SOUTH AFRICAN CIVIL AVIATION AUTHORITY

*Section/division* **Accident and Incident Investigations Division** Form Number: CA 12-12b

# AIRCRAFT SERIOUS INCIDENT REPORT AND EXECUTIVE SUMMARY

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | Reference: | CA18/3/2/1264 | | |
| **Aircraft Registration** | **ZS-DFJ** | **Date of Incident** | 5 April 2019 | | **Time of Incident** | 0546Z | |
| **Type of Aircraft** | Dassault Aviation Falcon 900B | | **Type of Operation** | | Air Transport (Part 135) | | |
| **Pilot-in-command Licence Type** | ATPL | | **Age** | 51 | **Licence Valid** | Yes | |
| **Pilot-in-command Flying Experience** | Total Flying Hours | | 5328 | | Hours on Type | 1550 | |
| **Last point of departure** | Robert Gabriel Mugabe International Airport (FVRG), Zimbabwe | | | | | | |
| **Next point of intended landing** | Victoria Falls International Airport (FVFA), Zimbabwe | | | | | | |
| **Location of the incident site with reference to easily defined geographical points (GPS readings if possible)** | | | | | | | |
| 50 nm South-East of FVFA (18° 33' 36" South, 026° 44' 00" East) | | | | | | | |
| **Meteorological Information** | Wind: 120°/8 kt, Temperature: 23°C, Dew point: 8°C, Visibility: CAVOK, QNH: 1023 hPa | | | | | | |
| **Number of people on-board** | 2 + 8 | **No. of people injured** | 0 | **No. of people killed** | 0 | | |
| **Synopsis** | | | | | | | |


On Friday, 5 April 2019, at 0509Z, a Dassault Aviation Falcon 900B, with registration markings ZS-DFJ, departed Robert Gabriel Mugabe International Airport (FVRG) in Harare, Zimbabwe, on an unscheduled charter flight to Victoria Falls International Airport (FVFA) in Zimbabwe. On-board the aircraft were two crew members and eight passengers.

The aircraft reached a cruising altitude of 38 000 feet (FL380) en-route to FVFA. At approximately 60 nautical miles (nm) from FVFA, the crew commenced with the descent. While passing through FL250, the pilot-in-command, who was seated on the left seat, reported that his Electronic Horizontal Situation Indicator (EHSI), Electronic Attitude Direction Indicator (EADI) and Multi-Function Display (MFD) started to blink and then went blank. This was followed by various warning lights on the "master caution" panel. Shortly after this, the First Officer (FO) noticed smoke entering the flight deck through the roof lining above the right-hand flight deck window. The flight crew immediately donned their oxygen masks and carried out the necessary checklists from the aircraft flight manual (AFM) regarding electrical smoke or fire. The FO declared an emergency and broadcasted a Mayday call to FVFA tower frequency. The aircraft was given priority and cleared for a straight-in approach for Runway 30. The crew expedited the descent and, while passing FL190, the smoke began to dissipate. When passing through FL140, the crew removed their oxygen masks and prepared the aircraft for the approach. The FVFA Aircraft Rescue and Fire-Fighting (ARFF) services were ready for the aircraft and positioned themselves next to the runway. The aircraft landed safely at 0602Z and taxied to the apron where the occupants disembarked normally. The aircraft sustained damage to a wiring loom that had burnt in the ceiling of the flight deck, as well as excessive heat damage to a ceiling panel above the wire loom. The operator had done a modification by installing an automatic dependent surveillance-broadcast (ADS-B) system on 30 August 2018 and that required an additional wire to be added to the loom rooting to the circuit breaker panel. The last maintenance conducted in this area of the burnt loom was during the last C check on 8 November 2018 which was a visual inspection. None of the occupants sustained any injuries during the incident sequence.

The investigation revealed that during the modification which required cable be threaded on to the wiring loom secured by a clamp, it is likely that when the wire was threaded through the clamp, the wire insulation was inadvertently damaged due to the clamp not being opened, and the open damaged wire started to arc on the clamp causing high temperature which resulted on the smoke in the flight deck, multiple system failure.


| | | | |
|---|---|---|---|
| SRP Date | 12 November 2019 | Publication Date | 18 November 2019 |

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| ABBREVIATION | DESCRIPTION |
|---|---|
| AFM | Aircraft Flight Manual |
| AMM | Aircraft Maintenance Manual |
| AMSL | Above Mean Sea Level |
| ARFF | Aircraft Rescue and Fire-Fighting |
| ATPL | Airline Transport Pilot Licence |
| CAAZ | Civil Aviation Authority of Zimbabwe |
| CAVOK | Ceiling and Visibility OK |
| C of A | Certificate of Airworthiness |
| C of R | Certificate of Registration |
| DME | Distance Measuring Equipment |
| EADI | Electronic Attitude Direction Indicator |
| EHSI | Electronic Horizontal Situation Indicator |
| FALA | Lanseria International Airport |
| FL | Flight Level (Standard Air Pressure, Expressed in Hundreds Of Feet) |
| FO | First Officer |
| FVFA | Victoria Falls International Airport, Zimbabwe |
| FVRG | Robert Gabriel Mugabe International Airport (Harare), Zimbabwe |
| ft | Feet |
| GP | Ground Proximity |
| hPa | hectopascal |
| kt | Knot |
| ICAO | International Civil Aviation Organization |
| IFR | Instrument Flying Rules |
| IIC | Investigator-in-Charge |
| MFD | Multi-Function Display |
| MHz | Megahertz |
| NM | Nautical Mile |
| PAPI | Precision Approach Path Indicator |
| PIC | Pilot-In-Command |
| QNH | Query: Nautical Height |
| SACAR | South African Civil Aviation Regulations, 2011 |
| SACAT | South African Civil Aviation Technical Standards, 2011 |
| SAWS | South African Weather Service |
| STC | Supplemental Type Certificate |
| VHF | Very High Frequency |
| Z | Zulu (Term for Universal Coordinated Time - Zero Hours Greenwich) |

| | |
|---|---|
| **Reference Number** | **:** CA18/3/2/1264 |
| **Name of Owner** | **:** Cirano Investments 307 (Pty) Ltd |
| **Name of Operator** | **:** Zenith Air CC |
| **Manufacturer** | **:** Dassault Aviation |
| **Model** | **:** Falcon 900B |
| **Nationality** | **:** South African |
| **Registration markings** | **:** ZS-DFJ |
| **Place** | **:** En-route to Victoria Falls Airport (FVFA), Zimbabwe |
| **Date** | **:** 5 April 2019 |
| **Time** | **:** 0546Z |

*All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.*

**Purpose of the Investigation:**

*In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011, this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and* ***not to apportion blame or liability****.*

**Investigations process:**

*The Accident and Incident Investigations Division (AIID) of the South African Civil Aviation Authority (SACAA) was informed about an aircraft incident involving a Dassault Aviation Falcon 900B, which occurred during the descent into Victoria Falls Airport on 5 April 2019. This serious incident was delegated to the AIID on 30 April 2019 by the Civil Aviation Authority of Zimbabwe (CAAZ) as per the provisions contained in the International Civil Aviation Organisation (ICAO) Annex 13, Chapter 5, paragraph 5.1.2.*

*The AIID appointed an investigator-in-charge (IIC) with an investigation team (Team). The (CAAZ had sent notifications to the State of Registry, State of Operator and the State of Manufacture and Design. The Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA) of France that is representing the State of Manufacture has nominated an accredited representative. The AIID will lead the investigation and issue the Final Report.*

*Notes:*
*1. Whenever the following words are mentioned in this Report, they shall mean the following:*

- *Incident — this investigated incident;*
- *Aircraft — the Dassault Aviation Falcon 900B involved in this incident;*
- *Investigation — the investigation into the circumstances of this incident;*
- *Pilot — the pilot/s involved in this incident;*
- *Report — this incident report.*

*2. Photos and figures used in this report are taken from different sources and may be adjusted from the original for the sole purpose of improving the clarity of the report. Modifications to images used in this report are limited to cropping, magnification, file compression or enhancement of colour, brightness, contrast or addition of text boxes, arrows or lines.*

**Disclaimer:**

# 1. FACTUAL INFORMATION

## 1.1 History of Flight

1.1.1 On Friday, 5 April 2019, at 0509Z, a Dassault Aviation Falcon 900B with registration markings ZS-DFJ, departed Robert Gabriel Mugabe International Airport (FVRG) in Harare, Zimbabwe, on an unscheduled charter flight to Victoria Falls International Airport (FVFA), Zimbabwe. On-board the aircraft were two crew members and eight passengers. The flight was carried out in accordance with Air Transport Operations (Part 135) of the Civil Aviation Regulations (CAR), 2011.

1.1.2 The aircraft reached a cruising altitude of 38 000 feet (ft.) (FL380) en-route to FVFA. Approximately 60 nautical miles (nm) from FVFA, the crew commenced with the descent. While passing FL250, the pilot-in-Command (PIC) who was seated on the left seat reported that his Electronic Horizontal Situation Indicator (EHSI), Electronic Attitude Direction Indicator (EADI) and Multi-Function Display (MFD) initially started to blink and then went blank. This was followed by various warnings on the “master caution” panel. Shortly after this, the First Officer (FO) noticed smoke entering the flight deck from the ceiling panel above the right-hand flight deck window.

1.1.3 The flight crew immediately donned their oxygen masks and carried out the necessary checklists from the Airplane Flying Manual (AFM) regarding electrical smoke or fire. The FO declared an emergency and broadcasted a Mayday call to the FVFA tower, which gave landing priority to the aircraft and cleared it for a straight-in approach for Runway 30.

1.1.4 The crew expedited the descent and, while passing FL190, the smoke began to dissipate. After passing FL140, the crew removed their oxygen masks and prepared the aircraft for the approach. The Airport Rescue and Fire-Fighting (ARFF) services at FVFA were placed on standby and were positioned next to the runway. The aircraft landed safely at 0602Z using Runway 30 and taxied to the apron where occupants disembarked normally. The total flight time was 53 minutes.

1.1.5 The aircraft sustained damage to a wire loom (various electrical conducting wires which are insulated and bound together), which had burnt in the ceiling of the flight deck, as well as burn damage to the ceiling panel above the wire loom. The duration from the first sighting of smoke to the time it began to dissipate was approximately 3 minutes.

1.1.6 None of the occupants sustained any injuries during the incident sequence.

1.1.7 The flight was conducted under Instrument Flying Rules (IFR) by day with fine weather conditions prevailing at the time.


**Figure 1:** The ZS-DFJ aircraft. (Source: Jetphotos.com/Wesley Moolman)

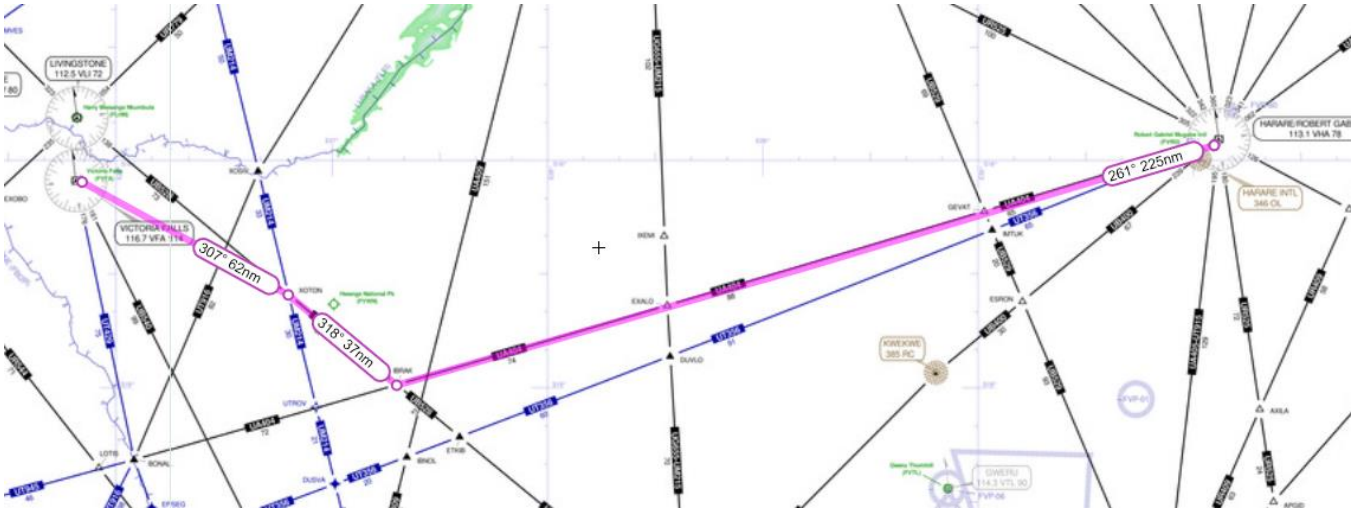



**Figure 2:** The flight routing from FVRG to FVFA. (Source: Skyvector)

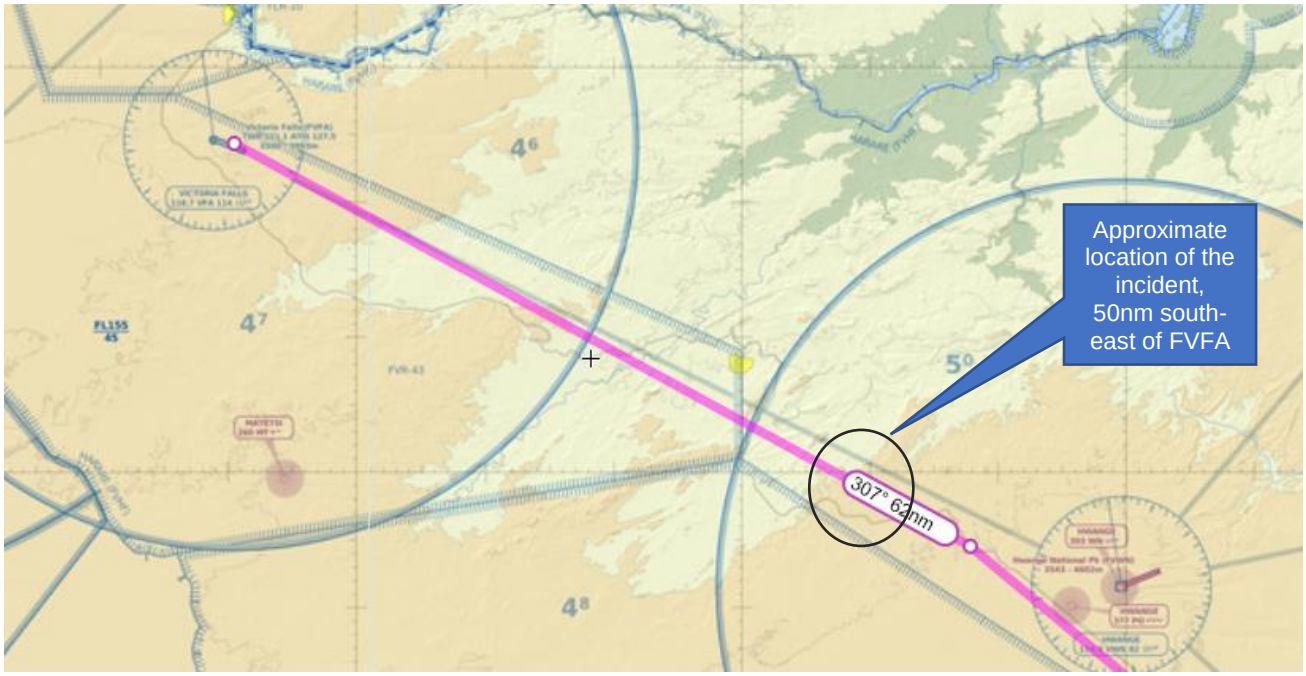



**Figure 3:** The approximate location of the incident 50nm south-east of FVFA. (Source: Skyvector)

## 1.2 Injuries to Persons

| Injuries | Pilot | Crew | Pass. | Other |
|---|---|---|---|---|
| Fatal | - | - | - | - |
| Serious | - | - | - | - |
| Minor | - | - | - | - |
| None | 2 | - | 8 | - |

1.2.1 Seven passengers were Zimbabweans and one passenger was a South African. The two crew members were also South Africans

## 1.3 Damage to Aircraft

1.3.1 The aircraft sustained minor damage to an overhead panel located between frame 4 and 5 which showed signs of burning. The loom had run directly below this panel. The burn damage to the loom was limited to an area near a mounting clamp which had failed.

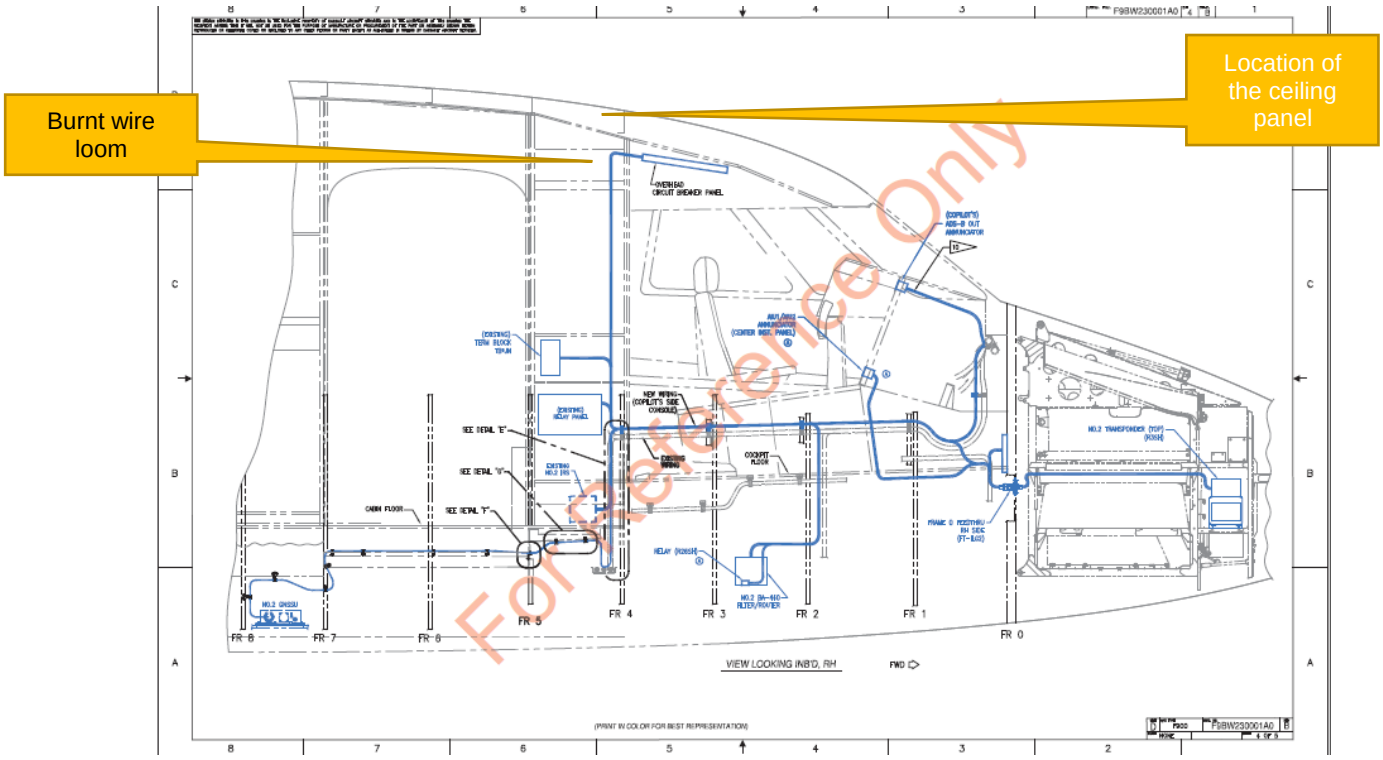



**Figure 4:** Location of the burnt ceiling panel and position of the burnt loom. (Source: Dassault Aviation)

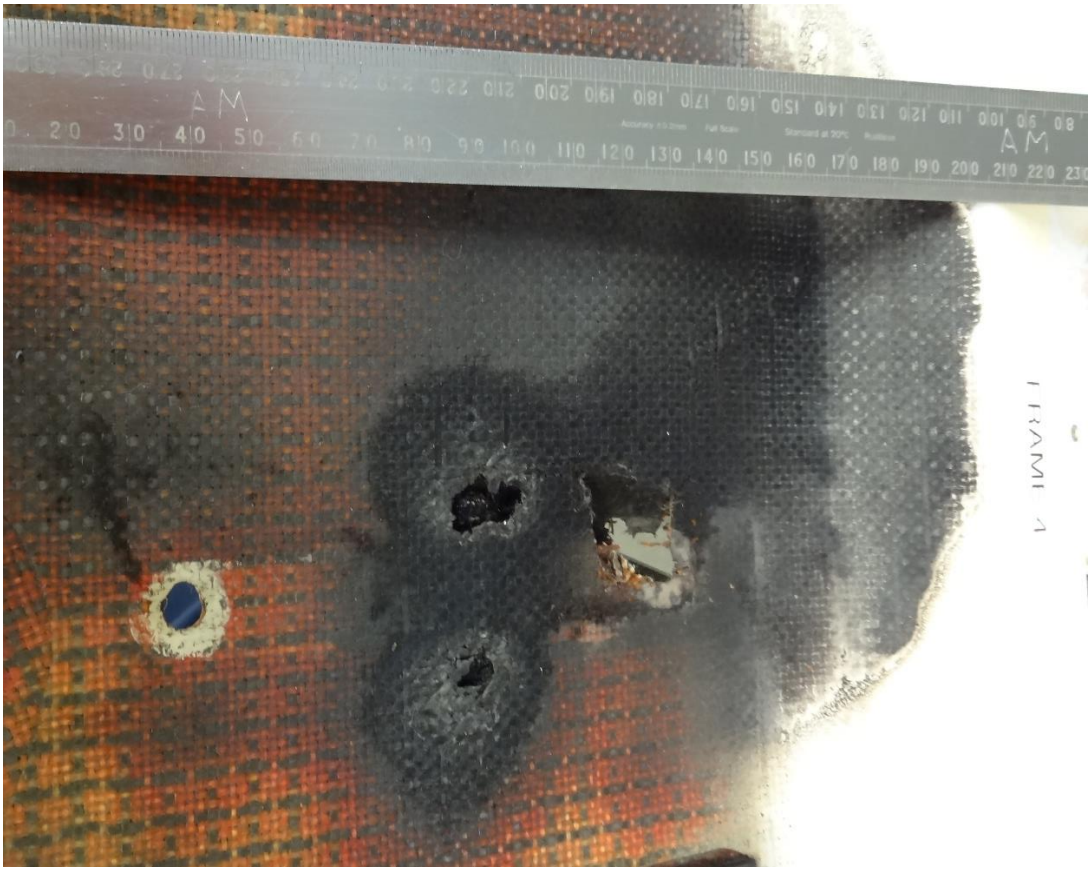


**Figure 5:** Burn damage sustained to the ceiling panel. (Source: Zenith Aviation)

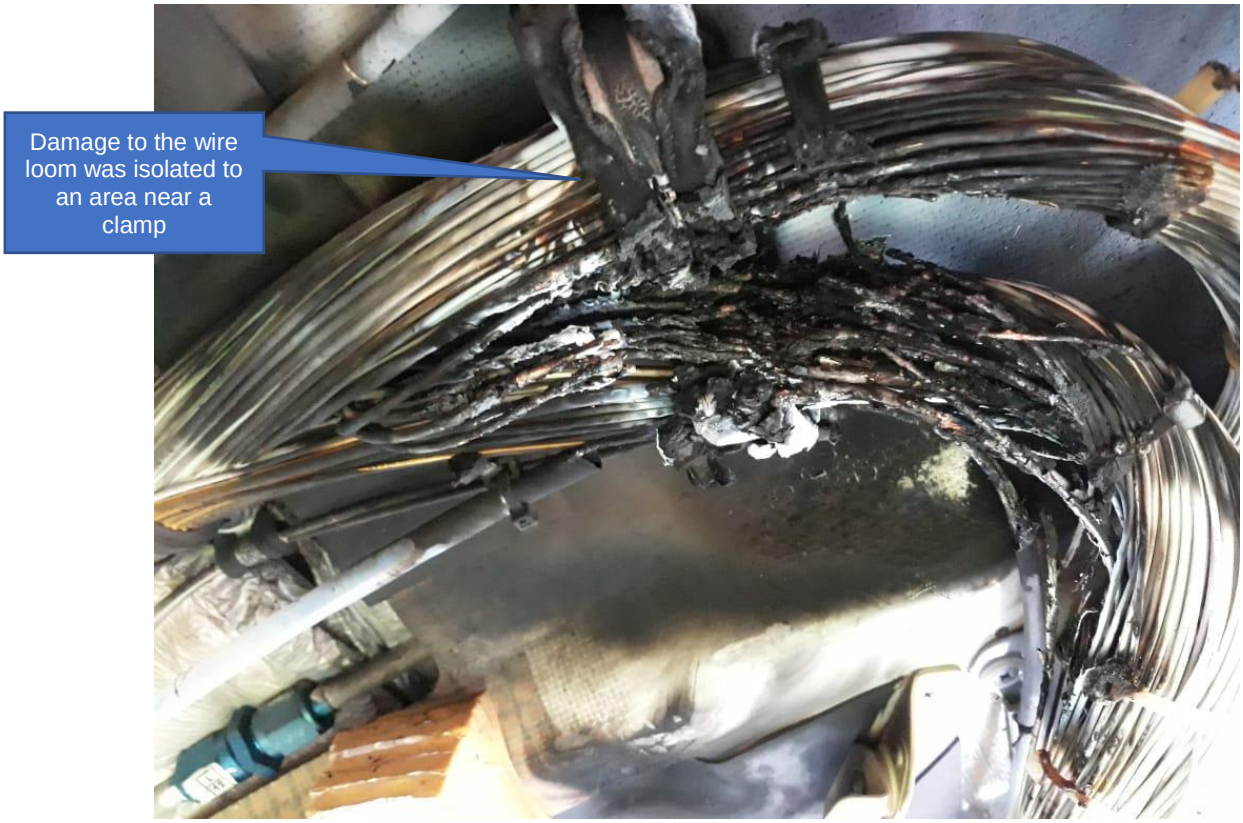



**Figure 6:** Burn damage sustained to the wire loom (Source: Zenith Aviation)

## 1.4 Other Damage

1.4.1 None.

## 1.5 Personnel Information

1.5.1 On 4 April 2019, the day preceding the incident flight, both crew members flew a total of 1.3 hours on a flight from Lanseria International Airport (FALA) to FVRG. The flight arrived at FVRG at 2016Z.

1.5.2 The incident flight was the first flight of the day and had departed FVRG for FVFA at 0509Z.

1.5.3 The PIC was seated on the left seat and the FO was seated on the right seat.

1.5.4 Pilot-in-command

| | | | | | |
|---|---|---|---|---|---|
| Nationality | South African | Gender | Male | Age | 51 |
| Licence number | ********** | Licence type | Airline Transport Pilot | | |
| Licence valid | Yes | Type endorsed | Yes | | |
| Ratings | Instrument, Night | | | | |
| Medical expiry date | 31 May 2020 | | | | |
| Restrictions | Corrective lenses | | | | |
| Previous incident | None | | | | |

1.5.5 The PIC was the holder of a valid class 1 aviation medical certificate, which was issued on 14 May 2019 with an expiry date of 31 May 2020.

Flying experience:

| | |
|---|---|
| Total hours | 5 328 |
| Total past 90 days | 103 |
| Total on type past 90 days | 103 |
| Total on type | 1 550 |

1.5.6 First Officer

| | | | | | |
|---|---|---|---|---|---|
| Nationality | South African | Gender | Male | Age | 48 |
| Licence number | ********** | Licence type | Airline Transport Pilot | | |
| Licence valid | Yes | Type endorsed | Yes | | |
| Ratings | Instrument, Night, Test Pilot (Class 2), RNP-APCH | | | | |
| Medical expiry date | 30 April 2020 | | | | |
| Restrictions | Corrective lenses | | | | |
| Previous incidents | None | | | | |

1.5.7 The FO was the holder of a valid class 1 aviation medical certificate, which was issued on 11 April 2019 with an expiry of 30 April 2020.

Flying experience:

| | |
|---|---|
| Total hours | 8 342 |
| Total past 90 days | 140 |
| Total on type past 90 days | 103 |
| Total on type | 201 |

1.5.8 Aircraft Maintenance Engineer

| | | | | | |
|---|---|---|---|---|---|
| Nationality | South African | Gender | Male | Age | 29 |
| Licence number | ********** | Licence type | Aircraft Maintenance Engineer | | |
| Licence valid | Yes | Type endorsed | Yes | | |
| Ratings | Category W, X | | | | |

1.5.9 Aircraft Maintenance Engineer (dual inspector)

| | | | | | |
|---|---|---|---|---|---|
| Nationality | South African | Gender | Male | Age | 34 |
| Licence number | ********** | Licence type | Aircraft Maintenance Engineer | | |
| Licence valid | Yes | Type endorsed | Yes | | |
| Ratings | Category A, C | | | | |

1.5.10 The Civil Aviation Regulations, Part 67 (Medical Certification) does not stipulate that an aircraft maintenance engineer (AME) needs to carry out or maintain a valid aviation medical certificate.

## 1.6 Aircraft Information

Airframe

| | | |
|---|---|---|
| Type | Falcon 900B | |
| Serial number | 141 | |
| Manufacturer | Dassault Aviation | |
| Year of manufacture | 1994 | |
| Total airframe hours (at time of incident) | 5 211.9 | |
| Last scheduled inspection (hours & date) | 5 094.8 | 8 November 2018 |
| Hours since last inspection (C Check) | 117.1 | |
| C of A (issue date) | 10 December 2018 | |
| C of A (expiry date) | 9 December 2019 | |
| C of R (issue date) (Present owner) | 2 May 2018 | |
| Operating categories | Standard Transport | |

1.6.1 On 30 August 2018, a single wire was threaded through the failed clamp without loosening the clamp during a modification embodiment. This wire linked the ADS-B system to its associated circuit breaker. According to the operator, a dual inspection was carried out on completion of the modification.

1.6.2 The last maintenance conducted in the area of the burnt loom was during the last C check on 8 November 2018. This was a visual inspection.

1.6.3 The aircraft was last refuelled at FALA on 4 April 2019. A total of 7016lbs of Jet A-1 fuel was uplifted. On arrival at FVFA, the aircraft had 1116 lbs of fuel remaining on-board.

1.6.4 During preparation for departure from FALA to FVRG on 4 April 2019, the flying crew noticed that the right reversion controller panel was unserviceable. After carrying out troubleshooting, it was decided that the aircraft would be dispatched with the right reversion controller panel inoperative. This dispatch was done according to the limitations of the Minimum Equipment List (MEL) which required operation not to exceed 10 calendar days from midnight on the day of dispatch. According to the MEL, the reversion controller panel had to be replaced before 15 April 2019 (refer to Appendix G).

1.6.5 The reversion controller panel allows the pilot to interact with the Electronic Flight Information System (EFIS) by using the inertial reference system, selecting between indicated airspeed and Mach number and selecting between the horizontal situation indicator and the attitude director indicator. Refer to Appendix H for the EFIS layout.

Engine No. 1

| | |
|---|---|
| Type | Honeywell |
| Part number | TPE731-5BR-1C |
| Serial number | P-101226 |
| Hours since new | 5 126.1 |
| Hours since overhaul | 3 046.2 |

Engine No. 2

| | |
|---|---|
| Type | Honeywell |
| Part number | TPE731-5BR-1C |
| Serial number | P-101228 |
| Hours since new | 5 056.8 |
| Hours since overhaul | 2 976.9 |

Engine No. 3

| | |
|---|---|
| Type | Honeywell |
| Part number | TPE731-5BR-1C |
| Serial number | P-101235 |
| Hours since new | 5 126.1 |
| Hours since overhaul | 2046.2 |

## 1.7 Meteorological Information

1.7.1 The pilots received their briefing from the South African Weather Service SAWS prior to departing for FVFA on the morning of the incident flight.

| | | | | | |
|---|---|---|---|---|---|
| Wind direction | 120° | Wind speed | 8 kt | Visibility | CAVOK |
| Temperature | 23°C | Cloud cover | Nil | Cloud base | Nil |
| Dew point | 8°C | QNH | 1023 hPa | | |

1.7.2 The flight was conducted during day light conditions with fine weather prevailing for the duration of the flight.

## 1.8 Aids to navigation

1.8.1 The aircraft was dispatched with the right-hand reversion controller panel being inoperative. Due to the right-hand reversion controller panel being inoperative, the crew were reliant on the left-hand navigation display for guidance. The crew lost all navigation displays due to the damage caused by the burnt wires and the aircraft carried out a visual approach to land at FVFA.

1.8.2 Records show that on 30 August 2018, the aircraft was modified with a Global Positioning System/Wide Area Augmentation system to ensure the aircraft was Automatic Dependent Surveillance – Broadcast (ADS-B) compliant. The installation was carried out in accordance with the Supplemental Type Certificate (STC) number: ST02970NY (Refer to Appendix H). The system was fitted, tested and found serviceable. The requirement to carry out the South African Civil Aviation (SACAA) mandated modification is listed in the Aeronautical Information Circular 023-2017 (See Appendix D). To accomplish the above modification, the wire for the ADS-B system was threaded through the clamp without loosening the clamp. The

modification was carried out by an approved aircraft maintenance organisation (AMO) at FALA.

1.8.2.1 Due to the fact that the CoA was not revoked during modification and the Weight and Balance (W&B) was not changed, SACAA regards the modification as minor and thus not requiring any approval only submission of documents for filing.

1.8.3 Skybrary (https://www.skybrary.aero/index.php/Automatic_Dependent_Surveillance_Broadcast_(ADS-B) defines ADS-B as: "*ADS-B is a Surveillance technique that relies on aircraft or airport vehicles broadcasting their identity, position and other information derived from on board systems (Global Navigation Satellite System etc.). This signal (ADS-B Out) can be captured for surveillance purposes on the ground (ADS-B Out) or on-board other aircraft in order to facilitate airborne traffic situational awareness, spacing, separation and self-separation (ADS-B In). ADS-B is automatic because no external stimulus is required; it is dependent because it relies on on-board systems to provide surveillance information to other parties. Finally, the data is broadcast, the originating source has no knowledge of who receives the data and there is no interrogation or two-way contract.*"

## 1.9 Communication

1.9.1 The aircraft was equipped with standard communication equipment as per the minimum equipment list approved by the Regulator (SACAA). There were no recorded defects prior to the incident.

1.9.2 The aircraft was in contact with FVFA approach at the time of the incident and a Mayday call was broadcasted to this station on frequency 121.1 megahertz (MHz).

## 1.10 Airport Information

| | |
|---|---|
| Airport location | Victoria Falls, Zimbabwe |
| Airport co-ordinates | 18°06'06.36" South 025°50'55.02" East |
| Airport elevation | 3 494 ft AMSL |
| Runway designations | 12/30 |
| Runway dimensions | 4 000 x 45m |
| Runway used | 30 |
| Runway surface | Asphalt |
| Approach facilities | PAPI, Runway lights |
| Airport status | Licensed |

1.10.1 The aircraft carried out a visual approach to land using Runway 30. The runway is 4000m long and 45m wide. It has a prepared asphalt surface. Runway 30 has Precision Approach Path Indicator (PAPI) lights installed.

1.10.2 FVFA ARFF is rated at category 7 (refer to appendix F). The ARFF were placed on standby and escorted the aircraft to the apron.

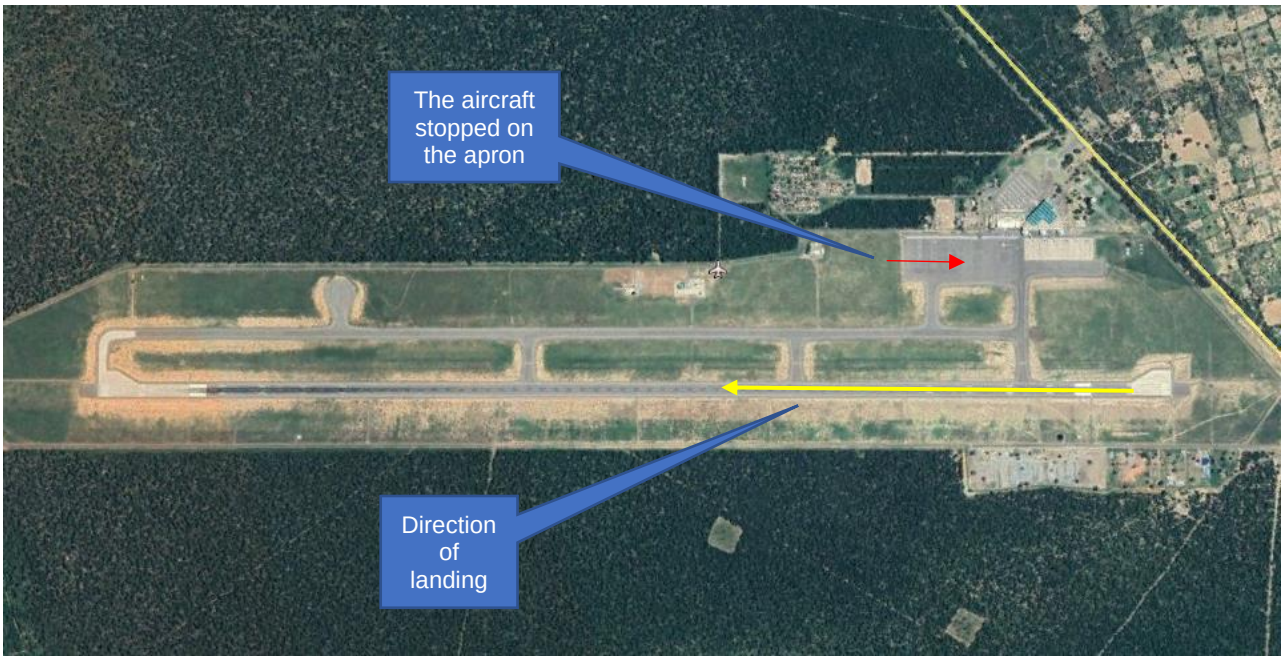



**Figure 7:** FVFA Airport layout (Source: Google Earth)

## 1.11 Flight Recorders

1.11.1 The aircraft was fitted with an L3 Technologies cockpit voice recorder (CVR). The part number for the CVR was: 2100-1025-22 and the serial number was: 001205828. The CVR was downloaded by the same service provider who downloaded the FDR at FALA. The CVR had a recording time of 2 hours, however the CVR recordings for the incident flight were not available as the data had been overwritten.

1.11.2 The aircraft was fitted with an L3 Technologies solid state Flight Data Recorder (FDR). The part number for the FDR was: 2100-4043-00 and the serial number was: 001203248. The recording was downloaded after the incident by the service provider at FALA.

## 1.12 Wreckage and Impact Information

1.12.1 Not applicable.

## 1.13 Medical and pathological information

1.13.1 None.

## 1.14 Fire

1.14.1 There was no evidence of a pre- or post-impact fire, however, there was smoke in the flight deck area during the descent into FVFA. The cause of the smoke was due to a wire loom overheating and melting the insulation around it. Due to the excessive heat generated, one ceiling panel above the loom showed signs of excessive heat damage, and it was the source of the smoke which entered the flight deck.

1.14.2 The smoke entered the flight deck as the aircraft was passing through FL250 on the descent. After carrying out the required AFM steps, the smoke began dissipating as the aircraft passed FL190 before clearing.

1.14.3 The ARFF at FVFA had been placed on standby and escorted the aircraft to the apron. The smoke did not affect the evacuation process and the occupants disembarked normally.

## 1.15 Survival aspects

1.15.1 The incident was considered survivable as the aircraft never lost control as a result of the damaged loom and it landed safely at FVFA. The smoke began dissipating after the crew carried out the required AFM checklists.

## 1.16 Tests and Research

1.16.1 The remains of the wiring loom repair were sent to Dassault Aviation for analysis. Due to the condition of the remnants, Dassault Aviation were unable to carry out any testing to determine the integrity of the wires.

**Figure 9:** The wire off cuts sent to Dassault Aviation after the temporary repair was carried out. (Source: Dassault Aviation)

1.16.2 The operator had received the aircraft with clamp already installed. The last visual inspection of the area was carried out in 8 November 2018. The Supplemental Type

Certificate (STC) requires the AME who is embodying the modification to refer to the Dassault Falcon 900B Aircraft Maintenance Manual (AMM) when further information is required about the aircraft wiring that is related to the modification. The AMM for this aircraft does not state that a clamp is required to be opened when inserting a wire through it. See appendix J.

1.16.3 The clamp is made up of a steel loop covered with a silicone cushion.


**Figure 10:** The failed clamp (Source: Zenith Air)

1.16.5 The wire loom routed above the ceiling to an overhead circuit breaker panel. As the wire loom started heating up, the circuit breakers began tripping, causing the circuits of each wire in the loom to be disconnected from its associated system. This is a protection feature to prevent excessive current conditions from damaging the aircraft and its systems. The tripping of the circuit breakers also led to multiple systems failure, such as the PIC's display going off-line.

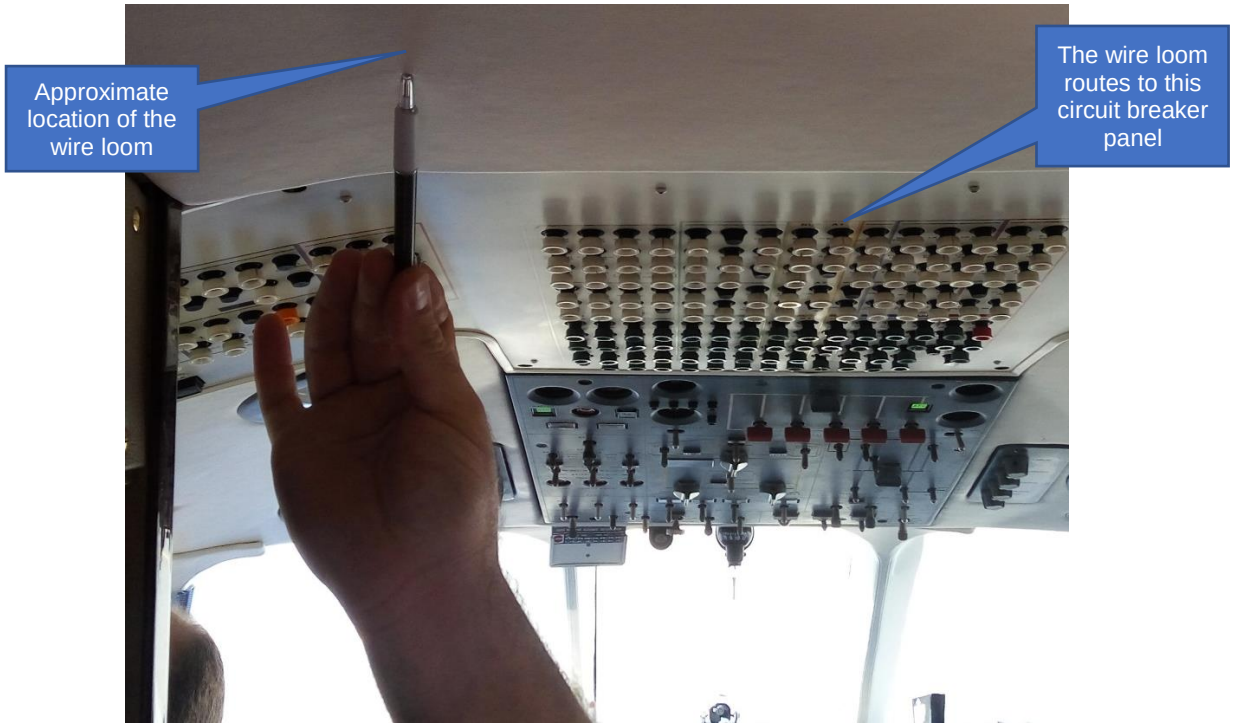



**Figure 11:** Location of the wire loom and circuit breaker panel.

1.16.6 The Civil Aviation Authority of New Zealand's Vector magazine of December 2001 defines a circuit breaker as "*A Circuit Protection Device (CPD) is used to protect electrical/electronic circuit components from an over-voltage or overcurrent condition, by automatically interrupting the current flow. The most common types of CPD's used in aircraft are the circuit breaker and the fuse. They are designed to interrupt the flow of electrical current when specific conditions of time and current are reached. Those conditions generate heat, and circuit breakers are designed to trip (open the circuit) before this heat damages either wiring. A specification might be for a breaker to trip under a massive short jolt (eg, 10 times the rated load of the circuit breaker for between .5 to 1.4 seconds) or a longer, less intense overload (eg, twice the rated amperage for 3–130 seconds, depending on the type of circuit breaker). If the designed overload conditions are not exceeded, the circuit breaker will not trip. The very tolerances that must be built into a circuit breaker to prevent nuisance tripping, such as the high transient current that flows when a motor or component is started, mean some glitches may not trip the breaker*."

1.16.7 With reference to Figure 12, during normal operation, the thermal element remains in place and the latch mechanism holds the button in place. This keeps the current flowing through the circuit. If an overheat condition occurs, the thermal element expands, which then pulls back the latch mechanism and the spring-loaded button pops out. This causes a break in the circuit, essentially switching the system off.

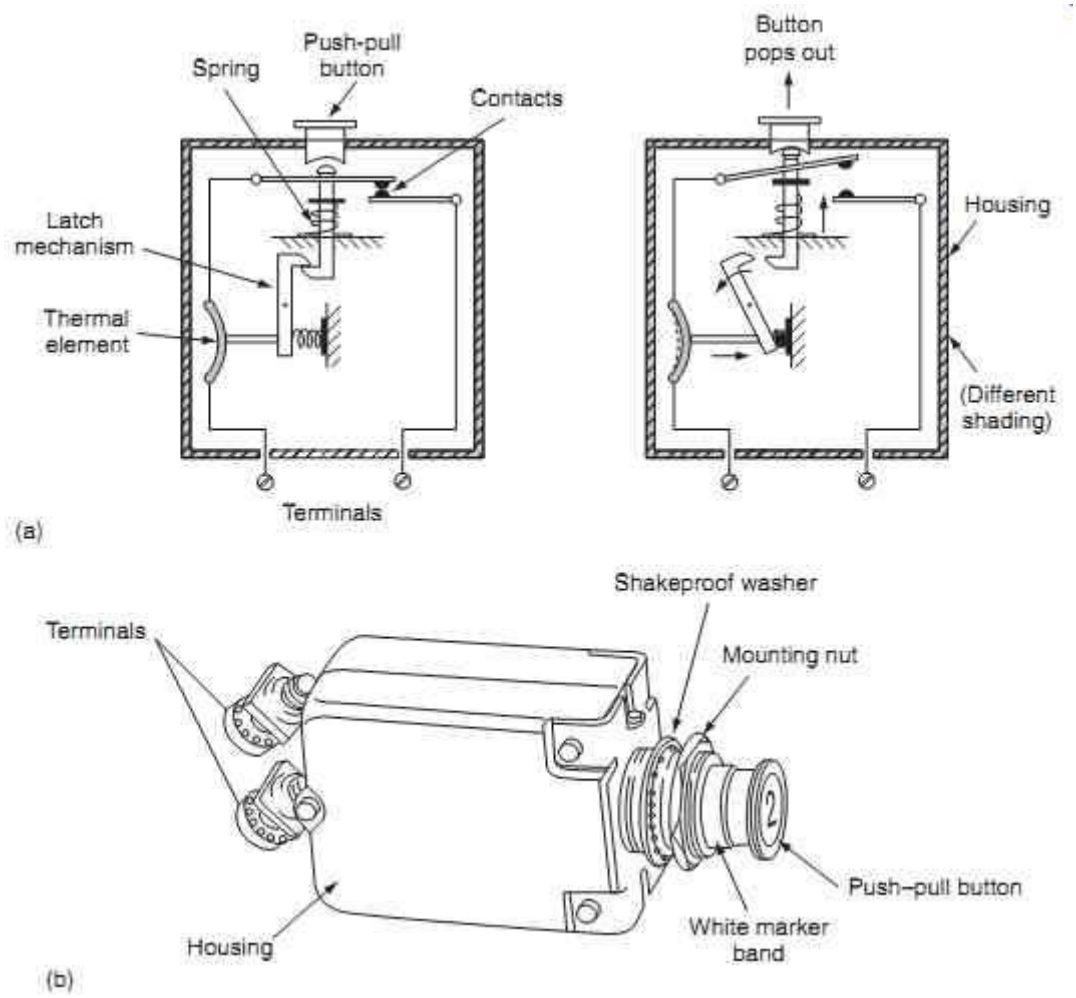



**Figure 12:** A typical aircraft circuit breaker. (Source: http://www.industrial-electronics.com)

1.16.8 The last electrical load analysis was carried out by AMO on 08 November 2018 at 5094.8 airframe hours and the AMO concluded that the electrical load values for each item reflect the manufacturers specification. See appendix K.

## 1.17 Organisational and Management Information

1.17.1 The operator had been issued with an international air service licence on 11 November 2010 and was also issued with an Air Operator Certificate (AOC) on 6 June 2018 with an expiry date of 31 May 2019.

1.17.2 The aircraft maintenance organisation (AMO) number 1230 had been issued with a Part 145 Approval certificate on 21 May 2018 with an expiry date of 31 May 2019.

1.17.3 The AMO number 0198, which incorporated the STC in November 2018, had been issued with an Approval certificate on 4 October 2018 with an expiry date of 31 October 2019.

## 1.18 Additional Information

1.18.1 Physlink.com (https://www.physlink.com/education/askexperts/ae470.cfm) defines a short circuit as "*A short circuit is simply a low resistance connection between the two conductors supplying electrical power to any circuit. This results in excessive current flow in the power source through the 'short,' and may even cause the power source to be destroyed. If a fuse is in the supply circuit, it will do its job and blow out, opening the circuit and stopping the current flow. A short circuit may be in a direct- or alternating-current (DC or AC) circuit. Short circuits can produce very high temperatures due to the high-power dissipation in the circuit.*" While Circuit Globe defines a short circuit as "*The circuit that allows the electric current to pass through the random path which has low resistance is known as the short circuit. The short circuit causes the heavy current which damages the insulation of the electrical equipment. It mainly occurs when the two wire touches each other or when the insulation between the conductor breaks down.*"

1.18.2 By considering the above definitions, if the integrity of the insulation of two adjacent wires in the wire loom were compromised, an excessive heating effect would take place. This added heating would affect the integrity of the remaining wires in the loom, causing a further increase in heating as more wires short circuit.

## 1.19 Useful or Effective Investigation Techniques

1.19.1 None.

# 2. ANALYSIS

From the evidence available, the following analysis was made with respect to this incident. These shall not be read as apportioning blame or liability to any organisation or individual.

2.1 The PIC had been issued with an airline transport pilot licence (ATPL) with the required rating to operate the aircraft. The PIC accumulated a total of 1550 hours on the Falcon 900 and also had a total of 5328 flying hours. The PIC had been issued with an aviation medical certificate with the limitation to wear corrective lenses.

2.2 The FO had been issued with an airline transport pilot licence (ATPL) with the required rating to operate the aircraft. The FO accumulated a total of 201 hours on the Falcon 900 and also had a total of 8342 flying hours. The FO had been issued with an aviation medical certificate with the limitation to wear corrective lenses.

2.3 The aircraft had been issued with a certificate of airworthiness (CoA) which was within its time limits and a certificate of registration (CoR).

2.4 The last major inspection was a C check which was carried out on 8 November 2018 at 5 094.8 airframe hours and the aircraft had flown a further 117.1 hours since its last inspection.

2.5 The weather at the time of the incident was visual meteorological condition (VMC) with no reports of any significant conditions that may have adversely affected the operation of the aircraft. Although the weather was VMC, the aircraft was operating under radar control and was required to operate under Instrument Flying Rules (IFR)

2.6 The operator had been issued with an operating certificate which allowed the operator to carry out commercial air transport operations.

2.7 The AMO which maintained the aircraft had been issued with a maintenance approval which allowed the AMO to maintain the aircraft.

2.8 The aircraft was in a descent and passing FL250 when the PIC's instruments failed, and smoke entered the flight deck. The crew donned their oxygen masks and carried out the required AFM steps. The smoke began to dissipate as the aircraft was passing through FL190. The aircraft landed safely on Runway 30 at FVFA.

2.9 FVFA is a licensed-manned Airport. The runway is a prepared asphalt with a length of 4000 metres (m) and a width of 45m. The ARFF rated at category 7 were placed on standby and escorted the aircraft as it was taxiing to the apron.

2.10 On 30 August 2018, a modification was embodied to ensure the aircraft is ADS-B compliant. The modification required that a single wire be added to the wire loom. The wire was routed through the clamp (without the clamp being opened); and the wire was threaded through it (the clamp). The aircraft standard practices manual does not state that a clamp should be opened when adding an additional wire to a loom. The last maintenance conducted in this area of the burnt loom was during the last C check on 8 November 2018 which was a visual inspection.

2.11 The investigation revealed that there had been a modification which required that a cable be threaded on to the wiring loom which is secured by clamps to the airframe. During the threading of the cable, the securing clamp was not opened, and it is likely that when the wire was threaded through the clamp, the insulation was inadvertently compromised, and the open wire started to arc on the clamp. That in turn caused the increase in temperature which compromised the other wires, resulting in the smoke in the flight deck, as well as multiple systems failure.

## 3. CONCLUSION

### 3.1 General

From the evidence available, the following findings, causes and contributing factors were made with respect to this incident. These shall not be read as apportioning blame or liability to any organisation or individual.

To serve the objective of this investigation, the following sections are included in the conclusions heading:

- **Findings —** are statements of all significant conditions, events or circumstances in this incident. The findings are significant steps in this incident sequence, but they are not always causal or indicate deficiencies.

- **Causes —** are actions, omissions, events, conditions or a combination thereof, which led to this incident.
- **Contributing factors —** are actions, omissions, events, conditions or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or incident occurring, or mitigated the severity of the consequences of the incident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

## 3.2 Findings

3.2.1 The PIC had been initially issued an airline transport pilot licence (ATPL) on 14 December 1998 and, after his last skills test which was carried out on 18 February 2019, he had been issued a renewal with an expiry date of 29 February 2020. The PIC held the necessary ratings to operate the aircraft and had flown a total 1 550 hours on type. The PIC had also been issued with a class 1 aviation medical certificate on 14 May 2019 with an expiry date of 31 May 2020 and his certificate was issued with a limitation to wear corrective lenses.

3.2.2 The FO had been issued with an airline transport pilot licence (ATP) on 30 September 2003 with an expiry date of 29 February 2020. His last skills test was carried out on 18 February 2019 and due to expire on 29 February 2020. The FO had the necessary ratings to operate the aircraft and had flown a total 201 hours on type. The FO had been issued with a class 1 aviation medical certificate on 11 May 2019 with an expiry date of 30 April 2020 and his certificate was issued with a limitation to wear corrective lenses.

3.2.3 The aircraft had been issued with a certificate of airworthiness on 10 December 2018 with an expiry date of 31 December 2019.

3.2.4 The last scheduled maintenance check that was carried out on the aircraft prior to the incident flight was a C check that was certified on 8 November 2018 at 5 094.8 airframe hours. The aircraft had accumulated an additional 117.1 airframe hours since the last inspection.

3.2.5 The aircraft had been modified on 30 August 2018, to ensure it was ADS-B compliant. During this process, a wire from the system was added to the loom and routed through the clamp (without the clamp being opened); and the wire was threaded through it (the clamp). The aircraft had flown a total of 151.3 hours and carried out 117 cycles since the modification was embodied. The last maintenance conducted in this area of the burnt loom was during the last C check on 8 November 2018 which was a visual inspection.

3.2.6 Although the weather was VMC, the crew were required to operate under IFR as they were under radar control. The weather did not play a role in the incident and fine weather conditions prevailed.

3.2.7 After this incident, the aircraft had undergone a temporary repair under the supervision of the Civil Aviation Authority of Zimbabwe (CAAZ) on 6 and 7 April 2019 and was ferried back to its base in South Africa, which is in FALA on 8 April 2019.

3.2.8 The CVR had a recording time of 2 hours, however the CVR recordings for the incident flight were not available as the data had been overwritten. The CVR download was considered to be irrelevant to the investigation.

3.2.9 The aircraft sustained damage to the wire loom and the flight deck ceiling panel. The crew and passengers were not injured during the incident sequence.

3.2.10 The investigation revealed that there had been a modification which required that a cable be threaded on to the wiring loom which is secured by clamps to the airframe. During the threading of the cable, the securing clamp was not opened, and it is likely that when the wire was threaded through the clamp, the wire insulation was inadvertently damaged, and the open wire started to arc on the clamp. That in turn caused the increase in temperature which resulted in the smoke in the flight deck, as well as multiple systems failure.

### 3.3 Probable Cause

3.3.1 During the modification which required cable be threaded on to the wiring loom secured by a clamp, it is likely that when the wire was threaded through the clamp, the wire insulation was inadvertently damaged due to the clamp not being opened, and the damaged wire started to arc on the clamp causing high temperature which resulted on the smoke in the flight deck, multiple system failure.

### 3.4 Contributory Factors:

3.4.1 Wiring clamp not opened during the threading of the wire on to the wiring loom.

## 4. SAFETY RECOMMENDATIONS

### 4.1 General

The safety recommendations listed in this report are proposed according to paragraph 6.8 of Annex 13 to the Convention on International Civil Aviation and are based on the conclusions listed in heading 3 of this report; the AIID expects that all safety issues identified by the investigation are addressed by the receiving States and organisations.

### 4.2 Safety Recommendation/s

4.2.1 None.

## 5. APPENDICES

Appendix A (Airplane Flight Manual Procedures: Air Conditioning Smoke)
Appendix B (Airplane Flight Manual Procedures: Electrical Smoke or Fire)
Appendix C (Airplane Flight Manual Procedures: Smoke and unusual odour removal)
Appendix D (Aeronautical Information Circular 023-2017)
Appendix E (Systems Affected by The Damaged Loom)
Appendix F (ICAO ARFF categories)
Appendix G (MEL Extract for Reversion Controller Panel)
Appendix H (EFIS layout)
Appendix I (Supplemental Type Certificate)
Appendix J (STC embodiment procedure)
Appendix K (Electrical Load Analysis)

# Appendix A



## AIR CONDITIONING SMOKE

**WARNING** – Smoke at air conditioning outlets
– *or* AFT LAV SMOKE *light on (modification M2325 complied with).*

**PHASE 1**

- Crew oxygen masks ..... Donned – 100 % + EMERGENCY
- Smoke goggles ..... Donned – Vent valve open
- Microphone selector ..... MASK – Tested
- [ ] light pushbutton ..... On
- PASSENGER OXYGEN controller ..... OVERRIDE
  - Passenger masks ..... Donned – Checked

**PHASE 2**

- Crew air gaspers ..... Open
- Isolation valve knob ..... ISOLATION
  - ISOL light ..... On
- Bleed air CREW switch ..... OFF
- *COND control lever (A/C SN < 163 )* ..... *TIED*
- *Crossfeed valve (A/C SN ≥ 163 )* ..... *Open*

If smoke persists:

- Bleed air CREW switch ..... ON
- Bleed air PASSENGER switch ..... OFF

If smoke disappears:

- Continue the flight with the faulty BLEED AIR system isolated.

If smoke persists:

- CREW temperature controller ..... MANUAL / 40 % HOT

If smoke disappears:

- Continue flight and use CREW temperature controller as required to establish the appropriate cabin temperature. Do not select a position lower than 40 % HOT.

If smoke persists:

- Bleed air CREW switch ..... OFF
- APPLY SMOKE REMOVAL PROCEDURE starting at PHASE 2 (see 2-05-7).

**Appendix B**



## ELECTRICAL SMOKE OR FIRE

**WARNING** – Smoke and unusual odors
– *or* **AFT LAV SMOKE** *light on (modification M2325 complied with).*

**PHASE 1**

– Crew oxygen masks ..... Donned – 100 % + EMERGENCY
– Smoke goggles ..... Donned – Vent valve open
– Microphone selector ..... MASK – Tested
– [ ] light pushbutton ..... On

**ONLY IF NO FLAME IN CABIN:**

- PASSENGER OXYGEN controller ..... OVERRIDE
- Passenger masks ..... Donned – Checked

**PHASE 2**

– Crew air gaspers ..... Open

If the origin of the fire or smoke is evident:

- Suspected equipment ..... Isolated

If the origin of the fire or smoke is not evident and **flight conditions permit a total electrical power shutdown**:

- BAT 1, GEN 1, BAT 2, GEN 2, GEN 3 ..... Off
- *E. BATT switch (modification M2331 complied with)* ..... *Depress / Off*

- After smoke has stopped, determine which power system causes smoke to reoccur (bus A LH side with battery 1 or bus B RH side with battery 2) by switching the batteries on one at a time, one after the other:
  - Suspected side, BAT switch ..... Off
  - Other side, BAT + GEN switch(es) ..... On
- Do not tie buses.

**If flight conditions do not permit a total electrical power shutdown, shutdown selectively**:

- BAT 2 and GEN 2 switches ..... Off
- A – B buses: FLIGHT NORM ..... Checked
  - [BUS TIED] light ..... Out
- PASSENGER temperature controller ..... MANUAL / COLD

If smoke persists:

- AUTO / MAN pressure selector switch ..... MAN
- BAT 2 and GEN 2 switches ..... On
- BAT 1, GEN 1 and GEN 3 switches ..... Off
- CREW temperature controller ..... MANUAL / COLD

If fire is visibly verified to be out:

- Continue the flight.

If fire is not visibly verified to be out:

- **Land as soon as possible.**

**Cont'd next page**

**PHASE 2** (cont'd)

**If smoke persists:**

- Crew air gaspers ..... Open
- Descent to below 14,000 ft or to the safe altitude.

**CAUTION**

**The following procedure must not be applied if flames are present in cabin or cockpit.**

At 14,000 ft or below:

- UP–DN control ..... UP

At a speed below 215 KIAS:

- LH direct vision window ..... Open

**PHASE 3**

- Descent to 10,000 ft or to the safe altitude.

If smoke persists or fire is not visibly verified to be out:

- **Land as soon as possible.**

**Appendix C**



## SMOKE AND UNUSUAL ODORS REMOVAL

**PHASE 1**

- Crew oxygen masks ..... Donned – 100 % + EMERGENCY
- Smoke goggles ..... Donned – Vent valve open
- Microphone selector ..... MASK – Tested
- [light] light pushbutton ..... On

——— **ONLY IF NO FLAME IN CABIN:**

- PASSENGER OXYGEN controller ..... OVERRIDE
- Passenger masks ..... Donned – Checked

**PHASE 2**

- Crew air gaspers ..... Open
- CREW and PASSENGER temperature controllers ..... MANUAL / COLD
- Descent to below 14,000 ft or to the safe altitude.

**CAUTION**

**The following procedure must not be applied if flames are present in cabin or cockpit.**

——— At 14,000 ft or below:

- Pressurization switch ..... DUMP

——— At a speed below 215 KIAS:

- LH direct vision window ..... Open

**PHASE 3**

- Descent to 10,000 ft or to the safe altitude.

——— If smoke persists or fire is not visibly verified to be out:

- **Land as soon as possible.**

# Appendix D

| | | |
|---|---|---|
| SOUTH AFRICAN CIVIL AVIATION AUTHORITY<br>Tel: (011) 545-1000<br>Fax: (011) 545-1465<br>E-Mail: mail@caa.co.za | **REPUBLIC OF SOUTH AFRICA**<br>CIVIL AVIATION AUTHORITY<br>**AERONAUTICAL INFORMATION CIRCULAR** | CAA<br>Private Bag x73<br>Halfway House<br>1685<br>**AIC**<br>**Series D**<br>023/2017<br>20 JUL 2017 |

***AIR NAVIGATION SERVICES***

***COMMUNICATION***

***ADS-B 1090 MHz and Mode S "Extended Squitter" AIRCRAFT TRANSPONDER REQUIREMENTS IN SOUTH AFRICA***

**1. Purpose**

*The purpose of this AIC is to inform the South African ATM community of intended developments in terms of enhancing and improving Air Traffic Surveillance Services. It also serves as a means to open dialogue for the purposes of consultation with the Aviation Industry prior to the proposed implementation of the Surveillance Services.*

*In the Republic of South Africa, transponder equipage; and operation in CLASS A, and CLASS C airspace is mandated according to SA-AIP ENR 1.6.1 to ENR 1.6.5. Furthermore, Regulation 91.05.1 of the Civil Aviation Regulations, 2011 (CAR 2011) read together with the SA-CATS 91.05.1; provide further clarity and support to this ENR mandate.*

**2. Introduction**

*In order to continue with the provision of safe, orderly, expeditious and efficient Air Traffic Management solutions and associated services; it is necessary to continuously review the enabling technologies that allow for improved continuation of these services.*

*To this extent, the need to inform Aviation Industry of more flexible, efficient, and cost-beneficial Surveillance Technologies such as Automatic Dependant Surveillance-Broadcast (ADS-B) has been identified; with a view to replace legacy, less efficient, and more expensive Primary Surveillance Radar (PSR) and Monopulse Secondary Surveillance RADAR (MSSR) technologies.*

*Due to the increase traffic volumes, especially in complex terminal areas, the introduction of Mode Select (Mode S) transponders are also required to ensure operational performance of the surveillance sensors.*

*The positive gains in Total Surveillance System Performance that ADS-B and Mode S provides has been proved by other ANSP's; and as such, ADS-B been identified to be suitable for fitment on all relevant Instrument Flight Rules (IFR) and Visual Flight Rules (VFR) flights in the RSA in order to ensure that pertinent and essential information is fed to the Automated Air Traffic Management System, which is in support of the future operating environment.*

**3. General**

*If a new transponder is installed in an IFR or VFR aircraft, it is highly recommended that it be equipped with serviceable ADS-B and Mode S transponder in order to comply with the future effective dates for planned Mode S and ADS-B equipage.*

***Mode S and ADS-B Planned Dates of Applicability***

*The proposed fitment of approved ADS-B equipage is as follows:*

***2018 – IFR Forward fit:*** *Any aircraft that is first registered on or after 1 January 2018 and is operated under IFR must carry a serviceable Mode S and ADS-B transponder that complies with the requirements below.*

***2020 – All IFR aircraft:*** *On and after 1 April 2020 operated under IFR must carry a serviceable Mode S and ADS-B transponder that complies with the requirements below.*

***2020 –New aircraft and Newly installed transponders:*** *Any aircraft that is first registered or modified by having its transponder replaced on or after 1 April 2020, and is operated in Class A, B, C or E airspace must carry a serviceable ADS-B and Mode-S transponder that complies with the requirements below.*

***Mode S and ADS-B Transponder Requirements***

*In order to realise the full operational benefits of ADS-B, it is recommended that the equipment meets the current standard 1090ES ADS-B Link Version 2 (RTCA/DO-260B/EUROCAE ED-102A) for transponders fitted to aircraft operating in South African airspace.*

*Aircraft that are additionally equipped with antennae fitted on to the top and bottom of the fuselage will have the benefit of line-of-sight to the evolving based services as well as terrestrial services (e.g. ACAS, ADS-B, etc).*

*(RTCA/DO-260B/EUROCAE ED-102A) transponders feature both ADS-B "out", as well as ADS-B "in" for the purposes of Traffic Information, Service Broadcast (TIS-B), and Flight Information.*

*In South Africa, (RTCA/DO-260B/EUROCAE ED-102A) compliant transponders shall include only those operating on 1090 MHz. This standard will expressly exclude the use of Universal Access Transceivers (UAT) that operates on 978 MHz.*

*In addition to meeting the above requirements, the equipment shall also be certified in accordance with the FAA or EASA (E)TSO-C166() or a later approved version.*

*The mode S transponder equipment shall be certified in accordance with the FAA or EASA (E)TSO-C112 or a later approved version.*

*The aircrafts unique 24 bit address' (otherwise known as the mode S code issued by the Authority) shall be strapped to the transponders without error and ensuring that it corresponds exactly with the binary or hexadecimal address issued. Confirmation of the correct strapping must be conducted by using the correct ramp test equipment. Application for this code must be made to the Authority using form CA 91-12 which can be found on the SACAA website and must be accompanied by the prescribed fee.*

*The GNSS position source shall be certified in accordance with FAA or EASA (E)TSO-C145a, (E)TSO-C146a or (E)TSO-C196a or later approved versions. Some later versions of GNSS receivers certified to (E) TSO-C129 may also meet the requirements, such as those having FDE and HPL features incorporated.*

*The altitude source equipment supplying the pressure altitude to be transmitted by the ADS-B equipment shall be certified in accordance with the FAA or EASA (E)TSO-C88a or a later approved version.*

***4. Conclusion***

*Installations carried out on South African registered aircraft to meet the above requirements must be carried out strictly in accordance with Part 21 and Part 43 of the CAR, 2011 and must be conducted by an Aircraft Maintenance Organisation holding the current and appropriate rating to do so.*

*For further information, please contact the ATNS ADS-B helpdesk atads-b@atns.co.za*

***DIRECTOR OF CIVIL AVIATION***

## Appendix E

| Item | Wire number | Wd : | Identifier |
|---|---|---|---|
| 1 | 1LC1B | 640000204A7 | COCKPIT LIGHTING |
| 2 | 1HQ11A | 640000501A2 | LH BLOWER |
| 3 | 3EM1A | 620000301A1 | OIL 3 |
| 4 | L1FX | 680000711C4 | ADC1 |
| 5 | L1RP | 680000301A5 | ADF1 |
| 6 | L11SH | 650000201B4 | TCAS |
| 7 | L1CA | 680000731A5 | AFCS1 CMPTR |
| 8 | JA1A | 620000101A4 | IGNITION1 |
| 9 | L31FV | 680000851A7 | EFIS |
| 10 | FL51A | 640000601A5 | AI PROBES |
| 11 | PW31A | 610000106A1 | SIGN WARN PWR |
| 12 | 1WW1B | 640000802A1 | WARNING & INDICATION |
| 13 | 1JW2A | 620000101A4 | IGNITION 1 TEST |
| 14 | L1RJ | 680000771B4 | FMS 1 |
| 15 | L1RS | 680000101A4 | VOR 1 |
| 16 | 2WB41A | 620000501A2 | FUEL 2 SHUT OFF |
| 17 | L11FV | 680000851A7 | EADI LH |
| 18 | 1HA14A | 640000602A5 | ANTI ICE |
| 19 | L21FV | 680000851A7 | EHSI LH |
| 20 | L1RV | 680000101A4 | DME 1 |
| 21 | 51FV | 680000891B3 | SYMBOL GEN 3 |
| 22 | 1FL11A | 640000601A5 | STATIC HEAT LH |
| 23 | 1HN21E | 640000302A6 | AIRCONDITIONING |
| 24 | 3HN2B | 640000302A6 | AIRCONDITIONING |
| 25 | 1PP8AN | 610000201A3 | PANEL SHIELD |
| 26 | 11SH | 34-52-01-B4 | ATC1 |
| 27 | 3HA30A | 640000602A5 | ANTI ICE ENGINE |
| 28 | QN11A | 620000401A4 | BP FUEL PUMP |
| 29 | 1KK1A | 620000101A4 | STARTING |
| 30 | EK11A | 620000404A5 | FUEL LEVEL |
| 31 | 1UTL1A16 | | UTILITY PLUG |
| 32 | 1FP11A | 640000901A4 | IRS 1 BAT |
| 33 | WW3B | 640000802A1 | WARNING & INDICATION |
| 34 | FP31A | 640000901A4 | IRS 3 batt |
| 35 | 1LM1A | 630000401A2 | LIGHTS |
| 36 | 2QA1A | 620000401A4 | FUEL PUMP |
| 37 | 1EJ1A | 620000405A4 | FUEL GAUGES |
| 38 | J101-E | 34-55-91-A7 | GPS 1 |
| 39 | WW4B | 640000802A1 | WARNING & INDICATION |
| 40 | DL1C | 601681500B2 | FLAP POS |
| 41 | L1FF | 680000611A3 | DDRM 1 |
| 42 | 1QN4A | 620000401A4 | FUEL PUMP |
| 43 | L11CA | 680000731A5 | AFCS 1 |
| 44 | 1EP1A | 620000107A6 | ENGINE CMPTR |
| 45 | 1FX1A | 640000111A3 | ARTHUR |
| 46 | 1LK1A | 640000201A8 | INST. LIGHTING |

| | | | |
|---|---|---|---|
| 47 | 1WW21A | 640000802A1 | TEST LIGHT |
| 48 | 1LC1A | 640000204A7 | LIGHTING |
| 49 | 1SQ | 34-44-51-B1 | WEATHER RADAR R/T |
| 50 | 1LJ31A | 630000402B1 | EXTERNAL LIGHTS |
| 51 | 1PA1A | 610000101B4 | DC POWER |
| 52 | 1HA2B | 640000602A5 | AI ENGINE |
| 53 | WK3A | 660000151A4 | DIM/BRT BELTS SIGNS |
| 54 | LC17A | 640000204A7 | LIGHTING |
| 55 | 2WW21A | 640000802A1 | TEST LIGHT |
| 56 | 1WB1A | 620000501A2 | FIRE DET. EXT. |
| 57 | L11RJ | 680000771 | CDU 1 |
| 58 | 1KK4A | 620000101A4 | STARTING |
| 59 | QN14A | 620000401A4 | BP FUEL PUMP |
| 60 | 1PD1B | 610000101B4 | DC POWER |
| 61 | 1PE1B | 610000101B4 | DC POWER |
| 62 | WJ3A | 660000151A4 | DIM/BRIGHT |
| 63 | 3HN4B | 640000302A6 | AIR COND. |
| 64 | 1HA30A | 640000602A5 | AI ENGINE |
| 65 | 3HA12A | 640000602A5 | AI ENGINE |
| 66 | 1EP2B | 620000107A6 | ENGINE CMPTR |
| 67 | FG2A | 640000901A4 | IRS 1 BATT |
| 68 | 1LM12B | 630000401A2 | LANDING LIGHT |
| 69 | 1FL2A | 640000601A5 | PROBE HEATING |
| 70 | 1KK2A | 620000101A4 | STARTING |
| 71 | EK1B | 620000404A5 | FUEL LEVEL |
| 72 | 1LK4A | 640000201A8 | INST. LIGHTING |
| 73 | 1FL32A | 640000601A5 | PROBE HEATING |
| 74 | FL22A | 640000601A5 | PROBE HEATING |
| 75 | HJ14A | 640000604A7 | AI WINGS |
| 78 | HH15A | 640000605A2 | WINDSHIELD HEAT |
| 79 | 3EP2B | 620000107A6 | ENGINE CMPTR |
| 80 | 3EP1D | 620000107A6 | ENGINE CMPTR |
| 81 | 3PD2B | 610000101B4 | DC POWER |
| 82 | WJ1A | 660000151xx | NO SMOKE |
| 83 | 3EP1A | 620000107A6 | ENGINE CMPTR |
| 84 | LE121A | 660000151A4 | CABIN LIGHTS |
| 85 | 1FL31A | 640000601A5 | PROBE HEATING |
| 86 | LJ21A | 630000402B1 | NAV/STROBE LIGHTS |
| 87 | 3HU1A | 640000604A7 | AI WINGS |
| 88 | FL21A | 640000601A5 | PROBE HEATING |
| 89 | 1HH1A | 640000605A2 | WINDSHIELD HEAT |
| 90 | 1HU1A | 30-16-04-A7 | HP Bleed |
| 91 | 1QA6A | 28-24-01-A4 | X-BP 1-2 |
| 92 | 1QA1A | 28-24-04-A4 | X-BP 1-2 |
| 93 | EK13A | 28-24-04-A5 | FUEL LEVEL |
| 94 | LJ1A | 33-44-02-B1 | NAV/STROBE LIGHTS |
| 95 | HJ16A | 30-16-04-A7 | AI WINGS |
| 96 | 1MK2A | 30-47-01-A3 | WINDSHIELD WIPERS |

| | | | |
|---|---|---|---|
| 97 | 3KK1A | 80-01-01-A4 | AUTO IGNITION |
| 98 | 3KK1B | 80-01-01-A4 | AUTO IGNITION |
| 99 | 3KK1D | 80-01-01-A4 | AUTO IGNITION |
| 100 | 1FL1A | 30-36-01-A5 | PROBE HEATING |
| 101 | HH31A | 30-46-05-A3 | WINDSHIELD HEAT |
| 102 | 3452-0500-20 | ADSB-STC | AIU INTERFACE |
| 103 | 1LK1B | 33-12-01-B2 | INST. LIGHTING |
| 104 | 3JW2A | 80-01-01-A4 | AUTO IGNITION |
| 105 | 1MK1C | 30-47-01-A3 | WINDSHIELD WIPERS |
| 106 | 1LFV | 34-28-51-A7 | SG1 |
| 107 | 1LFP | 34-45-61-A2 | IRS 1 |
| 108 | 12GP | | EGPWS |
| 109 | 1SA | 34-45-01-A2 | RAD ALT |
| 110 | 61FV | 34-28-91-B3 | MFD/ WRD |
| 111 | 1LRC | 23-11-01-B1 | VHF 1 |
| 112 | L11RE | 23-14-01-A9 | HF CONTROL |
| 113 | 21LCA | 22-17-31-A5 | YAW DAMPER |
| 114 | L1RL | 23-43-01-D2 | ICS LH |
| 115 | L51LK | 33-12-01-A8 | ANNUNC LH |
| 116 | L41CA | 22-17-31-A5 | AFCS 1 ADVIS |
| 117 | L21fp | 34-45-18-A6 | IRS 3 |
| 118 | L1RE | 23-14-01-A9 | HF 1 PWR |
| 119 | 1WL1A | 31-58-30-A2 | AUDIO WARN A |
| 120 | 1QN14A | 28-24-01 | ST-BY PUMP |
| 121 | HJ15A | 30- | AI WINGS |

# Appendix F

With reference to SACATS, 2011 139.02.15 (AIRPORT RESCUE AND FIREFIGHTING), the following extracts of the SACAR's define ARFF categorisation.

## Airport Category Classification matrix

| Column I | Column II | Column III | Column IV |
|---|---|---|---|
| **Aerodrome Category** | **Aircraft Overall Length** | **Aircraft Maximum Fuselage Width** | **Number of firefighting Vehicles** |
| **1.** | N/A | N/A | N/A |
| **2.** | N/A | N/A | N/A |
| **3.** | at least 12 m but less than 18 m | 3 m | 1 |
| **4.** | at least 18 m but less than 24 m | 4 m | 1 |
| **5.** | at least 24 m but less than 28 m | 4 m | 1 |
| **6.** | at least 28 m but less than 39 m | 5 m | 2 |
| **7.** | at least 39 m but less than 49 m | 5 m | 2 |
| **8.** | at least 49 m but less than 61 m | 7 m | 3 |
| **9.** | at least 61 m but less than 76 m | 7 m | 3 |
| **10.** | at least 76 m but less than 90 m | | 3 |

(a) The level of protection provided at an Airport for rescue and firefighting shall be based on the longest aeroplanes and its fuselage width using the Airport.

(b) The level of protection shall be appropriate to the Airport category determined where the number of movements of the aeroplanes in the highest category using the Airport is more than 700 total in the busiest consecutive three months.

(c) During reduced activity, of less than 700 total movements for the busiest consecutive three months for aeroplanes in the highest category, for Airports above category 4 the level of protection available shall be no less than that needed for the highest category of aeroplane planned to use the Airport, during the time of the actual movements and may be reduced by one level during other times.

(d) When using the classification matrix contained in paragraph 1 above, Airports qualifying for the issue of an Airport licence in category 4, may provide an aircraft Category 3 firefighting service at all times if –

(i) a full risk assessment has been carried out by the operator which indicates that even with a lower category firefighting service, an acceptable level of safety can be maintained.

(ii) the level of Airport rescue and firefighting services protection provided is no less than that required for a category 3 level of protection and includes both the foam, dry chemical powder and rescue equipment requirements.

(iii) fully trained and permanently appointed firefighting personnel are provided.

(iv) for category 3 aircraft firefighting service, each firefighting vehicle is capable of discharging its content at the required application rate as indicated in Column VI of the minimum useable amount of extinguishing agent table in the appropriate mixture. Where nitrogen is used as the propellant to eliminate possible faulty pump operational systems; the full (pre mixed) content can be discharged as firefighting foam. This does not preclude the use of a firefighting vehicle fitted with a pump and foam induction system provided that the full content can be discharged at the required application rate.

(e) For Airports issued with a category 3 license the level of firefighting service and equipment required shall be based on a risk assessment and shall not exceed the requirement contained in the classification matrix. The risk assessment shall consider number of movements, prevalent aeroplane size, operational hours, minimum level of pilot proficiency, aircraft types, location, etc. Notwithstanding the aforementioned, for category 3 Airports with more than 700 total movements during the busiest consecutive three months, the level of service shall comply with the classification matrix at all times.

**Minimum Useable Amounts of Extinguishing Agent**

| Aerodrome Category | Foam meeting performance level A | | Foam meeting performance level B | | Foam meeting performance level C | | Complementary agents | |
|---|---|---|---|---|---|---|---|---|
| | Water (L) | Discharge rate foam solution/minute (L) | Water (L) | Discharge rate foam solution/ minute (L) | Water (L) | Discharge rate foam solution/ minute (L) | Dry chemical powders (kg) | Discharge rate (kg/sec) |
| 1 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 2 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 3 | 1 800 | 1 300 | 1 200 | 900 | 820 | 630 | 135 | 2.25 |
| 4 | 3 600 | 2 600 | 2 400 | 1 800 | 1 700 | 1 100 | 135 | 2.25 |
| 5 | 8 100 | 4 500 | 5 400 | 3 000 | 3 900 | 2 200 | 180 | 2.25 |
| 6 | 11 800 | 6 000 | 7 900 | 4 000 | 5 800 | 2 900 | 225 | 2.25 |
| 7 | 18 200 | 7 900 | 12 100 | 5 300 | 8 800 | 3 800 | 225 | 2.25 |
| 8 | 27 300 | 10 800 | 18 200 | 7 200 | 12 800 | 5 100 | 450 | 4.5 |
| 9 | 36 400 | 13 500 | 24 300 | 9 000 | 17 100 | 6 300 | 450 | 4.5 |
| 10 | 48 200 | 16 600 | 32 300 | 11 200 | 22 900 | 7 900 | 450 | 4.5 |

(v) These firefighting vehicles shall have both a hand-line and a roof mounted turret/mirror. A discharge distance of at least the length of the longest aeroplane using the Airport is required through the vehicle turret.

(vi) The fire appliances deployed shall be a self-propelled 4 X 4 vehicle that can achieve the required response times of 0 to 80 km/h within 25 seconds as depicted for Rapid Intervention Vehicles when fully laden and have a maximum speed of not less than 105 km/h.

(vii) The ancillary equipment to be carried on the vehicle shall consist of the equipment depicted in the rescue equipment list below.

(e) The Airport operator shall ensure that both principal and complementary agents are provided at an Airport and the principal extinguishing agent shall be –

(i) a foam meeting the minimum performance level A; or

(ii) a foam meeting the minimum performance level B; or

(iii) a foam meeting the minimum performance level C; or

(iv) a combination of these agents; except that the principal extinguishing agent for Airports in categories 1 to 3 shall preferably meet a performance level B or C foam.

(f) At Airports where operations by aeroplanes larger than Airport category are planned, the quantities of water shall be recalculated and the amount of water for foam production and the discharge rates for foam solution shall be increased accordingly.

(g) The quantity of foam concentrates that is separately provided on vehicles for foam production shall be in proportion to the quantity of water provided and the foam concentrate selected.

(h) The amount of foam concentrate provided on a vehicle shall be sufficient to produce at least two loads of foam solution.

(i) Supplementary water supplies, for the expeditious replenishment of rescue and firefighting vehicles at the scene of an aircraft accident, shall be provided.

(j) Dry chemical powders shall only be substituted with an agent that has equivalent or better firefighting capabilities for all types of fires where complementary agent is expected to be used.

(k) A reserve supply of foam concentrate equivalent to 200% of quantities and 100% of complementary agent including propellant gas shall be maintained at the Airport for vehicle replenishment purposes. If a major delay in replenishment is anticipated the amount of reserve supply shall be increased as determined by the risk assessment.

(l) Where a major delay in the replenishment of the supplies is anticipated, the Airport operator shall ensure that a contingency plan is put in place to address the delay.

# Appendix G

| ZENITH AIR | ZS-DFJ | | | AIRCRAFT: F900B<br>SERIAL NO: 141 |
|---|---|---|---|---|
| MINIMUM EQUIPMENT LIST | EASA MMEL REV. NO: 10<br>DATE: 22/07/2011 | | | MEL REV. NO: Initial<br>DATE: 21/05/2018 |
| 1. SYSTEM,<br>SEQUENCE NUMBERS & ITEM | 2. REPAIR CATEGORY | 3. NUMBER INSTALLED | 4. NUMBER REQUIRED FOR DISPATCH | 5. REMARKS AND EXCEPTIONS |
| 34 NAVIGATION | | | | *Refer to (O) & (M) Section for procedures* |
| 4. Reversion Controller Panel (RCP) | | | | |
| (1) F900B | C | 2 | 1 | One may be inoperative provided Display Controller Panels (DC 820) are operative. |
| 5. Remote Instrument Controller (RI 820) (ASEL / DH Selection) | C | 1 | 0 | (O) May be inoperative provided:<br>- As required by Regulations,<br>Ref: *(See Appendix Q)*<br>- **RVSM operations are not planned.**<br>*[OPER 22-1 on section 2-22]* |
| 7. Attitude and Heading System (AHS) | | | | **Note:** For specific RNAV operations, refer to [OPER 34-0 on section 2-34]. |
| (1) Inertial Reference System (IRS) | D | 3 | 2 | One may be inoperative. |
| | A | 3 | 1 | (O) One or more may be inoperative provided:<br>- Standby horizon and standby magnetic compass are operative,<br>- Monitoring of the remaining operating IRS by the standby horizon and standby magnetic compass is performed with care,<br>- Flight is performed in daylight VMC conditions,<br>- Repairs are made within three consecutive calendar days.<br>*[OPER 34-7.1 on section 2-34]* |
| (2) Standby Horizon and Power Supply | | | | |
| (a) F900B | B | 1 | 0 | May be inoperative for daylight VMC operation only. |
| (Continued) | | | | |

| ZENITH AIR | | | | ZS-DFJ | |
|---|---|---|---|---|---|
| MINIMUM EQUIPMENT LIST: *DEFINITIONS, ABBREVIATIONS & NOTES* | | | | | |
| AIRCRAFT: | F900B | EASA MMEL REV.: | 10 | MEL REV.: | Initial Issue |
| SER. NO: | 141 | DATE: | 22/07/2011 | DATE: | 21/05/2018 |

## DEFINITIONS, ABBREVIATIONS & EXPLANATORY NOTES

### DEFINITIONS

1. The System numbers are based on the Air Transport Association (ATA), Specification Number 100 and items are numbered sequentially.

2. The MMEL-related Dispatch Assistance information consists of:
   - The Fault Guide Dispatch Assistance (FGDA), reference DGT 118448,
   - This approved MMEL, and
   - The associated Operational and Maintenance procedures, gathered in the "Maintenance and Operating procedures" document, reference DTM611.

3. The MMEL Item List provides the list of component, instrument, equipment, system, or function which may be inoperative prior to dispatch. Items are gathered by ATA chapter and provided under a table format. The structure of the MMEL item list table is as follows:

**3.1. System & Sequence Numbers Item** - Column (1) - details the component, instrument, equipment, system, or function listed.

**3.2. Rectification Interval** - Column (2) - Inoperative items, deferred in accordance with the MEL, must be rectified at or prior to the rectification intervals established by the following letter designators:

**3.2.1 Category A:**
No standard interval is specified. However, items in this category shall be rectified in accordance with the conditions stated in the "Remarks or Exceptions" column - Column (5)
(i) Where a time period is specified in calendar days or flight days, the interval excludes the day of discovery.
(ii) Where a time period is specified other than in calendar days or flight days, it shall start at the point when the defect is deferred in accordance with the operator's approved MEL.

**3.2.2 Category B:**
Items in this category shall be rectified within three (3) calendar days, excluding the day of discovery.

**3.2.3 Category C:**
Items in this category shall be rectified within ten (10) calendar days, excluding the day of discovery.

## Appendix H

**FALCON 900B**
**AIRCRAFT MAINTENANCE MANUAL**

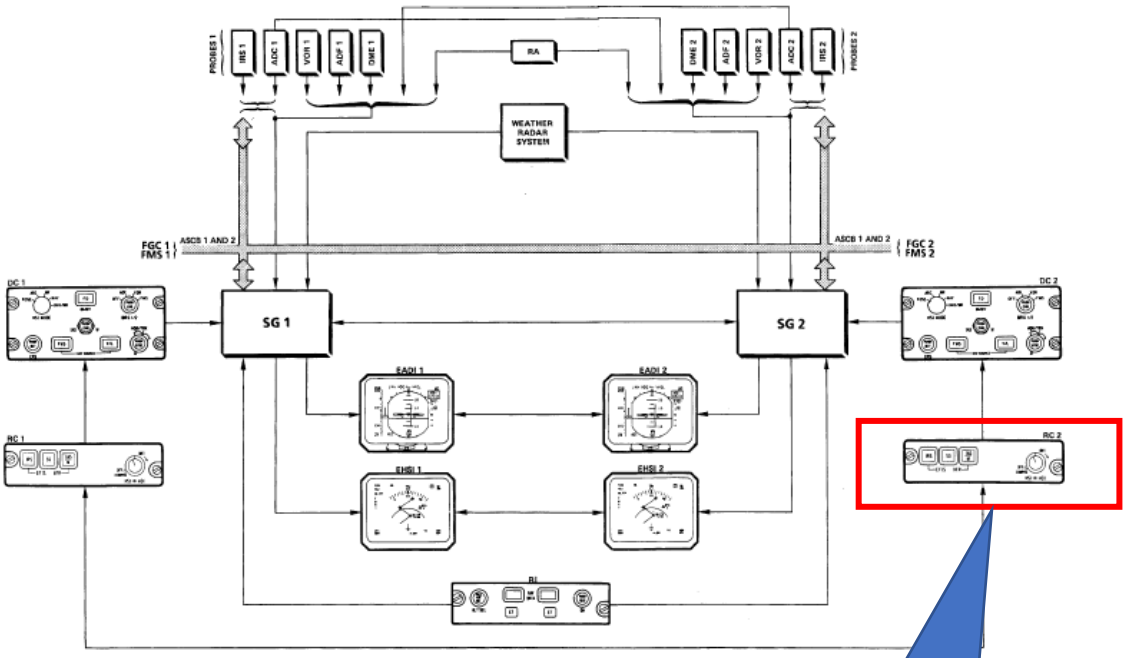



**Figure 1: EFIS system description**

Right hand reversion controller panel was inoperative

**Appendix I**

*United States of America*
*Department of Transportation*
*Federal Aviation Administration*

# *Supplemental Type Certificate*

*Number:* ST02972NY

*This certificate issued to:* Dassault Aircraft Services (DAS)
191 North DuPont Highway, New Castle, DE 19720

*certifies that the change in the type design for the following product with the limitations and conditions therefore as specified hereon meets the airworthiness requirements of Part* 25 *of the Federal Aviation Regulations.*

Original Product – Type Certificate Number: A46EU
Make: Dassault Aviation
Model: Mystere-Falcon 900

Description of Type Design Change:

Installation of ADS-B Out system in accordance with Dassault Aircraft Services **(1)** Master Data List, F9BW-D0025-005, Revision IR, dated 07/14/2014, or later FAA approved revision. **(2)** Instructions for Continued Airworthiness (ICA) F9BW-D0025-155, Revision B, dated 03/07/2014 or later FAA accepted revision. The ICA and its contents must be incorporated into the operator's maintenance program. **(3)** Airplane Flight Manual Supplement (AFMS) F9BW-D0025-150, Revision I/R, dated 07/14/2014 for Config. 1 (DO-260A), or F9BW-D0045-150, Revision IR, dated 08/31/2016 for Config. 2 (DO-260B), or later FAA approved revisions.

Limitations and Conditions:

(1) STC ST02970NY for installation of Honeywell GPS Landing System Sensor Unit (GLSSU) is a pre-requisite for this alteration, and must be installed either prior to, or in conjunction with this alteration.
(2) The installer must determine whether this design change is compatible with previously approved modifications.

(See Continuation on Page 3 of 3)

*This certificate and the supporting data which is the basis for approval shall remain in effect until surrendered, suspended, and revoked or a termination date is otherwise established by the Administrator of the Federal Aviation Administration.*

Date of application: 8/6/2013
Date reissued: 11/25/2014
Date of issuance: 7/14/2014
Date amended: 09/1/2016

*By direction of the Administrator*

*Signature*

*Title* Administrator, ODA-955240-NE



FAA Form 8110-2 (8/13)

Page 1

United States of America
Department of Transportation
Federal Aviation Administration

# Supplemental Type Certificate

(Continuation Sheet)
Number: ST02972NY

Date Amended: September 1, 2016

*Limitations and Conditions (continued)*

(3) If the holder agrees to permit another person to use this certificate to alter the product, the holder shall give the other person written evidence of that permission.

*Certification Basis*

Based on 14 CFR §§ 21.115 and 21.101, and the FAA policy for significant changes in FAA Order 8110.48, the certification basis for the Dassault Aviation, model Mystere-Falcon 900 is as follows:

(1) The type certification basis for Dassault Aviation, Model Mystere-Falcon 900 airplane is shown on TCDS A46EU for parts **not changed or not affected** by the change.

(2) The certification basis for parts **changed or affected** by the change since the reference date of application August 6, 2013, is based upon part 25 as amended by Amendment 25-56 with the exception of those listed above amendment 25-56, below.

**Regulations at later amendment than 25-56**

| **14 CFR Part** | **Amendment** |
|---|---|
| 25.625(a) | 25-72 |
| 25.869(a)(4) | 25-72 |
| 25.1581(a)(2)(b)(d) | 25-72 |

.....END.....

B. PROCEDURE

(1) Transponders TDR-94D (P/N 622-9210-501) #1 and #2 shall be installed in the Existing Avionics Rack in the L/H Crew Closet and in the Nose Radio Rack R/H Side respectively, according to the document entitled "#1 & #2 DO260B TRANSPONDER INSTL".

(2) Annunciator Interface Units (AIU's) (P/N BA-440) shall be installed in the respective locations under the cockpit floor between frames 2 and 3 and also between stringers 18 and 19 according to the document entitled "BA-440 FILTER / ROUTER INSTALLATION".





(3) AIU Annunciator (P/N LED-50-17-BB-E1GYC) and ADS-B System and Transponder Annunciators (P/N LED-50-17-BB-E1GYB ) shall be installed in the respective locations in the cockpit according to the documents entitled "ANNUCIATOR INSTL (ADS-B OUT)".

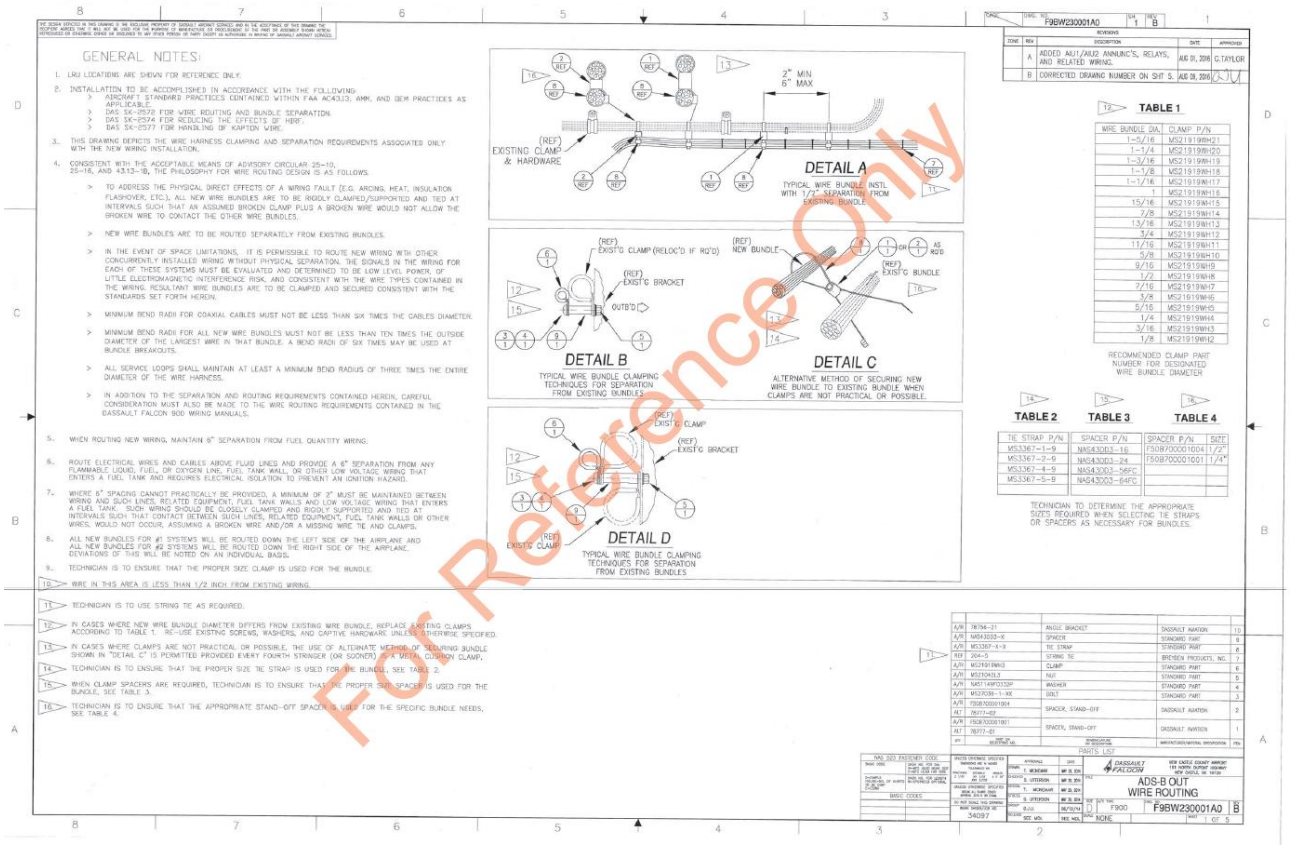
(4) Wiring shall be installed according to the documents entitled:

- ATC: ADS-B DO-260B

(5) Transponders TDR-94D shall be connected to GPS, according to the document entitled "ATC: ADS-B OUT - D0260B".

(6) Transponders TDR-94D shall be connected to AIU and respective annunciators, according to the documents entitled:

- "ATC: ADS-B OUT DO-260B"



Appendix K

Dassault Aircraft Services
191 North DuPont Highway
New Castle, DE 19720

| Document Number: | Rev: | Date: |
|---|---|---|
| F9BW-D0045-210-1 | IR | 22-AUG 16 |

**NOTES:**

1. No additional load for the added Led annunciators as these items are supplied electrical power through the cockpit 5 AMP 14/28V dimming circuit and their load when illuminated is insignificant.
2. Electrical load values presented herein for each item reflect the manufacturer's specifications.

**CONCLUSION:**

The installing agency is responsible to attach this document to the existing electrical load reports for the aircraft upon completion of the installation and to verify the individual busses loads are not exceeded for all phases of flight.