AAIB
Air Accidents Investigation Branch

Statement on an investigation into why launch vehicle LauncherOne did not reach orbit following its launch from Cornwall Spaceport on 9 January 2023

Introduction

The Air Accidents Investigation Branch (AAIB), acting as the UK's Space Accident Investigation Authority (SAIA), is responsible for the investigation of spaceflight accidents in accordance with The Spaceflight Activities (Investigation of Spaceflight Accidents) Regulations 2021[1].

This statement summarises SAIA engagement with an investigation to determine why the LauncherOne launch vehicle did not reach orbit following its launch from Spaceport Cornwall on 9 January 2023.

History of the launch

On 9 January 2023, the launch operator (hereafter the operator) attempted the first orbital launch from the UK, using LauncherOne, a two-stage orbital launch vehicle (rocket) designed to be carried to the launch area and dropped from under the wing of a modified Boeing 747-400 (Cosmic Girl). The aim of the launch was to insert a payload of satellites into orbit.

The carrier aircraft departed from Spaceport Cornwall, Newquay Airport, which had been granted a Spaceport Licence[2] by the Civil Aviation Authority (CAA). The CAA had granted the operator a Spaceflight Operator Licence[3] and a Range Control Licence[4]. The launch was also licensed by the FAA, a requirement under the applicable US regulatory framework.

At 0043 hrs on 10 January 2023, the SAIA was notified that the mission had not been successful. The rocket had been carried to the launch area and dropped from the carrier aircraft successfully but a fault in the second stage engine caused it to shut down before the stage achieved orbit.

UK-US agreements relating to a launch failure[5]

Technology Safeguards Agreement

An agreement between the UK and US, in the form of a Technology Safeguards Agreement[6] (TSA), establishes the principles under which US Technology[7] may be licensed by the US authorities for export to the UK for use in spaceflight activities. In the TSA, the governments agree mutually to *'provide … information necessary to determine the cause of the launch anomaly or failure'*.

Footnote

1 https://www.legislation.gov.uk/ukdsi/2021/9780348223699 [accessed August 2024].
2 https://www.caa.co.uk/publication/download/20107 [accessed August 2024].
3 https://www.caa.co.uk/publication/download/20111 [accessed August 2024].
4 https://www.caa.co.uk/publication/download/20115 [accessed August 2024].
5 The term 'launch failure' is used to mean that the purpose of a launch – in this case, to insert satellites into orbit – was not achieved.
6 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/927083/CS_UK_USA_1.2020_USA_Techno_Safeguards_Space_Launches.pdf [accessed August 2024].
7 'US Technology' means US launch vehicles and spacecraft, US-related equipment, components or debris, and US Technical data.

Technical Assistance Agreement

A Technical Assistance Agreement (TAA) is a US domestic legal document required to allow the export of hardware and technical data that are subject to export-controls[8]. The US Government requires a TAA to be in place before a US operator may share export-controlled information with the SAIA during an investigation. A launch failure TAA was drawn up by the operator but US policy was not to approve it ahead of the launch.

Response to the launch failure

The launch was licensed by the by the Federal Aviation Administration (FAA), as well as the CAA, and the FAA decided to carry out an investigation into what it termed a mishap[9].

The SAIA may investigate spaceflight accidents[10] occurring in or over the UK. Where a spaceflight accident occurs elsewhere than in or over the UK and another state is investigating, the SAIA may conduct a safety investigation only when requested by that state to assist with its investigation. On 11 February 2023 the FAA invited the SAIA to engage in *'joint oversight'* of the operator's technical investigation into the cause of the launch failure.

A stipulation of the launch failure TAA, which was approved after the launch failure, was that approval would be required from the Defense Technology Security Administration[11] (DTSA) before the operator could disclose to the SAIA technical data associated with its investigation, or investigators from the FAA Office of Commercial Space Transportation (FAA-AST) could disclose information from their discussions with the operator. The practical result of this requirement was that the SAIA was not provided with up-to-date information about the technical investigation as it progressed.

In early March 2023, four Inspectors from the SAIA visited the operator's facilities in California. They were given briefings on investigation methodology, updated on some investigation findings, and visited the factory and testing facilities. The information given to the Inspectors was limited by export controls in that it did not reflect the most current information on the state of the investigation.

The SAIA was given access to a secure website to view historic export-controlled documents supporting the issue of Operator and Range Control licences and related to the operator's Safety Case and Emergency Response Plan.

On 4 April 2023, the operator filed for bankruptcy under Chapter 11 of the US Bankruptcy Code. The SAIA was informed by the FAA-AST that, although the operator's investigation was continuing, the company had suspended its support for SAIA participation because of financial constraints imposed by the Chapter 11 process. The company subsequently ceased operating.

Footnote

8 The International Traffic in Arms Regulations (ITAR).
9 The US definition of 'mishap' is wide ranging but includes a failure to complete a launch as planned.
10 The UK definition of 'spaceflight accident' includes the circumstances of this event.
11 DTSA controls the transfer of export-controlled information and technology from the US.

The investigation into the launch failure

The operator's technical investigation

On 5 July 2023, the SAIA received a copy of the '*Failure Investigation and Final Report*' from the operator. The operator's report is subject to export-control restrictions and the information within it cannot be included in this statement, but the operator's findings were consistent with public statements it made during its investigation. The following information was previously made public by the operator.

The mission proceeded as expected through the following stages:

- Pre-flight preparations.
- Carrier aircraft takeoff.
- 'Captive carry' of LauncherOne under the carrier aircraft to the launch area.
- Rocket release.
- Ignition of the Newton 3 first stage engine.
- Separation of the first stage.
- Ignition of the Newton 4 second stage engine.
- Fairing deployment of the rocket.

From the beginning of the first burn of the second stage engine, it is likely that a fuel filter within the fuel feedline dislodged from its normal position. This conclusion was supported by ground testing that matched the observed flight data. This caused the fuel pump downstream of the filter to operate at degraded efficiency, resulting in fuel flow to the Newton 4 engine being lower than expected. This, in turn, caused the engine to operate at a temperature significantly higher than expected.

Components in the vicinity of the abnormally hot engine malfunctioned causing the second stage engine to shut down prematurely. The early reduction in thrust meant that the second stage and its payload did not reach orbital velocity and fell back to Earth, landing within the approved flight corridor in the Atlantic Ocean, north of the Canary Islands.

The SAIA considered the account of events and findings within the operator's report to be credible, a view also taken by the FAA-AST.

Nothing in the operator's report suggested that the UK licensing process or the operation from Spaceport Cornwall contributed to the launch failure. Nevertheless, regulatory and other activities undertaken to enable the launch to take place were the subject of a review by the UK Space Agency, which published a '*Lessons Learned Report*'[12] in December 2023.

Footnote

[12] https://www.gov.uk/government/publications/uk-pathfinder-launch-lessons-learned-report/pathfinder-launch-lessons-learned-report-html [accessed August 2024].

The SAIA investigation into the flight safety analysis

As part of the licensing process, the CAA carried out an independent analysis of the risks associated with the planned flight corridor, and this analysis was reviewed by the SAIA and discussed with the CAA. The SAIA considered that the CAA had carried out a thorough analysis when concluding that the operator *'had taken all reasonable steps to reduce the risks to as low as reasonably practicable (ALARP) and that the residual risks were acceptable'*. The CAA's guidance on risk levels is set out in CAP 2220[13].

Current and future work

The SAIA is currently working with the UK Department for Transport, the UK CAA and relevant US agencies to improve the flow of information to the SAIA should there be a future launch failure involving a US launch vehicle in or over the UK.

The SAIA is also reviewing its own procedures in light of lessons learned during the investigation and in preparation for launches from UK and European launch operators, which are expected to occur before the next launch from a US operator.

Footnote

[13] Principles and guidelines for the spaceflight regulator in assessing ALARP and acceptable risk (CAP 2220). https://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=detail&id=10557 [accessed August 2024] .