is also possible that flying fragments could have damaged the fuel tanks in the fuselage floor. The fuel puddle visible on the video could be a sign for it. On the other hand, due to the destroyed compressor the air supply of the combustion chamber had ceased which could be a possible cause for its burnt-out. That the triggered APU fire extinguisher system had no effect could be proof for such a massive course of events.

The fire developed very rapidly. Image 1 in the Appendix shows a glaring light which is probably the effect of deflagration due to the burning through of the combustion chamber described above.

Witnesses observed leakage of fuel in the area of the left landing gear below the fuselage; this was also proven by the video recordings the police helicopter made. The fuel ignited and formed burning puddles.

It cannot be entirely ruled out that during APU operation failures or damages occur which may result in fire. If the APU chamber burns, the fire should be contained within the chamber and not propagate to other areas of the airplane. APU fracture pieces should also remain in the APU chamber. In this particular case the APU fire area was not sufficiently isolated from the rest of the airplane.

Due to the intense and rapid fire propagation the fire extinguisher system of the APU was ineffective.

Because live animals were transported, the cargo door had been open. When the fire reached the cargo compartment it was fuelled by the good oxygen supply through the open door.

It has to be noted that the maintenance in 2007 was not performed by the manufacturer. Due to the degree of destruction it could not be determined to what extent this influenced the APU failure.

Fire Brigade Operation

The tower notified the airport fire brigade by direct alert at 0208:01 hrs. At that time the APU chamber had already burnt through toward the cargo compartment and the outside. Initially fire station east, then 33 seconds later, fire station west was notified. The accident site was located in the sector of the fire station west, but could not be seen from there. The fire brigade had to ask the tower where the occurrence site was. Separating the alert and the subsequent information about the occurrence site was disadvantageous, because wrong assignments and delays are possible; as happened in this case. Once they had the information about the occurrence site, the first fire truck left the fire station at 0209:23 hrs. At that time 1:22 minutes had elapsed since the direct alert. The fire truck arrived at the occurrence site at 0212:06 hrs. Therefore 4:05 minutes (245 seconds) had elapsed between initial notification and arrival of the first fire truck at the site. The discharge of extinguishing agent was not part of this time recording. ICAO Annex 14 stipulates a reaction time of the fire brigade of 180 seconds in optimal conditions between alert and at least 50% of the required discharge rate of extinguishing agent. The fire brigade was not able to safe the airplane because the burnt-out had already occurred at the time the tower had alerted the fire brigade and the fire had developed to a full fire during the reaction time.

Several airport fire trucks discharged a total of 4,000 l extinguishing foam and 70,000 l water. The fire brigade was able to prevent the spreading of the fire to the wing fuel tanks. The amount of extinguishing foam used was beyond that required by ICAO Annex 14.

Conclusions

The fire originated in the APU and propagated rapidly to the cargo compartment. The fire was not contained within the APU chamber. The propagation and severity of the

fire were aided by the leaking fuel from the fuselage bottom tanks and the burning light metal alloy components of the APU.

Safety Recommendation

Recommendation No XX/2017

The Ukrainian civil aviation authority should ensure that the manufacturer of the Antonov AN 12 takes appropriate measures to prevent fire propagation or the escape of components from the APU chamber in case of APU failure.

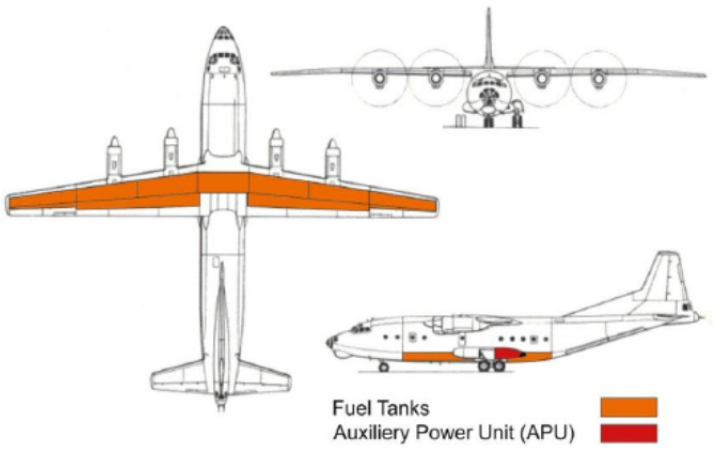
The BFU will not issue a safety recommendation to the airport fire brigade and the responsible supervisory authority, because the deficits in the alerting system, which had caused delays in announcing the occurrence site, have been remedied by implementation of a new alarm system. In addition, to improve communication between tower and fire brigade unannounced alarm exercises are conducted and at least once a week coordinated training drives of the fire vehicles along the taxiway system take place.

Investigator in charge:	Nehmsch
Field investigation:	Nehmsch, Karge, Wenzel, Borrmann, Pokrandt
Assistance:	Karge, Ritschel

Braunschweig: 31 January 2017

Appendix

Technische Daten:	
Länge:	33 m
Höhe:	10,5 m
Spannweite:	38 m
MTOW:	61 t
Reichweite:	3.600 km
Besatzung:	5 Mann



Technical data of the Antonov AN-12 BK

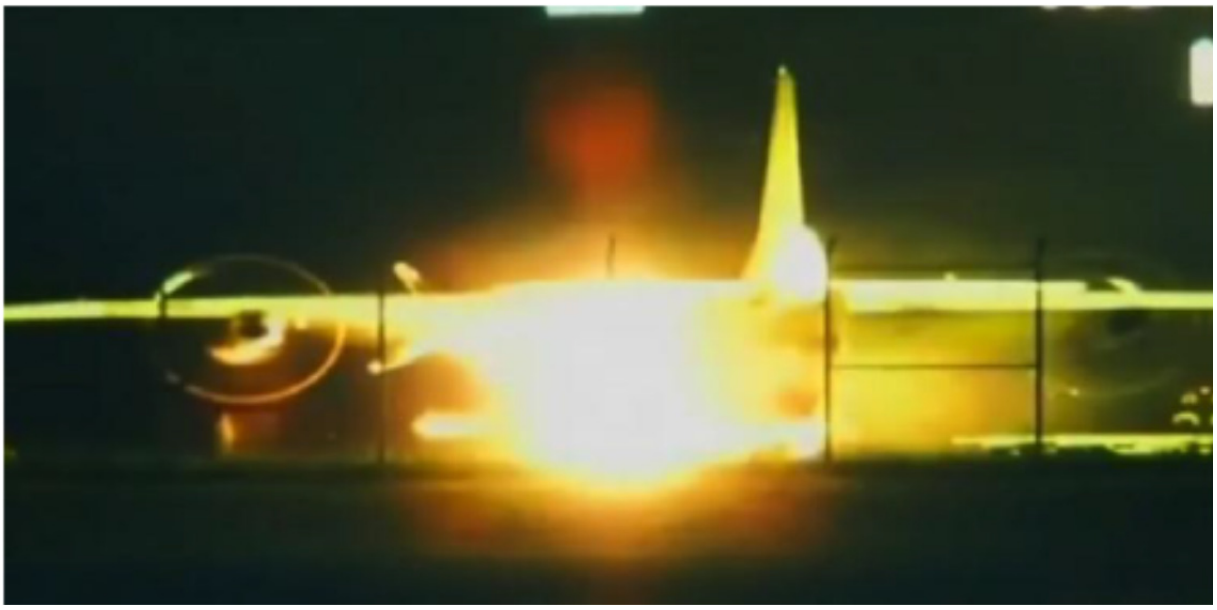


Image 1: Eruption of the fire Source: Internet

Image 2: Burnt-out wreckage AN-12 BK Source: BFU

Image 3: Emergency exit Source: BFU

Image 4: APU Source: BFU

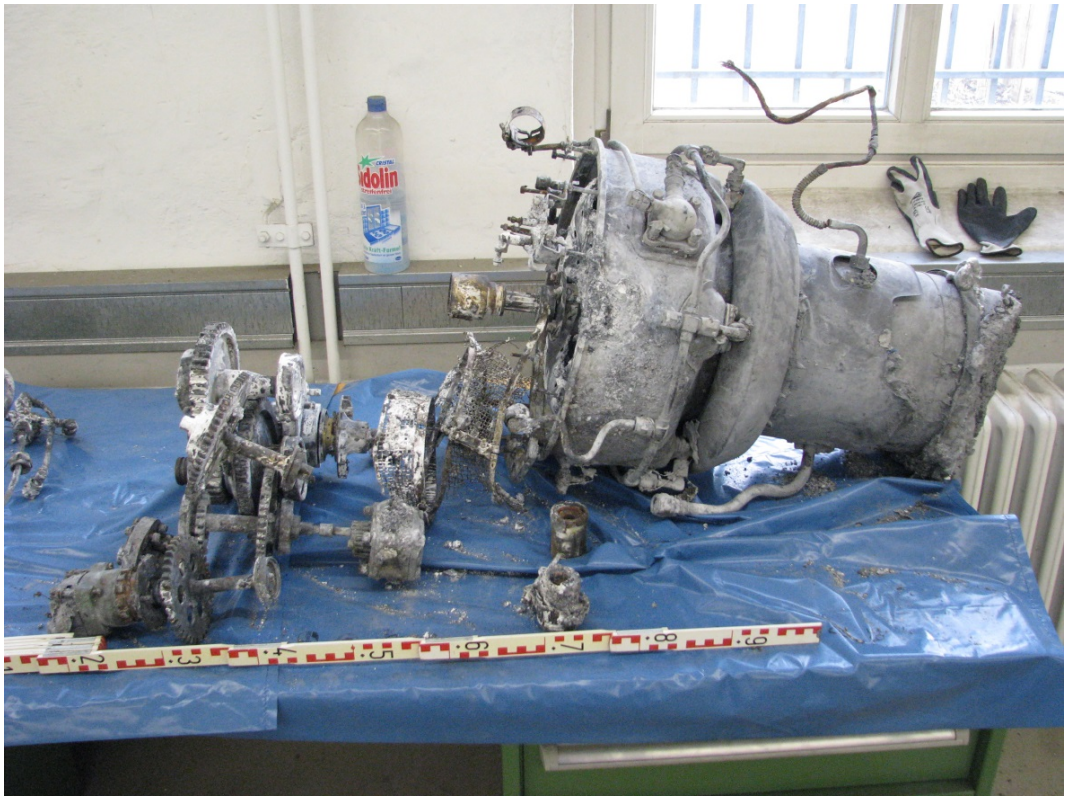


Image 5: Gas turbine including APU gearbox gear wheels Source: BFU

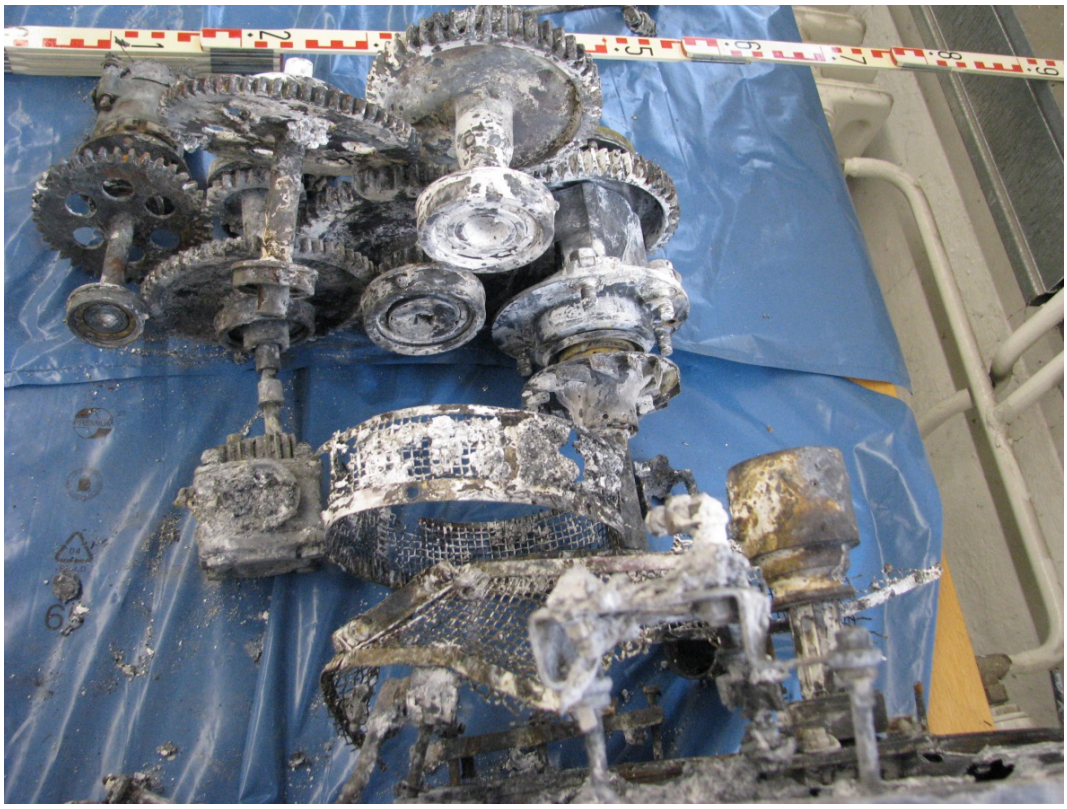


Image 6: Reconstructed APU gearbox; air intake grid (front) Source: BFU

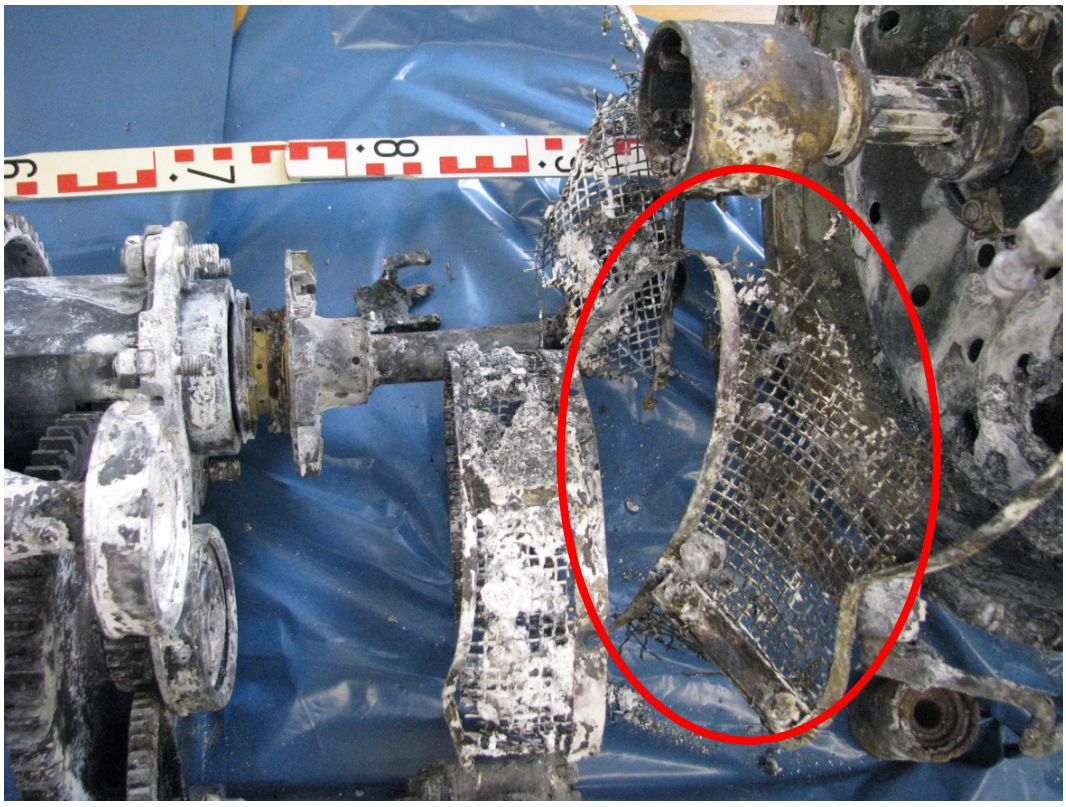


Image 7: Air intake grid Source: BFU

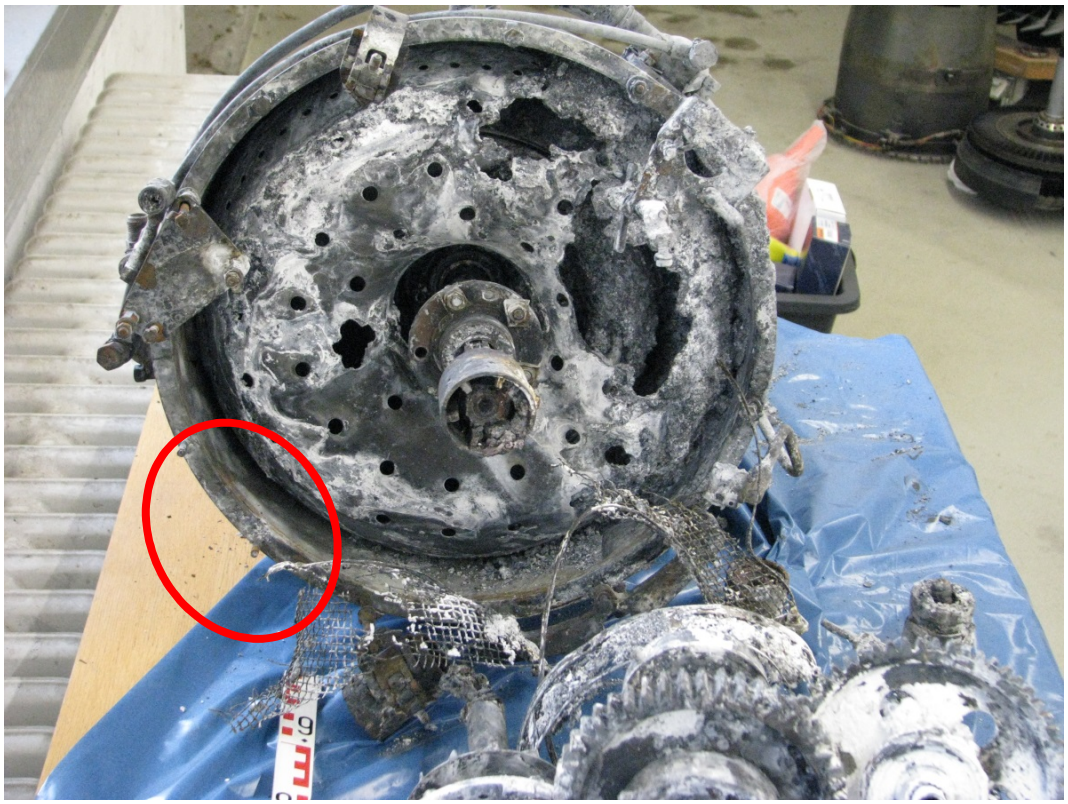


Image 8: Bolts without heads Source: BFU

In accordance with the provisions of ICAO Annex 13, the National Bureau of Air Accidents Investigation of Ukraine, representing the state of design and manufacture of aircraft, registry and operator requests to append the following statement to the Final Report:

- the crew's explanations concerning the personnel disposition at the time of engine starting and actions at fire break-out, as well as the witness's testimony, state that at the engine starting, nobody directed the starting from outside of the aircraft. That complicated the identification of APU inflammation time and scale and taking the necessary response actions.

In our opinion, this circumstance should be noted in the section "History of the Flight" and in the section "Analysis" "Aircraft Fire". *This circumstance is also a contributing factor, which could mitigate severity of the fire consequences;*

- to enter the data on the residual resource and residual life of APU TG-16 - 368 hours and till 28.11.2017, respectively.

- in the section "Fire": I suggest to enter the information concerning use or non-use by the crew of stationary fire extinguishing means, which are located on the aircraft parking area, and to indicate the place of their disposition relative to the occurrence site.

- in the section "Organisations and their Procedures" (the last paragraph on page 8): there is no indication of a reason, for which the information concerning the occurrence location was not transmitted on the airport radio frequency on the day of this incident. Was it accidentally switched off, or was it so instructed by the notification procedures?

- to the section "Antonov AN-12BK": I suggest to add information concerning CS-25 SUBPART J requirements for APU CS 25J901 (d) installation, which do not provide APU protection against burn through or rupture, as well as against an uncontained rotor failure at installation aboard the aircraft:

> (d) The APU installation must comply with CS 25.1309, except that the effects of the following need not comply with CS 25.1309(b) (see AMC 25.901(c)):
>
> (1) APU case burn through or rupture;
> and
> (2) Uncontained APU rotor failure.

Thus, ***the fire propagation*** from APU section to the fuselage and entire aircraft was bolstered not by APU direct inflammation and APU section burn through, but by APU section rupture resulted from an uncontained failure (destruction) of the compressor wheel, at which the fire extinguishing system inside APU section became inefficient.

A negative effect from the similar failures is minimized by observance of the requirements contained in CS-E, "Engines".

For this purpose, a protective metal casing is mounted on APU TG-16, but only on the turbine wheel.

- in the section "Analysis" "Aircraft Fire": it should be substantiation of the statement that "APU fracture pieces should also remain in the APU chamber" with reference to the specific standard or equivalent document;

- in the section "Fire Brigade Operation": it should be indicated, which depot the first fire truck departed from;

- conclusion that "The fire brigade was not able to safe the aircraft because the burned-out had already occurred at the time the tower had alerted the fire brigade and the fire had developed to a full fire during the reaction time" cannot be unambiguous, since at fire suppression, the recommendations of ICAO Annex 14 concerning the response time not exceeding three minutes (180 sec) were not observed. Besides, the analysis indicates only the time of arrival of the first fire truck, but not the time, at which the foam delivery rate was, at least, 50 percent.

In connection with the abovementioned, we consider that this circumstance is also a contributing factor, which could mitigate severity of the fire consequences.

- in the section "Conclusions": we suggest to take into account the contributing factors noted above, namely:
  - absence outside of the aircraft of a supervisor for engine starting that impeded identification of APU inflammation time and scale;
  - delayed notification by the airport services of the occurrence location, that resulted in exceeding the ICAO-recommended response time for fire-prevention service.

- we suggest to add the section "Safety Recommendations" with the recommendations about obligatory presence of a starting supervisor at engine starting, as well as actions, which were taken to reduce the time of occurrence location notification and fire fighting team response.

In accordance with the provisions of ICAO Annex 13, the Interstate Aviation Committee, representing the state of design and manufacture of APU requests to append the following statement to the Final Report:

- *There are some doubts that the overhaul really was conducted in 2007. We believe that the analysis of APU (OM4502251) logbook item 15.3 'Turbine generator acceptance certificate' shows that the entry to the logbook was fabricated.*

- *It should be mentioned that the APU was not operated In accordance with specified requirements. The entry to the logbook on its overhaul in 2007 was fabricated. The APU overhaul nonfulfillment could contribute into the APU high degree of destruction.*

This investigation was conducted in accordance with the regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and the Federal German Law relating to the investigation of accidents and incidents associated with the operation of civil aircraft (*Flugunfall-Untersuchungs-Gesetz - FlUUG*) of 26 August 1998.

The sole objective of the investigation is to prevent future accidents and incidents. The investigation does not seek to ascertain blame or apportion legal liability for any claims that may arise.

This document is a translation of the German Investigation Report. Although every effort was made for the translation to be accurate, in the event of any discrepancies the original German document is the authentic version.

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