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pour la sécurité de l'aviation civile

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REPORT
ACCIDENT

Refuelling error, power drop during initial climb, ditching in the sea

Aircraft	PA46 350P Malibu Mirage registered D-ESPE, Lycoming TIO-540-AE2A engine
Date and time	31 August 2015 at 08 h 55[1]
Operator	Private
Place	Mandelieu (06)
Type of flight	General aviation
Persons on board	Pilot and passenger
Consequences and damage	Pilot and passenger slightly injured, aeroplane destroyed

[1] Except where otherwise indicated, times in this report are local.

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.

1 - HISTORY OF FLIGHT

The pilot, accompanied by two passengers, had undertaken a flight between the aerodromes of Triengen (Switzerland) and Cannes Mandelieu (06) on the previous Friday.

On arrival, at about 20 h 00, when he had just got out of the aeroplane, a ramp agent asked him if he wanted to refuel. The pilot accepted. The operator in charge of refuelling received a request for Jet A1 fuel and went to the stand where the aeroplane was. On arrival, he asked the pilot[2], in French, how much fuel he wanted. After confirmation of the price by the operator, the pilot said that he wanted to fill up, and then returned to moor the aeroplane. The operator refuelled the right wing tank with Jet A1, then the left wing. Following the refuelling, he filled in the delivery note mentioning the quantity[3] and the type of fuel supplied then had the document signed by the pilot, who kept a copy.

[2] The pilot is German-speaking.

[3] 403 litres were added.

On the Monday, the pilot, accompanied by a passenger, arrived at about 08 h 15 at the aerodrome, to perform a flight between Cannes Mandelieu and Triengen. He performed the pre-flight check then started the engine without encountering any problems and asked for clearance to taxi at 08 h 50. He performed the engine tests at the stop point, lined up on runway 17 and took off.

During initial climb, the engine made some unusual noises. The pilot checked the engine parameters. These were normal. The power decreased and aeroplane's speed dropped suddenly. The pilot maintained a straight flight path and sufficient speed for the flight and ditched in the sea. The pilot and the passenger were slightly injured on impact.

2 - ADDITIONAL INFORMATION

2.1 Aircraft information

The Piper PA 46 350P is equipped with a Lycoming TIO-540-AE2A piston engine that runs on AVGAS 100LL petrol. Placards are placed on the wings near each tank filler cap to indicate the type of fuel to use. The tank filling ports do not allow nozzles used for refuelling with Jet A1 to be inserted, as they are fitted with fool proof devices, in order to prevent refuelling errors.

Figure 1 : placard on the wing

The aeroplane is equipped with wing tanks with a capacity of 60 US gallons[4] each. The fuel flows from these tanks to 1 US gallon collector tanks located in each wing wheel well area. Non-return valves prevent the fuel present in the collector tanks from flowing back into the tanks[5]. The fuel then flows into the engine through pipes and filters. A sump drain is located in each collector tank. There is no other drain at the level of the tanks.

[4] Equal to 227 litres.

[5] The manufacturer stated that it is not impossible for the fuel present in the collector tanks to mix with the fuel in the other tanks.

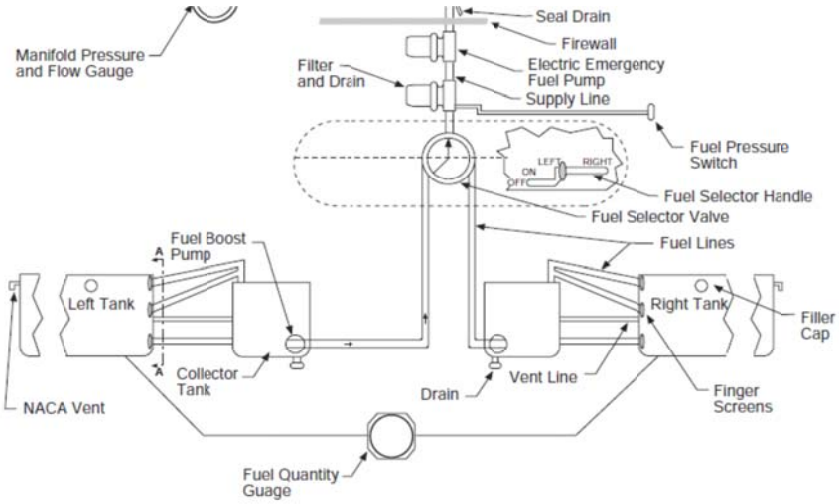


Figure 2 : fuel system

The fuel delivered to the pilot the previous Friday was Jet A1. This fuel being denser than 100LL petrol, it settled into the lower parts of the wing tanks.

2.2 Pre-flight procedure

This procedure describes the actions for the pilot to take before the flight, specifically relating to checking the fuel. For each wing, the pilot must check the fuel at the level of tank cap, drain and check for water, sediment and proper fuel.

2.3 Refuelling procedures

2.3.1 Aerodrome operator's refuelling procedure

This procedure states that the Cannes Mandelieu aerodrome operator uses a fuel depot for the refuelling needs of aircraft using the aerodrome.

It states that a procurement system for the supply and onboard delivery of fuel was attributed to the Air BP fuel supplier and that onboard delivery was sub-contracted by the supplier to the Norbert Dentressangle Hydrocarbures company. The procedures applicable by the sub-contractor were those of the fuel supplier: one procedure described the ordering of fuel, another the refuelling. They are repeated to all operators responsible for refuelling during their recurrent training, which takes place annually.

The aerodrome operator undertakes the administrative management of fuel activity and specifically records the requests and the fuel delivery notes.

2.3.2 Fuel supplier's procedure for fuel ordering

This procedure states that confirmation of the grade of fuel must be done at each of the six stages described below:

- 1. When the fuel order is made to the sub-contractor, the details relating to the grade and quantity of fuel, the aircraft registration and the time of the operation must be requested from the client. When a verbal order is made face to face, a reformulation of the request using the terms « *Jet A1* » or « *AVGAS* » is required.
- 2. The details of the order are copied by the sub-contractor onto a fuel order form, except in case of a verbal order from the client to the operator in charge of refuelling next to the aeroplane in the case of immediate refuelling.
- 3. The person taking the fuel order passes it on to the operator in charge of refuelling, possibly via another operator.
- 4. When the operator in charge of refuelling receives the fuel order, he/she must reformulate exactly all of the details of the order to the person who gives it to him/her and must record it on an order form which should be in the vehicle cabin. The order form is specific for each of the two types of fuel, with a distinctive colour for each product.

- 5. Before beginning refuelling the aircaft, the operator in charge of refuelling makes a cross-check of three points:
  - check of the order form;
  - check that the fuel required corresponds to the fuel that the vehicle is carrying;
  - check the placards on the aircraft at the level of the tank caps, which must correspond to the order, before any operation involving installing the refuelling equipment. If there is no placard on the aircraft, refuelling must not take place before applying the « *no decal, no fuel* » procedure.
- 6. At the end of aeroplane refuelling, a delivery note must be written by the operator in charge of refuelling, preferably in the presence of the client, so that the latter signs the section of the document corresponding to the confirmation of the grade of fuel.

At Cannes Mandelieu aerodrome, the aerodrome operator is the first contact for the client in relation to requests for fuel. He then retransmits the request to the sub-contractor, specifying the type of fuel required, the registration and the position of the aeroplane at the stand. The procedure for taking an order used by the sub-contractor described above is not applicable by the aerodrome operator. This must be done by the operator in charge of refuelling on his/her arrival at the aeroplane; specifically, the procedure states that the operator must reformulate the request to the pilot by using the terms « *Jet A1* » or « *AVGAS* », once arrived at the aeroplane with the truck corresponding to the type of fuel already chosen following the exchanges with the aerodrome operator.

2.3.3 Refuelling procedure via nozzle with a refuelling vehicle

This procedure states that before refuelling, a confirmation is made at the aeroplane with the aid of the placards indicating the type of fuel and that this stage must always be performed before installing any refuelling operation equipment.

If the type indicated on the placard is different from the type of fuel contained in the vehicle, the operator must request confirmation by the client by filling out a grade order confirmation form, which should be signed by, and write a report on this near-incident.

If the aeroplane does not have a placard clearly indicating the type of fuel used, the operator must apply the « *no decal, no fuel* » procedure by filling out a grade order confirmation form, stating the correct type required, which the pilot must sign, and recording the event in the near-incident log and offering the pilot some placards correctly indicating the type of fuel on the aeroplane. In case of a refusal, the refuelling operation must stop.

The procedure also states that, if the aeroplane cannot accept the wide nozzle, a nozzle with a smaller diameter, available in the vehicle, will be fitted for refuelling and removed once the refuelling is finished. The operator must then fill out a grade order confirmation form, which he will get signed by the pilot.

air bp

Bon de Confirmation de carburant
Grade order Confirmation

Ce formulaire doit être utilisé si : *(cocher les cases)*

☐ 1. aucun autocollant d'identification du type de carburant n'est visible ; ou
☐ 2. l'embout sélectif n'est pas adapté à l'orifice du réservoir de l'avion ; ou
☐ 3. l'avion est équipé d'un moteur diesel et porte, à proximité de ses orifices de remplissage, des autocollants indiquant à la fois un avitaillement en carburéacteur (Jet Fuel) et en carburant diesel ; ou
☐ 4. le site d'Air BP, à l'aéroport de ..... bénéficie d'une autorisation exceptionnelle du fait de la nécessité d'utiliser un embout non sélectif pour avitailler la majorité des avions.

Renseignements sur l'avion et confirmation des exigences :
Le pilote ou l'opérateur de l'avion doit remplir cette section.

Registration / *Immatriculation*	Type d'avion

Exigences en carburant

	TYPE DE CARBURANT (*)	QUANTITÉ
JET FUEL (Aviation Turbine Kerosine)		
AVGAS (Essence aviation)		

(*) *Inscrire le type approprié dans la case, c'est-à-dire Jet A-1, Jet A, Avgas 100LL, etc.*

Pilote / opérateur de l'avion
Je confirme qu'il est correct d'utiliser le type de carburant susmentionné pour l'avion en référence ci-dessus. *I confirm it is correct to use the type of fuel for the aircraft mentioned above referenced.*

Nom / *Name* : .....
Date : .....
Heure / *hour* : .....
Signature :

Confirmation du remplacement de l'embout sélectif :
Section à remplir par l'opérateur Air BP
Si ce formulaire est utilisé en raison d'une situation correspondant au point 2 ci-dessus,

CONFIRMEZ QUE VOUS AVEZ REMIS L'EMBOUT SÉLECTIF SUR LE PISTOLET.
Signature

Figure 3: grade order confirmation form

2.4 Information on the refuelling tanker

On the refuelling tanker, there is a black placard indicating « *JET A1* ».

Figure 4: refuelling tanker

The hose is equipped with a wide nozzle. A safety system prevents the vehicle from starting if the hose is not equipped with the wide nozzle. A nozzle with a smaller diameter tip is also available on the tanker to replace the wide nozzle on the hose, in the context of the exceptional procedure mentioned above.

2.5 Information on the operator in charge of refuelling

The operator in charge of refuelling had been trained on the risks associated with a refuelling error and on the ways of avoiding it. He knew that this type of aeroplane could have various engines and required increased vigilance.

He stated that he received a request from the stopover management office. He noted the type of fuel, the registration of the aeroplane and the position on the stand. He filled out the order form and performed the tanker test before leaving.

He did not remember if he had asked the pilot for confirmation of the type of fuel on arrival at the aeroplane. The latter asked him the price of fuel and he showed him the price list, indicating verbally the price of Jet A1 « *1.28 € toutes taxes* »[6]. As the pilot repeated this price, it reinforced his belief that the latter was asking for this type of fuel.

[6] Including tax.

AEROPORT CANNES MANDELIEU	11. FORMULAIRES **TARIFS CARBURANT**	N° ..... ACA/ACM/ Carbu/ §.11 Rév. : 01 Date : 30/12/2011 Page : 1/1

Tarifs carburant applicables au : 1ER Août 2015

JET A1

Prix Hors Toutes Taxes :	**0,7500 € / Litre**
Valeur TIC :	**0,3211 € / Litre**
Prix HT (TIC incluse) :	1.0711 € / Litre *(valeur indicative)*
Prix TTC **(TVA 20%)** :	1,2853 € / Litre *(valeur indicative)*

Rappel 1 : La délivrance de carburant JET A1 en exonération de TIC et ou de la TVA est soumise à la présentation des documents justificatifs d'exonération en cours de validité. En l'absence de justificatifs le carburant sera facturé TTC.
Rappel 2 : Les paiements comptants **se font à la livraison**. Aucune facture ne sera envoyée avec paiement différé.
Rappel 3 : Les certificats « commercial of use » émis par les autorités de l'île de man, ne permettent pas l'exonération de taxes (TIC et TVA).

AVGAS 100 LL

Prix Hors Toutes Taxes :	1,2886 € / Litre *(valeur indicative)*
Valeur TIC :	**0,3781 € / Litre**
Prix HT (TIC incluse) :	1,6666 € / Litre *(valeur indicative)*
Prix TTC **(TVA 20%)** :	**2.000 € / Litre**

Figure 5 : fuel rates

He did not check if there were placards on the wings before starting refuelling. He didn't remember having removed the wide nozzle but did not fill out a grade order confirmation form, mandatory with a change of nozzle. He filled out the delivery note that indicated refuelling with Jet A1, then had the form signed by the pilot.

He stated that he started working at 14 h 00 and had had a busy day[7]. It was the fourth day in a series of six working days. He felt tired and may have been less vigilant than usual.

[7] He had previously undertaken ten refuellings and one tanker refill.

He added that a change of nozzle was common at this aerodrome because of the large number of helicopters. In fact, the use of the wide nozzle for refuelling helicopters with Jet A1 presents a risk of damage to the tank filler ports, due to their design. The nozzle with a smaller diameter was thus often used after obtaining the pilot's agreement, filling out the grade order confirmation forms not being systematic for clients that regularly refuelled at Cannes.

He added that he did not speak English very well and mainly communicated in French with pilots. He stated that he had spoken in French with the pilot of D-ESPE.

2.6 Pilot information

The pilot[8] had a total of 18,213 flying hours, of which 900 on type and 12 in the previous three months.

[8] Swiss nationality, German-speaking.

He spoke German and English fluently but did not speak French well.

He said that he had originally planned to fill up on the Monday morning before the departure. When the ramp agent asked him if he wanted to refuel he refused, indicating that he would do it on Monday. The ramp agent insisted, explaining to him that refuelling would be fast and that Monday morning was generally very busy. The pilot then accepted. When the passengers were leaving the stand, he saw the refuelling tanker approaching. According to him, the tanker was small and so he didn't think that it could contain Jet A1. He stated that he had asked the operator in charge of refuelling the price of the fuel and that the price indicated by the latter « *1.28 hors toutes taxes* »[9] was that of AVGAS. He didn't notice that the type of fuel was mentioned on the delivery note, he only checked the quantity and the total price before signature.

[9] Before tax.

During the pre-flight check, he checked the colour of the fuel by looking into the tank ports located above the wing. He was sure that the fuel was blue in colour[10]. He stated that he had been very careful with this check because he knew of a case of a refuelling error at this aerodrome. He did the drain to check for the absence of water. He did not pay attention to the colour, the small quantity of fuel sampled making that impossible.

[10] AVGAS 100 LL petro is blue, Jet A1 is transparent.

He added that the engine started up correctly and that all of the parameters were normal during the tests made on the engine.

He was wearing a noise-reduction headset, which may have altered his perception of the engine noise during taxiing.

2.7 Testimony

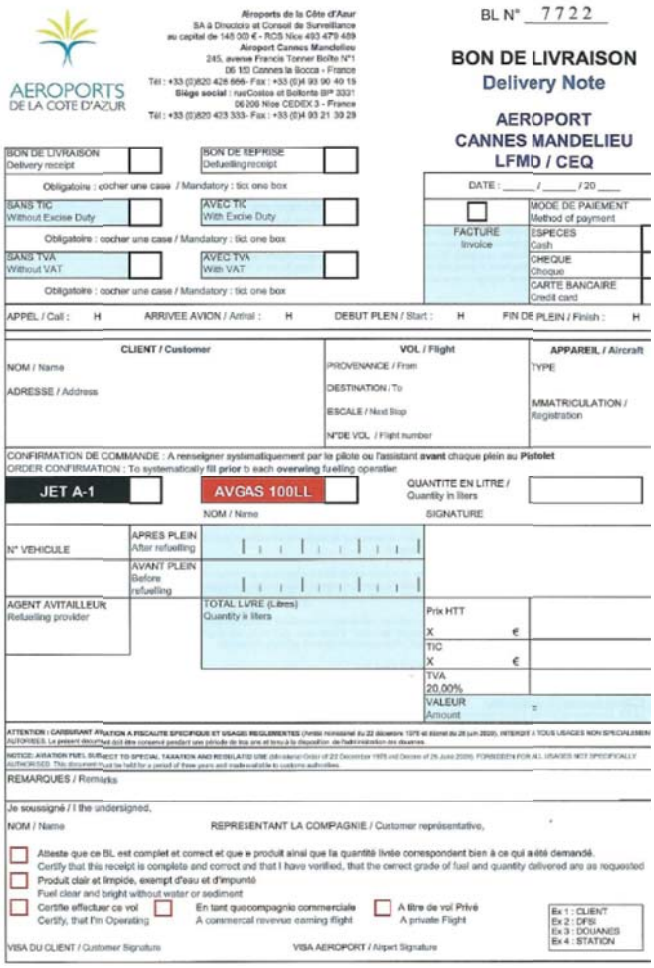
One of the passengers heard the pilot order AVGAS from the ramp agent.

The person present in the stopover management office stated that he/she received a call from the ramp agent for a refuelling operation with Jet A1 for this aeroplane. He/she noted this in the order book and sent the request to the operator in charge of refuelling.

According to a ramp agent, it is usual to offer additional fuel to all pilots.

2.8 Delivery note

An example of a delivery note is illustrated below. The operator ticks the box corresponding to the fuel delivered.



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BL N° 7722

BON DE LIVRAISON
Delivery Note

AEROPORT
CANNES MANDELIEU
LFMD / CEQ

BON DE LIVRAISON Delivery receipt ☐ | BON DE REPRISE Defuelling receipt ☐
Obligatoire : cocher une case / Mandatory : tick one box
SANS TIC Without Excise Duty ☐ | AVEC TIC With Excise Duty ☐
Obligatoire : cocher une case / Mandatory : tick one box
SANS TVA Without VAT ☐ | AVEC TVA With VAT ☐
Obligatoire : cocher une case / Mandatory : tick one box

DATE : ____ / ____ / 20 ____
☐ | MODE DE PAIEMENT Method of payment
FACTURE Invoice | ESPECES Cash | CHEQUE Cheque | CARTE BANCAIRE Credit card

APPEL / Call : H | ARRIVEE AVION / Arrival : H | DEBUT PLEIN / Start : H | FIN DE PLEIN / Finish : H

CLIENT / Customer
NOM / Name
ADRESSE / Address

VOL / Flight
PROVENANCE / From
DESTINATION / To
ESCALE / Next Stop
N°DE VOL / Flight number

APPAREIL / Aircraft
TYPE
IMMATRICULATION / Registration

CONFIRMATION DE COMMANDE : A renseigner systématiquement par le pilote ou l'assistant avant chaque plein au Pistolet
ORDER CONFIRMATION : To systematically fill prior to each overwing fuelling operation

JET A-1 ☐ | AVGAS 100LL ☐ | QUANTITE EN LITRE / Quantity in liters
NOM / Name | SIGNATURE

N° VEHICULE
APRES PLEIN After refuelling
AVANT PLEIN Before refuelling
AGENT AVITAILLEUR Refuelling provider
TOTAL LIVRE (Litres) Quantity in liters

Prix HTT X €
TIC X €
TVA 20.00%
VALEUR Amount =

ATTENTION : CARBURANT AVIATION A FISCALITE SPECIFIQUE ET USAGES REGLEMENTES (Arrêté ministériel du 22 décembre 1975 et décret du 26 juin 2009). INTERDIT A TOUS USAGES NON SPECIALEMENT AUTORISES. Le présent document doit être conservé pendant une période de trois ans et tenu à la disposition de l'administration des douanes.

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REMARQUES / Remarks

Je soussigné / I the undersigned,
NOM / Name | REPRESENTANT LA COMPAGNIE / Customer représentative,

☐ Atteste que ce BL est complet et correct et que le produit ainsi que la quantité livrée correspondent bien à ce qui a été demandé.
Certify that this receipt is complete and correct and that I have verified, that the correct grade of fuel and quantity delivered are as requested
☐ Produit clair et limpide, exempt d'eau et d'impunté
Fuel clear and bright without water or sediment
☐ Certifie effectuer ce vol ☐ En tant que compagnie commerciale A commercial revenue earning flight ☐ A titre de vol Privé A private Flight

Ex 1 : CLIENT
Ex 2 : DFS
Ex 3 : DOUANES
Ex 4 : STATION

VISA DU CLIENT / Customer Signature | VISA AEROPORT / Airport Signature

Figure 6 : delivery note

2.9 Specific features in refuelling helicopters

The filler ports of some helicopters that run on JET A1 have smaller dimensions than those for wide nozzles.

3 - LESSONS LEARNED AND CONCLUSION

3.1 Fuel order

The pilot accepted the ramp agent's offer to perform the refuelling on Friday evening while his attention was focused on other tasks.

The refuelling procedures in force at Cannes Mandelieu aerodrome do not anticipate that taking an order could be done by a ramp agent. The latter is thus not trained to take an order and does not know the associated procedure. It is however usual for him to ask the pilot the type of fuel required so that the operator in charge of refuelling comes to the stand with the tanker delivering the type of fuel required.

The investigation was not able to determine precisely the exact terms used at the time of the order. An erroneous order for Jet A1 was relayed to the operator in charge of refuelling through the stopover management office.

3.2 Confirmation of type of fuel

The pilot asked the operator in charge of refuelling for the price of fuel before the latter asked him for confirmation of the type of fuel. The operator showed him the price list, indicating verbally « *1.28 € toutes taxes* » (including tax). The pilot understood « *1.28 hors toutes taxes* » (before tax) and asked to fill up. This misunderstanding was likely due to the fact that the pilot did not speak French well. The price of Jet A1 including tax was identical to the price of AVGAS before tax. The pilot having repeated the stated price, the operator understood that the latter was asking to fill up with Jet A1. He thus did not formally ask for confirmation of the grade of fuel, as specified in the procedure for taking an order.

The pilot did not in fact make an explicit order, possibly because of a lack of attention at the end of a flight. He did not notice the indication of the type of fuel on the tanker and thought that it contained AVGAS because of its size.

Before starting refuelling, the operator did not check the placards on the aircraft, as specified in the procedure. These were marked « *AVGAS ONLY* ». The tank filler ports did not allow nozzles with foolproof devices to be used; the operator changed the nozzle, probably from habit, before going to the aeroplane. He did not fill out the grade order confirmation form, which should have been signed by the pilot, possibly also from habit. This would likely have allowed the pilot to notice the error.

Following the refuelling, the operator in charge of refuelling filled in the delivery note indicating the type of fuel delivered and got the pilot to sign the form. The latter signed the form without checking the type of fuel mentioned.

3.3 Pre-flight procedures

The pilot stated that he knew of a previous event with a refuelling error at this aerodrome. He was thus very careful to check the type of fuel at the level of the tank cap. However, this check was ineffective because the density of AVGAS 100LL meant that it settled on the surface of the fuel in the tank.

He did not check the type of fuel during the drain, as specified in the procedure. He said that the quantity of fuel sampled did not make this possible.

Further, the design of the fuel system did not guarantee the presence of JET A1 in the collector tanks. The check on the type of fuel during the drain was thus ineffective.

3.4 Conclusion

The engine shutdown resulted from refuelling with the wrong fuel, due to an initial error in taking the order, incomplete application of the procedures by the operator in charge of refuelling and the pilot's lack of attention, which did not make it possible to recover from the error.

The quantity of 100LL present in the collector tanks and ports made it possible to taxi and perform the takeoff run without the pilot noticing any anomalies. Once this quantity of 100LL was consumed, the JET A1 present in the lower parts of the tanks supplied the engine and led to the power drop.

The following factors contributed to the accident:

- the coordination between the aerodrome operator and its sub-contractors when the ramp agent takes the fuel order, which do not encourage the operator in charge of refuelling to confirm the type of fuel in a service that is provided under strong time pressure;
- the usual practice for refuelling certain types of helicopters, whose tank filler ports are not compatible with the dimensions of the standard refuelling nozzles, makes habitual the changing of the nozzle for refuelling with JET A1, which occasionally leads to filling out a grade order confirmation form. This thus reduces the effectiveness of the obvious safety barrier for the operator represented by the presence of foolproof devices specific to each grade of fuel;
- the ineffectiveness of the check item for the type of fuel in the preflight procedure, under the conditions in which the event occurred.

Following the accident, the sub-contractor in charge of fuel supply decided to use specific delivery notes for each type of fuel.