GOVERNMENT OF INDIA

CIVIL AVIATION DEPARTMENT

DIRECTORATE GENERAL OF CIVIL AVIATION

FINAL INVESTIGATION REPORT

Incident to M/s Indigo Airlines, Airbus A320 Neo aircraft, registration VT-IZR

on 23-Aug-2022 at Goa, India

Office of Director Air Safety (WR)

Integrated Operational Office Complex, Ville Parle (E)

Mumbai – 400099

FOREWARD

This document has been prepared based upon the evidences collected during the investigation, opinion obtained from the experts and laboratory examination of various components. The investigation has been carried out in accordance with Annex 13 to the convention on International Civil Aviation and under Rule 13(1) of the Aircraft (Investigation of Accidents and Incidents), Rules 2017.

The investigation is conducted not to apportion blame or to assess individual or collective responsibility. The sole objective is to draw lessons from this incident which may help to prevent such future incidents.

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LIST OF ABBREVIATIONS USED IN THIS REPORT

IST	Indian Standard Time
AMM	Aircraft Maintenance Manual
ATC	Air Traffic Controller
ATPL	Airline transport pilot licence
BOM	Mumbai Airport
CFT	Airport Crash Fire tender -vehicle
CVR	Cockpit Voice Recorder
DGCA	Directorate General of Civil Aviation (India)
ECAM	Electronic Centralised Aircraft Monitor
EGT	Exhaust Gas Temperature
FDR	Flight Data Recorder
FO	First Officer
FRTO	Flight Radio Telephonic operator licence
GOA/ VOGO	Goa Airport
HP Rotor	High Pressure Rotor
Hrs.	Hours (in time)
IDG	Integrated Drive Generator
IIC	an Investigation-in-Charge IIC
IR Rating	Instrument Rating
lb	Pounds
MAA	Chennai Airport
MAY DAY	A distress signal used in aviation communications to indicate that a life-threatening emergency exists.
MEL	Minimum Equipment List
METAR	Meteorological Aerodrome Report
P/N	Part Number
PAN PAN	Urgency signal used in aviation communications to indicate that an urgent situation exists but does not pose an immediate threat to life or safety.
PFR	Post Flight Report
PIC	Pilot In-Command
RWY	Runway
S/N	Serial Number
SCF–PP	System/Component Failure or Malfunction (Powerplant)
TR	Thrust Reverser
UTC	Coordinated Universal Time

Contents

FINAL INVESTIGATION REPORT

Incident to M/s Indigo Airlines, Airbus A320 Neo aircraft, registration VT-IZR

on 23-Aug-2022 at Goa, India

a. Aircraft	Manufacturer	:M/s Airbus
	i. Model	:A320-271N
	ii. State of Registry	: India
	iii. Registration	: VT-IZR
b. Name of the Owner		: M/s Klaatu Aircraft Leasing Ireland Ltd.
c. Name of the Operator		: M/s Interglobe Aviation Limited
d. Pilot – in – Command		: ATPL holder
e. Co-pilot	: ATPL holder	
f. Passengers:-		
a. No. of Persons on board		: 187
b. Extent of injuries		: 0
g. Place of incident		: Goa
h. Date & Time of Incident		: 23-08-2022, 13:24 Hrs IST
i. Last point of departure		: Goa
j. Point of intended landing		: Mumbai
k. Nature of Operation		: Scheduled Commercial
l. Phase of Operation		: Taxi-Out
m. Type of incident		:System/Component Failure or Malfunction (Powerplant) (SCF–PP)

(All timings in the report are in IST unless or otherwise specified)

SYNOPSIS

On 23-08-2022, M/s Indigo Airline Airbus A320 Neo aircraft registration VT-IZR was scheduled to operate its flight 6E-6097 from Goa to Mumbai at 13:10 Hrs.

Engine No. 1 was started at the bay and aircraft taxied out with single engine. Engine No.2 was started during taxi. While aircraft was taxied to the holding point of Runway 26, crew heard muffled bang sound from starboard side (Right) followed by

Engine No. 2 Fire message in Electronic Centralised Aircraft Monitor (ECAM) and Master Warning.
MAY DAY was declared by the crew and subsequently discharged both the fire bottles. Fire alarm went off, Airport fire services reported no visual fire at the engine. Passengers disembarked normally. There was no injury to any persons on board.

The Director General of Civil Aviation instituted an investigation into the incident and appointed an Investigation-in-Charge to investigate into the cause of the incident vide OrderNo: DGCA-15018(06)/24/2022-DAS dated 29-08-2022 under Rule 13(1) of The Aircraft(Investigation of Accidents and Incidents) Rules 2017.

Investigation concluded that the probable cause of the incident due to fire ignited by electrical arcing at the Pylon Interface terminal.

1. FACTUAL INFORMATION

1.1. History of the flight

Indigo Airlines A320 Neo aircraft registration VT-IZR operated a scheduled commercial flight from Goa to Mumbai on 23-08-2022 at 13:10 Hrs (IST) as flight 6E-6097. This was fourth sector of the day for the aircraft (BOM-MAA-BOM-GOI-BOM). First three sectors were operated uneventful.

The aircraft chocked off at 13:14 Hrs. with 187 passengers and 6 crew (2 cockpit crew + 4 cabin crew) on board. Engine No. 1 was started at bay and aircraft taxied out with single engine. Engine No. 2 was started during taxi.

Aircraft taxied on taxiway A and held short of the right turn for holding point N1 for Runway 26. Subsequently, on getting clearance, while the aircraft started taxi to holding point Runway 26, crew heard muffled bang sound from starboard side followed by Engine No. 2 Fire ECAM (Electronic Centralized Aircraft Monitor) and master warning. Distress message, MAYDAY was declared by the crew and subsequently discharged both fire bottles as per the ECAM actions. Subsequently the fire warning went off, crew cancelled MAYDAY and declared PAN PAN. There

was no smoke observed in the cockpit nor the cabin, few passengers reported sighting fumes from Engine No. 2.

The Crash Fire tender (CFTs) dispatched by the Indian Navy reported no sign of fire on either the engine nor the aircraft, and no firefighting agent was used. Crew had used both the engine fire bottles.There was no signs on fuel leaks or any other abnormalities/ marks observed on the incident site (N1 taxiway)
The aircraft was towed back to the bay and PAN PAN was cancelled after parking. Aircraft chocked ON at Bay 9 at 14:07 hrs. Passenger disembarkation was carried out normally through doors.

On arrival of aircraft to the bay, signs of burns, overheat and black residue of smoke observed on the in-board side of the Engine No.2 near Thrust reverser.

No other damages were observed to aircraft.

Nobody was injured in this incident. The incident took place at Daylight condition.

1.2. Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
Minor/None	Nil/06	Nil/187	

1.3. Damage to aircraft

Following damages were observed on Engine No. 2

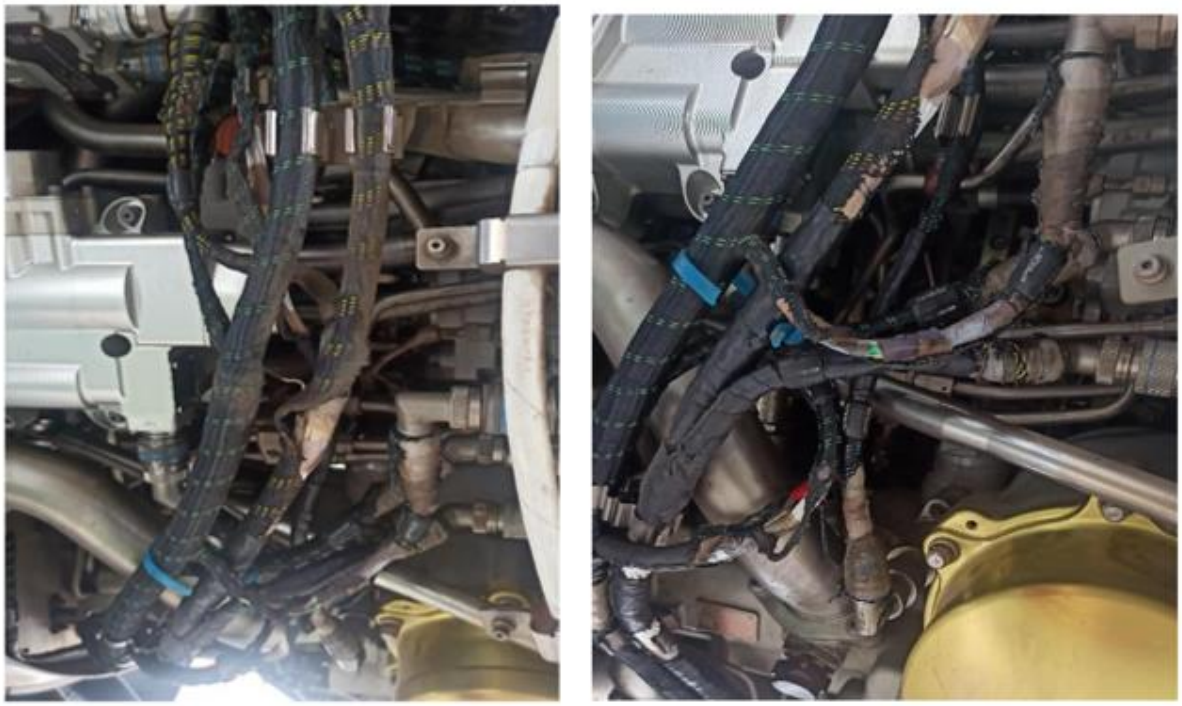
i. Paint peeled on bottom portion of Engine No. 2 TR Cowl sleeve.

ii. Damage to insulations of several harnesses inboard side of Engine# 2

iii. Integrated Drive Generator (IDG) Feeder cable damaged with burn marks.

(Fig. 1.1: Paint peel on the Lower Section of Engine No.2 Thrust Reverser Cowling)

(Fig.1.2: IDG Feeder cables damaged with burn marks)



(Fig. 1.3: Several cables and harness damaged)

1.4. Other damage

There were no other damages observed to the aircraft, airport, and its structures.

1.5. Personnel information

1.5.1. Pilot in-Command

AGE	: 37
License	: DGCA ATPL Licence
Date of issue	: 07/11/2020
Valid up to	: 06/11/2025
Category	: PIC
Date of medical Exam	: 27/06/2022
Medical Exam valid up to	: 09/07/2023

Date of issue of FRTO license	: 29/01/2020
FRTO license valid up to	: 28/01/2025
IR rating and instructor rating	: IR (11/07/2022)
Total flying experience	: 8072:00 Hrs.
Experience on type	: 7872:00 Hrs.
Experience as PIC on type	: 5013:13 Hrs.
Total flying experience during last 1 year	: 562:04 Hrs.
Total flying experience during last 6 month	: 247:59Hrs.
Total flying experience during last 30 days	: 30:10 Hrs.
Total flying experience during last 07 days	: 9:24 Hrs.
Total flying experience during last 24 hours	: 5:55 Hrs.
Duty period during last 24 hours	: 8:40 Hrs.

1.5.2. Co-Pilot

AGE	: 38
License	: DGCA ATPL Licence
Date of issue	: 02/08/2019
Valid up to	: 01/08/2024
Category	: PIC
Date of medical Exam	: 12/01/2023
Medical Exam valid up to	: 26/01/2024
Date of issue of FRTO license	: 28/01/2021
FRTO license valid up to	: 27/01/2026
IR rating and instructor rating	: IR (24/05/2023)
Total flying experience	: 5226:35 Hrs.

Experience on type : 5008:35 Hrs.

Experience as PIC on type : N/A

Total flying experience during last 1 year : 501:10 Hrs.

Total flying experience during last 6 month : 200:18 Hrs.

Total flying experience during last 30 days : 30:49 Hrs.

Total flying experience during last 07 days : 7:52 Hrs.

Total flying experience during last 24 hours : 5:55 Hrs.

Duty period during last 24 hours : 8:40 Hrs.

1.6. Aircraft information

1.6.1. General information

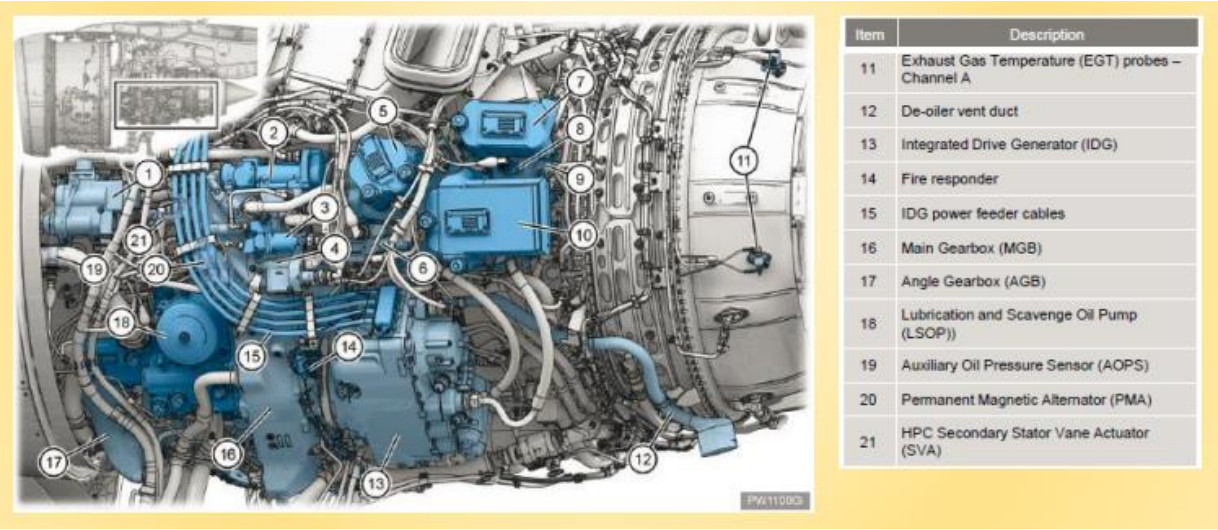
Manufacturer	Airbus
Aircraft Registration	VT-IZR
Aircraft model	A320-271N
Aircraft Serial Number	8771
Manufacturing Year	2019
Engine type	PW1127GA-JM
Certificate of Airworthiness (C of A)	7165
Airworthiness Review Certificate (ARC)	Valid up to 21/04/2023
Category	Passenger/Mail/Goods
Owner	M/s Klaatu Aircraft Leasing Ireland Limited, Ireland.
Operator	M/s Interglobe Aviation Limited, operated as 'Indigo'.
Maximum All Up Weight	74,000 Kgs
Aircraft hours Since New	9496:13 Hrs
Airframe hours Since C of A	9496:13 Hrs

The following Last Major scheduled inspections were carried out as a part of maintenance work:

Inspections details	On	at A/F Hrs.
PERFORMED 3000 FH / 360 DAYS INSPECTION	02/07/2022	8897:17
PERFORMED WEEKLY (7 DAYS/120 FH) INSPECTION SCHEDULE	19/08/2022	9463:41

1.6.2. Power Plant

The aircraft is fitted with two M/s Pratt & Whitney engines with a Bypass ratio of 12.5:1 thrust of 27,000 pounds. Engine Model: PW1127GA-JM.



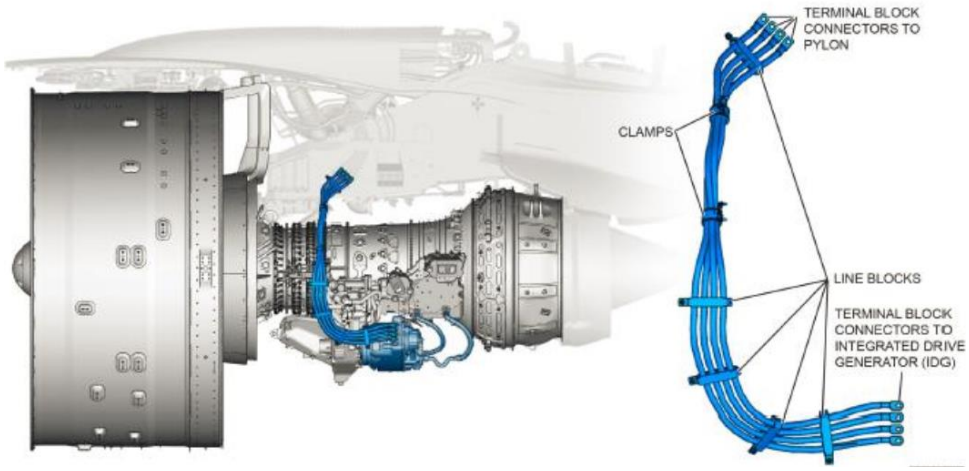
Item	Description
11	Exhaust Gas Temperature (EGT) probes – Channel A
12	De-oiler vent duct
13	Integrated Drive Generator (IDG)
14	Fire responder
15	IDG power feeder cables
16	Main Gearbox (MGB)
17	Angle Gearbox (AGB)
18	Lubrication and Scavenge Oil Pump (LSOP))
19	Auxiliary Oil Pressure Sensor (AOPS)
20	Permanent Magnetic Alternator (PMA)
21	HPC Secondary Stator Vane Actuator (SVA)

(Fig. 1.4: Installations on the Left side of the Engine)

- Affected EngineS.No : P770518
- Engine Position : No. 02
- Engine installed on VT-IZR : 20.08.2022 at Delhi
- Engine hrs/ cycles:
  - TSN (Time Since New) : 6339
  - CSN (Cycles Since New) : 4015
  - TSLV (Time Since Last Overhaul) : 4626
  - CSLV (Cycles Since Last Overhaul) : 2830
  - TSI (Time Since Inspection) : 27
  - CSI (Cycles Since Inspection) : 18

Integrated Drive Generator (IDG):

Each engine (HP rotor) controls its related Integrated Drive Generator (IDG) through the accessory gearbox. The drive speed changes in relation to the engine rating. The IDG supplies 115/200 VAC, 3-phase, 400 Hz power to the engine and aircraft, at the Point of Regulation (POR).

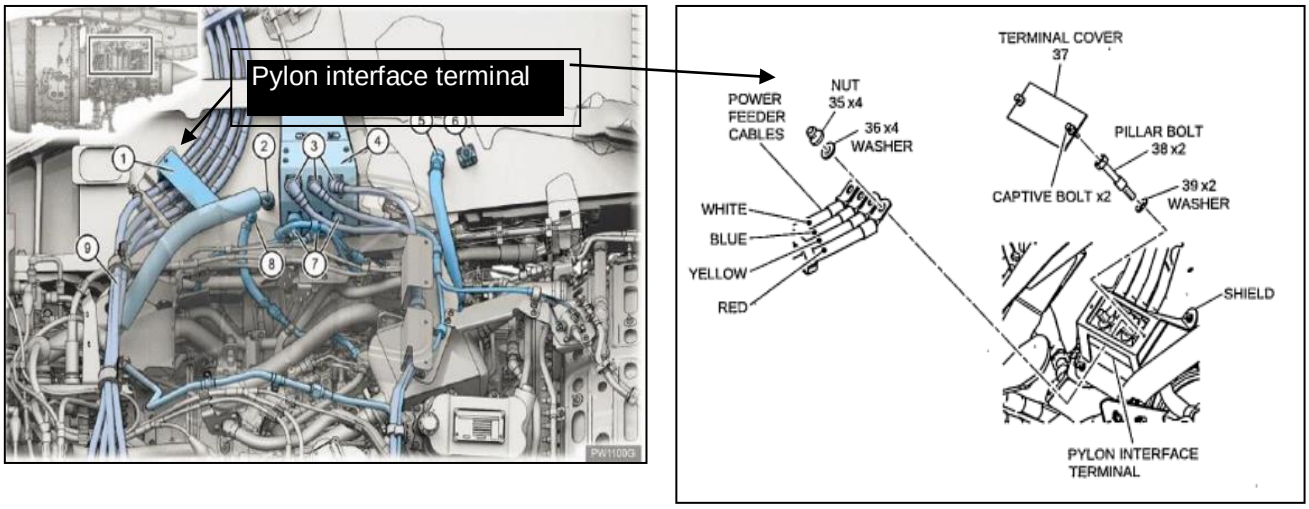


(Fig. 1.5:IDG Power **IDG** connected to pylon)

The IDG has two parts:

- The drive with the Constant Speed Drive (CSD) and,
- The generator.

The IDG power cables (Three-phase, one neutral) are connected, at one end, to the lower IDG power-cable disconnectblock attached to the IDG. The other end of the IDG power cables is connected to the upper IDGpower-cable disconnect-block installed on the left of the pylon above the diffuser case through the Pylon Interface Terminal.

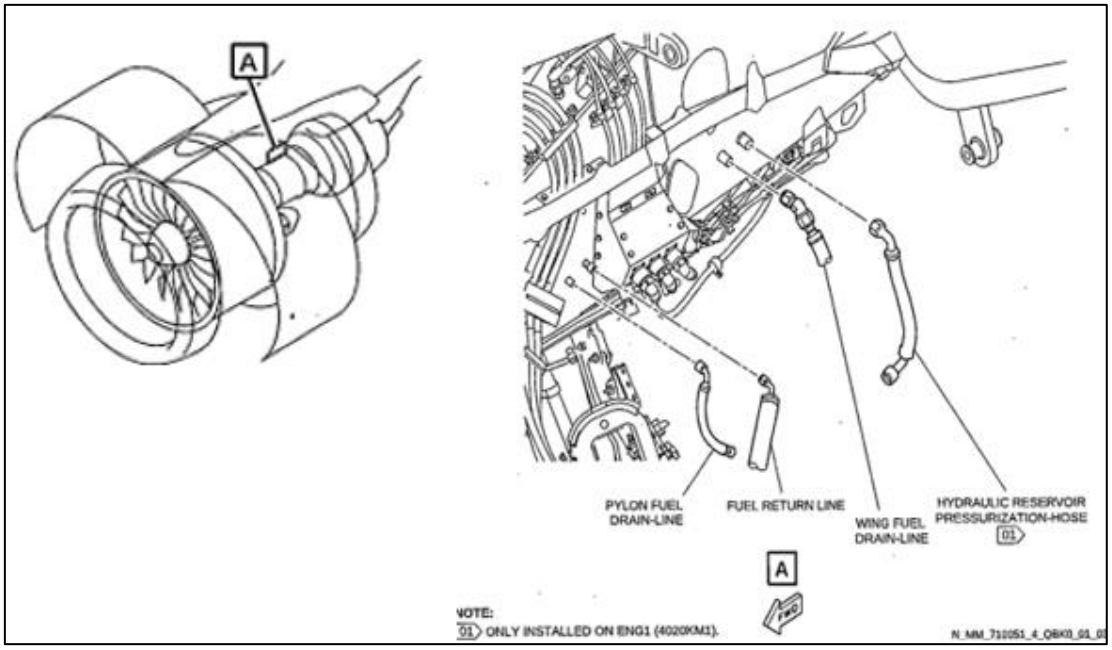


(Fig. 1.6:Pylon Interface Terminal and the IDG cables)

Engine installation on 20-08-2022:

The involved engine (ESN P770518) was removed from VT-IUP Position No.1 due to Low EGT margin and was installed on VT-IZR Position No.2 at New Delhi as per AMM task 71-00-51-400-802-A Installation of Power Plant (Boot strap method). Post installation, thrust rating conversion task was carried out. A duplicate inspection for Forward and Aft engine mount bolt torque, post engine replacement test and idle power test were carried out and found satisfactory.

During the installation of fuel lines, according to the AMM, the fuel return line should be torqued to a range of 36.65 to 39.97 lbf.ft using a torque wrench. This procedure applies to the affected side (LH side) of the engine.



(Fig. 1.7:Fuel hoses – Fuel return line)

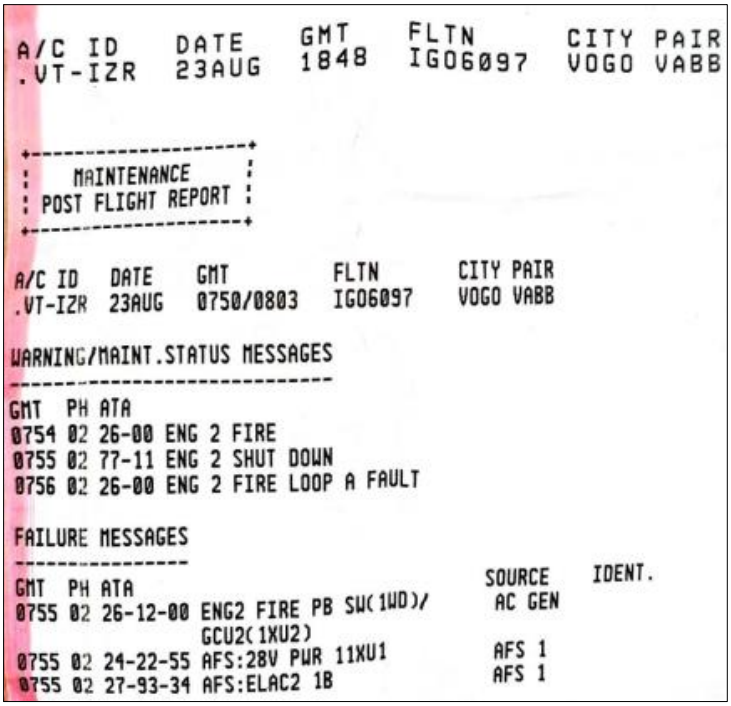
An inspection was conducted by DGCA to verify the availability and serviceability of the torque wrench (S.No. 0220705642, with a torque range of 16.67- 83.33 lbf-ft) in the stores and its utilization during the subject engine installation, and no abnormalities were observed.

The electrical connectors from IDG to pylon receptacle were removed and installed during engine replacement.

After installation of Engine on 20-08-2022, aircraft operated 18 sectors till the incident wherein no snags were reported and no work had been carried out on the affected engine.

1.6.3. Troubleshooting and Rectification:

Post Flight Report (PFR) of the incident flight reflected Engine# 2 Fire warning at 07:54 hrs UTC, followed by Engine# 2 shut down at 07:55hrs UTC. Failure messages recorded in the PFR are consequential to the fire warning and not contributory.



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A/C ID    DATE    GMT    FLTN       CITY PAIR
.VT-IZR   23AUG   1848   IG06097    VOGO VABB


+--------------------+
:   MAINTENANCE      :
: POST FLIGHT REPORT :
+--------------------+

A/C ID   DATE    GMT         FLTN      CITY PAIR
.VT-IZR  23AUG   0750/0803   IG06097   VOGO VABB

WARNING/MAINT.STATUS MESSAGES
-----------------------------
GMT  PH ATA
0754 02 26-00 ENG 2 FIRE
0755 02 77-11 ENG 2 SHUT DOWN
0756 02 26-00 ENG 2 FIRE LOOP A FAULT

FAILURE MESSAGES
----------------
GMT  PH ATA                                    SOURCE    IDENT.
0755 02 26-12-00 ENG2 FIRE PB SW(1WD)/          AC GEN
                 GCU2(1XU2)
0755 02 24-22-55 AFS:28V PWR 11XU1              AFS 1
0755 02 27-93-34 AFS:ELAC2 1B                   AFS 1
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(Fig. 1.8: Post Flight Report – current leg)

Previous leg PFR reflects Nil observations.

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A/C ID    DATE    GMT    FLTN       CITY PAIR
.VT-IZR   23AUG   0721   IG0179     VABB VOGO


+--------------------+
:   MAINTENANCE      :
: POST FLIGHT REPORT :
+--------------------+

A/C ID   DATE    GMT         FLTN      CITY PAIR
.VT-IZR  23AUG   0603/0714   IG0179    VABB VOGO

WARNING/MAINT.STATUS MESSAGES
-----------------------------
 NO WARNING MESSAGE

FAILURE MESSAGES
----------------
 NO FAILURE MESSAGE
```

(Fig. 1.9: Post Flight Report – Previous leg)

Deferred Defects:

The aircraft had following active MELs during the incident flight which were relevant to air conditioning system:

- MEL 21-00-04A Temperature Control 1 maintenance message Cat 'C' valid till31.08.2022
- MEL 21-52-01D Air-conditioning Pack 1'C' valid till 01.09.2022

Upon physical inspection of the aircraft and the incident-involved engine by the DGCA team on August 24, 2022, the following observations were made:

1. Signs of overheat and black residue of smoke were observed at the bottom of the T/R cowls on Engine No.2, with peeled paint, indicating evidence of an actual fire.
2. Signs of overheat were also noted on the heat shield on the inboard side of Engine No.2.
3. Burns and overheat damage were observed on the insulations of several harnesses on the inboard side of Engine No.2.
4. The IDG Feeder cable was damaged with burn marks.
5. No signs of fluid leakage were observed.
6. The hydraulic and engine oil quantities were within the normal range.
7. No chips were detected in any of the magnetic chip detectors.
8. Black soot was observed on the harness as well as on the LH heat shield of the TR cowl.
9. No physical damage was noted on the engine case or components.
10. The rotor of Engine No.2 was found to be turning freely without any abnormal sound or noise.
11. No abnormalities were observed on the LH (#1) engine.

Following the incident, the aircraft was grounded, and the engine manufacturer, Pratt & Whitney, was consulted. The following troubleshooting and rectification tasks were carried out by the operator:

1. Visual inspection of the engine after the fire, in accordance with AMM task 72 00-00-210-817-A, which included checks of the N1 rotor, hot air leaks, and fire caused by fluid leak (engine static condition). No abnormalities were observed.
2. Damaged harnesses were replaced.

3. Post-installation ENG-2 FADEC test was conducted, with the results being satisfactory.
4. The ENG2 Fire Extinguisher Bottles 1 & 2, along with serviceable cartridges, were replaced as per AMM task ref 26-21-41-000/400-001E. Operational checks of the loop/squib and the low-pressure indicating circuit were performed and found satisfactory.

In addition to the above, as advised by PW-CTS (Pratt & Whitney Customer Technical Support), the following tasks were performed:

1. Torque check of the return to tank connection at the pylon, which was found to be 36.25 lbf-ft. The connection was disconnected and inspected for any damage to the fitting/b-nut threads, which were found to be satisfactory. The return to tank hose on the pylon adapter was installed and torqued to a value of 38 lbf-ft (AMM ref task 73-11-48-400-803-A).
2. An engine motor leak test (dry method) was conducted, with no abnormalities observed.
3. An engine motor leak test (wet method) was also carried out and found to be satisfactory.
4. An idle power test was conducted, and it was found to be satisfactory.
5. An operational test of the IDG disconnect and reconnect (reset) function was performed with the engine in operation, which was found to be satisfactory.
6. A power assurance test was conducted, and the results were found to be satisfactory.
7. Visual inspection around the heat exchangers, the LPC VSV actuator and 2.5 Bleed actuator were found to be satisfactory.

Furthermore, as advised by PW-CTS, the following inspections were performed:

1. The area around the ACC air valve was inspected to confirm that the fuel line connections adhered to the instructions in SB 75-00-0024. No leakage was observed (Ref AMM task 75 24-01-400-801-a).
2. The DR122 line (FWD pylon drain hose) underwent a torque check and was

   found to be within specification. The line was removed at the pylon adapter and checked for clogging, with no blockage observed. The DR122 line was

then reinstalled on the pylon adapter and torqued to the specified value (AMM ref task 71-71-49-400-801-a).

Post carrying out the recommendations' of Engine Manufacturer, Aircraft was declared serviceable on 28.08.2022.

1.7. Meteorological information:

Incident time in UTC: 0754 Hrs, METAR issued once hourly at Goa Airport (VOGO), therefore weather at 0800 Hrs is taken for investigation.

The METAR/SPECI from VOGO at 08:00 UTC indicates that the weather conditions at the time of the incident were as follows:

- Wind: 30013KT (300 degrees at 13 knots)
- Visibility: 6000 meters
- Clouds: FEW015 (a few clouds at 1500 feet), SCT020 (scattered clouds at 2000 feet), BKN080 (broken clouds at 8000 feet)
- Temperature: 29 degrees Celsius
- Dew point: 24 degrees Celsius
- QNH: 1007 hPa
- No significant weather

1.8. Aids to navigation

The incident took place on the ground during taxi to runway. Navigation aids were not relevant to the incident.

1.9. Communications

During the incident, the aircraft was in two-way communication with ATC on frequency 121.5 MHz.

1.10. Aerodrome information

VOGO Airport (Dabolim) is a Defence airfield with civil terminal services provided by the Airports Authority of India (AAI) and airport operations handled by the Indian Navy. The airport has a single runway (08/26) that is 3,430 meters long and 45 meters wide.
ICAO aerodrome code: VOGO Geographical coordinates: 15° 22' 47.42" N, 73° 49' 40.17" E Elevation: 45.8 meters (150 feet) AMSL

Firefighting capabilities:

VOGO Airport has a Category 9 rescue and firefighting service.

1.11. Flight recorders

The data from Solid State Flight Data Recorder and Cockpit voice recorder were downloaded and available for investigation.

1.11.1. Flight Data Recorder (FDR)

M/s Honeywell FDR Part No: 980-4750-002; Serial No: FDR-06971 has a recording capacity of 25 hours of flight time.

Salient points:

Time (UTC)	Event
07:47:21:	Engine No.1 Started
07:50:02:	Engine No.2 Starter valve open
07:50:06:	Engine No.2 Started
07:50:31:	Fuel flow started for Engine No2 and
07:51:15:	N2 of Engine No.2 reached >50%
07:51:21:	APU generator was turned off.
07:54:22:	Fire warning pertaining to Engine No.2 came ON.
07:54:52:	Engine No.2 fuel flow was Shut-Off
07:54:58:	Engine No.2 fire push button was pressed.

- There was no Master Caution nor Master warning from start till the time Fire Warning triggered.
- Engine No. 1 N2 was maintained at 60-70%
- N2 of Engine No.2 was almost constant around 63%, similar compared to that of Engine No.1.
- There was no vibration observed on both the engines
- The EGT of Engine No.2 remained at around 700^{o}C, with no abrupt change.
- The engine oil temperature, quantity and pressure remained within the range and no abnormality observed.
- Air bleed Pushbutton for Engine No.2 was in OFF position for entire duration.
- IDG on Engine No.2 was generating constant voltage 115V after N2 reaches 50% till engine shutdown. No abnormalities observed in IDG cooling.

1.11.2. Cockpit Voice Recorder (CVR)

Part No.: 980-6032-023;Serial No.: CVR-09189

The flight's Cockpit Voice Recorder (CVR) recordings were accessible for investigative purposes. According to the CVR transcript, Engine No. 1 was initiated, and the aircraft commenced movement during the taxi phase. Engine No.2 was started while taxiing, with the crew conducting checklists, observing no irregularities until the aircraft reached Taxiway A and came to a halt, holding short of the N1 holding point for Runway 26.

At 07:54:22 UTC, a loud bang was audibly captured, closely followed by the activation of Engine No.2's fire warning system (ENG 2 FIRE ECAM). The flight crew promptly declared a MAYDAY to Air Traffic Control (ATC), explicitly indicating their intention to remain stationary due to the engine fire. This declaration was acknowledged by ATC, and the flight crew initiated the necessary ECAM actions.

Subsequently, the flight crew inquired with ATC whether the fire on Engine No.2 was visible from the ATC tower, to which the Air Traffic Controller responded in the negative. Simultaneously, the Airport Rescue and Firefighting (ARFF) team arrived on-site and reported no visual evidence of a fire. Crew decided to tow the aircraft to bay and carryout a normal disembarkation of passengers through door.

1.12. Wreckage and impact information.

The aircraft VT-IZR while operating flight no. 6E-6097 was involved in engine fire. The damage was limited within the engine and there was no disintegration of any part of the aircraft.

1.13. Medical and pathological information.

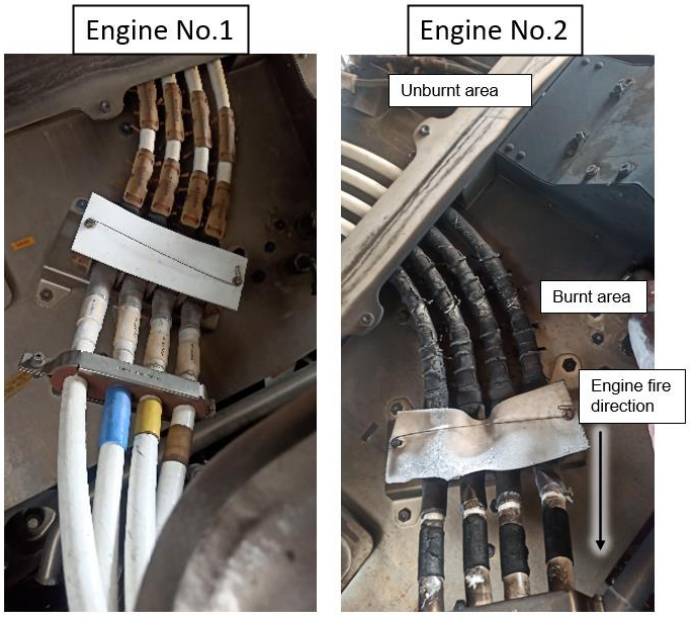
Both the crew had undergone Pre-flight Breath Analyser test before start of their Flight Duty period and were found negative.

1.14. Fire.

The fire occurred in the starboard engine (Engine No.2) while the aircraft was taxiing to runway. The fire was extinguished by the crew using fire bottles.

Although the Crash Fire Truck (CFT) team arrived on-site for firefighting, they didn't deploy extinguishing agents since the crew confirmed that the aircraft engine fire extinguishers had already successfully put out the fire.

The fire caused paint peeling on the bottom portion of the Engine No.2 TR Cowl sleeve, damage to the insulations of harnesses inboard side of Engine No.2, and burn marks on the IDG Feeder cable. Large concentration of burn marks and black soot were found on the inner part of the cowl covering IDG harness area, especially areas below the Pylon Interface terminal. The area above the Pylon Interface terminal remained unburnt.

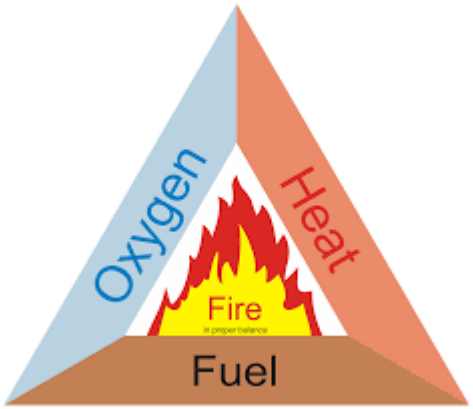


(Fig. 1.10: Power cables from IDG to pylon; Left- affected engine, Right – unaffected engine)

(Fig. 1.11: Enhanced image of terminal cover of Pylon Interface Terminal)

Evidence of localized heating and material degradation was observed on the terminal cover of the Pylon Interface Terminal, in the form of blistering.

Aircraft Engine Fires - The Three Elements of Combustion:



A fire is defined as a rapid chemical reaction that occurs when three crucial elements come together: fuel, heat, and oxygen.

Sources of Fuel in the Power Plant:

Jet Fuel: Fuel is the foundational element of the fire triangle and a primary factor in aircraft engine fires. Aircraft utilizes Jet fuel Jet A1. It has a flash point minimum of degrees 100°F C (38C) and a freeze point maximum of -47 °C.

Hydraulic Fluid: Used in hydraulic systems including tank, pumps, actuators and other consumer components. Its flash point is ~340°F.

Oil: The engine oil/ lubricating oil used in bearing system as well as in heat exchangers. The Flash point is ~450°F.

Source of Heat:

Heat is the second element in the fire triangle. Electrical faults, overheating components, friction, and hot surfaces within the engine are the sources of heat.

Source of Oxygen:

Oxygen is drawn into the engine for combustion process. The primary and secondary airflow has abundant supply of oxygen and hence supports fire.

Electrical arcing:

The Basics: Electrical arcing is a phenomenon where electrical current jumps a gap between two conductors. This jump creates an intense, sustained electrical discharge that looks like a miniature lightning bolt. The arc is composed of highly ionized gas (plasma) that is extremely hot.

Identification/ evidence of electrical arcing:

Below are common signs of arcing:

1. A bright light or flash accompanying the discharge.
2. A loud noise during the discharge.
3. Sparks flying from the point of discharge.
4. A burning smell coming from the area of discharge.
5. The area around the discharge becomes hot.
6. Electrical equipment in the area stops working properly.
7. Clear demarcation between the affected/burnt and unaffected area.

1.15. Survival aspects

The cockpit crew verified that the engine fire had extinguished, so they did not initiate emergency evacuation procedures. Instead, they decided to have the aircraft towed to the bay, where passengers disembarked normally through the door. The incident was survivable.

1.16. Tests and research

The Integrated Drive Generator (IDG) was dispatched to the shop for a comprehensive failure analysis. Although the report did indicate the presence of external dust soot resulting from the fire, a complete failure of the IDG was ruled out.

The operator was instructed by the IIC to submit the incident-involved components such as the IDG/ EDP Monitoring Harness, IDG Feeder Cable Pylon, and other harnesses to the shop check for failure/damage analysis.

The analysis on the burnt harnessed could have identified, whether the arc beads were formed due to electrical faults or consequential. However, the operator discarded/scrapped the components without authorization from the IIC.

1.17. Organizational and management information

M/s Indigo is a scheduled Indian airline headquartered in New Delhi. It operates a fleet of Airbus A320, A321, and ATR 72 aircraft. The airline began operations in 2006 and currently has a fleet of approximately 300 aircraft. Indigo flies to a variety of domestic and international destinations.

1.18. Additional information

Following are the sequence of actions required to be carried out by the flight crew in case of Engine fire (On ground)

- ✓ Parking Brake – SET
- ✓ ATC to be notified regarding nature of emergency and their intentions.
- ✓ Cabin crew should be alerted.
- ✓ Affected engine should be switched off (Master OFF)
- ✓ Affected Engine Fire Push Button to be pushed in
- ✓ Fire discharging agents 1 & 2 should be discharged.
- ✓ Emergency evacuation procedures should be applied.

1.19. Useful or effective investigation techniques.

NIL

2. ANALYSIS

2.1. Operational aspect

The flight crew did single engine taxi out and started Engine No.2while taxing to the holding point. There was proper coordination observed between the crew, as well as their communication with the ATC. Immediately after Engine Fire ECAM Warning came ON, the flight crew promptly declared a MAYDAY to Air Traffic Control (ATC), explicitly indicating their intention to remain stationary due to the engine fire. Subsequently both the fire bottles of Engine No.2 were discharged by the crew. All emergency services at the airport were activated.CVR indicates that the crew remained calm and followed procedures as per QRH & ECAM such as mentioned in para 1.18.

Subsequently, the flight crew inquired with ATC whether the fire on Engine No.2 was visible from the ATC tower, to which the Air Traffic Controller responded in the negative. The flight crew also enquired with their cabin crew and ground personnel regarding sighting of fire or smoke from the engine.

Since there was no indication of fire, flight crew did not opt for discharging extinguishing agent from the CFT and decided not to initiate emergency evacuation of passengers. Crew were well rested before the flight and there was no indication of crew fatigue.

The crew followed the procedures as per SOP. Therefore, crew handling of aircraft was not a factor to the incident.

2.2. Aircraft Maintenance:

The affected engine was installed on the aircraft in No.2 position 3 days prior to the incident. Since then, the aircraft had operated 18 sectors before the incident and no snag related to the engine was reported, also no scheduled/ non-scheduled inspection was carried out.

The engine manufacturer had advised series of tasks to identify source of fire. The significant checks were: Visual oil/ fuel leaks around all the components, especially Low Pressure Compressor VSV Actuator, 2.5 Bleed actuator and fuel lines connecting to pylon (return to tank valve) along with Dry& wet motoring. However, the only observation was, the torque check on the return to tank connection at the pylon revealed a reading of 36.25 lbf-ft, falling slightly below the specified AMM range of 36.65 to 39.97 lbf.ft.

There were two snags present during the incident which was deferred under MELs, however it did not have any impact on the incident.

Therefore, there was no evidence indicating that the aircraft was not maintained as per regulations and standards. Hence, airworthiness of the aircraft is not a factor to the incident.

2.3. Identification of source of Fire

Fire can exist only in the presence & combination of all the three elements:
i.e. Fuel, Heat, Oxygen.

- Oxygen is abundantly available at the Power plant area at all phases of flight.
- There are numerous source of heat present at the affected area, such as, actuators, Heat exchangers (Air/oil, IDG fuel/oil) corresponding modules. Heat can be caused due to Electrical faults, arcing, overheating components, friction.
- Source of fuel in the affected area are, Jet A1, Hydraulic fluid, Engine oil. Engine oil system (temperature, quantity, pressure) did not indicate any abnormalities and further it has very high its high flash point (~450°F). The possibility of fire due to hydraulic leak has also been ruled out due its high flash point (~340°F).

Probability of Fire due to fuel leak:

A torque check on the return to tank connection at the pylon revealed a reading of 36.25 lbf-ft, falling slightly below the specified AMM range of 36.65 to 39.97 lbf.ft. This deviation is categorized as an under-torque condition. However, it's imperative to acknowledge that the potential for fuel leakage from these connections cannot be entirely dismissed. Notably, the fuel in question is ‘heated fuel’ originates from the Ecology collector tank, which accumulates residual fuel following last engine shutdown, and recovered/ reused during next engine start. Leak of heated fuel onto the hot surface can elevate the temperature of the fuel to the point where it approaches or exceeds its flash point and can ignite fire,if there is an ignition source. In this case, even though fuel leak might have taken place, however, the investigation couldn't conclusively determine the precise ignition source that led to

the fire. Therefore, the fire due to fuel leak can't be substantiated in the absence of evidence.

Probability of Fire due to Electrical faults:

Physical inspection of affected area after the incident revealed signs of actual fire at the bottom of Thrust Reverser cowl area. All the harness, especially IDG feeder cables were damaged with burn marks. The burnt marks and damages were largely concentrated near the Pylon interface terminal.

The cockpit crew reported hearing a loud bang emanating from starboard side (right). This event coincided with CVR recordings, suggesting a potential electrical arcing event within the engine. This possibility is further strengthened by the presence of clear demarcation of burnt and unaffected areas, wherein the area above the Pylon interface terminal did not have evidence of fire. The blistering observed on the terminal cover of the Pylon Interface Terminal further supports this analysis, as it's a common consequence of localized heating due to electrical arcing.

Notably, the feeder cables were removed and installed on the Pylon interface terminal during engine replacement, which took place two days prior to the incident, and had flown for 27 Hrs / 18 cycles since replacement. The electrical arcing could take place on the Pylon Interface terminal due to incorrect engaging of mating connectors or un-cleaned connectors during installation of IDG cables, however the same could not be confirmed during the investigation.

An investigation of the damaged feeder cables could have confirmed the aforesaid analysis, however, the operator had discarded the evidences, rendering them inaccessible for analysis by the investigator.

3. CONCLUSIONS

3.1. Findings

1. The aircraft was certified, equipped and maintained in accordance with existing regulations and approved procedures.
2. There were two snags present during the incident which was deferred under MELs, however it did not have any impact on the incident.

3. The flight crew were appropriately licensed and qualified to conduct the flight and were well rested.
4. Engine No. 1 was started on the bay, and Engine No.2 was started while taxing.
5. Engine No.2 fire warning illuminated approx. three minutes after Engine No.2 - N2 reached 50%.
6. Flight crew declared MAYDAY call to ATC, by which emergency services responded as per procedures.
7. Fire was extinguished by discharging both the fire bottles. No external extinguishing agents were used.
8. The physical inspection of the engine revealed evidence of actual fire, which is consistent with the fire warning activation.
9. The affected engine was installed on the No.2 position in this aircraft on 20-08-2022, after which it had operated 18 sectors uneventful.
10. The presence of blistering on the terminal cover suggests that the fire in the engine was initiated due to electrical arcing at the Pylon Interface Terminal.
11. The Operator had discarded the harnesses and feeder cables, rendering them inaccessible for analysis by the investigator.

3.2. Cause:

The probable cause of the incident was due to fire ignited by electrical arcing at the Pylon Interface terminal.

4. SAFETY RECOMMENDATIONS

DGCA HQ may take appropriate action for finding No. 11 in para-3.1

Veeraragavan K
Assistant Director of Air Safety
Investigator-in-Charge for VT-IZR

Date: 10th November, 2023

End of Report