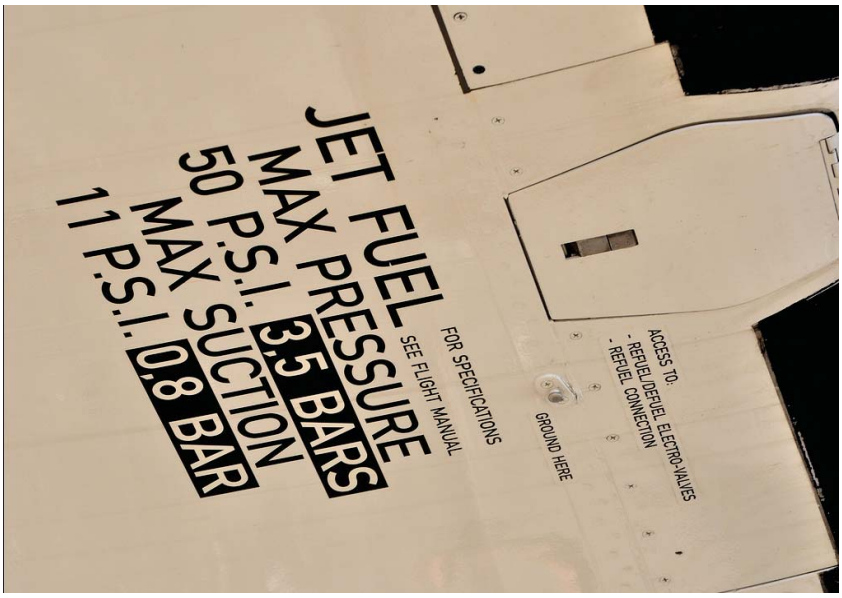

FUEL EXHAUSTION

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Everyone knows that lift is generated by speed and speed is generated by a propulsion system fed by fuel. Without fuel, a motor-powered aeroplane becomes a glider.

Research by EASA indicates that a total of 30 accidents and 35 incidents between 1970 and February 2011 were attributed to fuel exhaustion, causing a total of 322 fatalities.

According to ICAO fuel exhaustion is defined as "no usable fuel remains on the aircraft." The risk of fuel exhaustion has been present in aviation ever since the beginning of powered-flight. The consequences of fuel exhaustion have grown as aircraft have become larger and faster. At the same time the means of controlling the risk of fuel exhaustion have improved significantly. Today multiple tools are available to the flight crew to safely manage the fuel supply carried on board. It is up to the crew to make use of these tools in order to ensure flight safety.

Several causal factors of fuel exhaustion have been identified. Technical factors, as far as they have been identified, have already been taken care of or will be. EASA's NPA 2011-13 proposes additional certification requirements towards an enhanced Fuel Quantity Indicator System including additional indicating and alerting features.

Organisational and human factors are much less easily addressed. Two recent key accidents highlight the continued need for crew alertness, awareness, and discipline in following defined standards.

Tuninter Flight 1153 The ATR-72 ditched on August 6, 2005, into the Mediterranean Sea after a double flame-out. Post-craft investigation showed that a wrong fuel indicator had been installed leading the gauge to over read. The displayed fuel figure was higher than actual fuel quantity. This fault could have been detected on ground before departure by the crew had they adhered to operating procedures.

The captain had already flown the aircraft on the day before the ditching, August 5th. He had logged a faulty fuel quantity indication. Overnight mechanics replaced the fuel quantity indicator. But they installed the wrong replacement instrument, one for ATR-42 instead of one for ATR-72. The newly installed instrument showed a considerably higher amount of fuel than the fuel actually on board. But the difference of the amount indicated remained undetected.

As required by operational procedures, the captain had noted 790 kg of fuel on board upon landing on the company's Aircraft Technical Log (ATL). The following day, August 6th, when he resumed his duties on the same ATR-72, TS-LBB, he read 3100 kg on the fuel gauge. The captain trusted in the assurances given by the Flight Dispatcher, although his pre-flight documentation was not complete. In fact, the fuel slip was missing. At that stage he could have developed some doubts about the actual quantity of fuel on board.

But he continued to prepare for the flight and ordered an additional 700 kg of fuel to reach the required 3800 kg for the flight from Tunis to Bari. The quantity was set in the fuel panel. The refuelling slip of this uplift contained a quantity of 465 kg. No questions were raised by the flight or the ground crew.

During the flight from Tunis to Bari, the crew did not complete the operational flight plan (OFP), against company operational procedures. The compilation of the OFP is not an unnecessary bureaucratic act. It is an instrument to validate essential calculations and flight characteristics. Had the crew crosschecked the fuel used with the fuel planned, a difference of 400 kg in fuel consumption as per fuel gauges would not have gone unnoticed: The difference was 37% on a flight of 101 minutes. The Fuel Used indicator displayed a figure compatible with the consumption planned, but incompatible with the fuel quantity indicated. The difference would have been noted, had the fuel consumption first been recorded and then been analysed properly by the flight crew.

On August 29, 2010, the captain of Perimeter Aviation flight 107 turned his Dash 8 back to Winnipeg from where it had just departed. The crew realised while conducting the 10'000 ft climb check that they did not have enough fuel on board to safely complete the flight. In this case, the outcome was fortunate. The crew had followed the checklist procedure and detected the difference between the expected and the actual fuel quantity.

Procedural non-compliance on the ground had caused the crew to depart without having uplifted the fuel necessary for the flight intended. The crew

had radioed the required fuel figure to the FBO's customer service representative. The representative was distracted and didn't pass the fuel order to the line service foreman.

Company procedures required the pilots to supervise refuelling procedures. Instead both pilots walked away from the aircraft. They had seen the fuel truck under the wing. They did not know that the fuel truck operator did not know how much fuel was needed. As the foreman couldn't start the refuelling process, and since other aircraft needed refuelling, and after the foreman had tried unsuccessfully to contact the pilots, he left the Dash 8 to refuel the other aeroplanes. The crew came back and boarded the aircraft. The fuel truck had left. The flight crew believed the fuel upload had taken place. But they did not check the fuel quantity and remained unaware of what had happened while they had left the aeroplane standing unsupervised on the tarmac.

Simply adhering to company procedures would have avoided this embarrassing and costly mistake.

One of 10 Basic Risk Factors

According to the Flight Safety Foundation fuel exhaustion is one of the ten basic risk factors which need to be managed by air transport organizations. Fuel exhaustion risks can be mitigated by establishing appropriate operational procedures and by training crews to adhere to them. Flight Operations managers can minimise the risk by providing both an ATL and an OFP which allow the crew to detect disagreements between the planned and the actual fuel figures easily.

The Flight Crew As the Last Line of Defence

Gliders are fun to fly, but only, if they are designed as gliders. Motor-powered aeroplanes losing all thrust are much less fun to fly.

EASA has collected a number of accidents and incidents in which fuel exhaustion played a role. The number is much higher than what we might have expected.

Flight crews can take several basic precautions to manage the fuel supply and to minimize the risk of fuel exhaustion. Safe fuel management starts with the flight preparation. Check weather and plan flight accordingly. Additional headwinds and expected weather deterioration at the destination need to be taken account of. Calculate minimum fuel correctly. How reliable are the parameters of your flight planning system? How accurate are the weather data underlying the fuel calculation? Calculate estimated uplift based on the fuel quantity on board after the previous flight and compare to the actual uplift after refuelling. Never ignore missing fuel receipts. If the original cannot be found, request a copy from the fuel supplier. Be extremely careful with the unit of measurement. The same figure in litres, kilograms or Gallons makes a huge difference. Record all required data on the ATL and the OFP.

Once airborne perform regular time and fuel checks according to the flight plan. Confirm the quantity indicated by the gauges and pay attention to any irregularities. Make prudent use of the FMS to forecast fuel remaining at arrival. Take fuel imbalances seriously. They can be a symptom of a fuel leak. Only balance the fuel after you have understood the reason behind the imbalance. Maintain situational awareness regarding en-route alternates and the weather situation en-route and at destination and alternates. Last but not least, know when to declare a fuel emergency, and don't hesitate to declare a fuel emergency when you encounter one.

Managing fuel levels and reacting to changes requires good airmanship and decision-making skills. In most fuel exhaustion accidents disrespect of procedures, poor CRM and poor decision-making are at the heart of the failure to prevent and to react appropriately and to maintain flight safety.

Follow the procedures, even when they seem to be bureaucratic in nature. Completing forms is a means, not a goal. The goal is to cross-check the fuel figures in order to detect discrepancies between the actual and the required fuel level in all phases of flight.

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