PART 1.4 – ANALYSIS AND FINDINGS

Methodology

1.4.0.1 **Background**. The accident on 3 Jul 12 involved two fast jet aircraft and resulted in three fatalities. The sole survivor, and only witness, has no memory of the accident. The high energy collision over the sea produced a complex and highly destructive accident sequence leaving wreckage trails over 4 km² at water depths of up to 60 m. The combination of the complexity of the accident and the challenge presented by the inaccessibility of the wreckage trails complicated many aspects of the investigation. Nevertheless, a diagnosis was possible by means of both deduction and exclusion with the physical and electronic evidence available. A combination of the Domino Model and Reason Model[1] was used to construct a sequence of events template which would encapsulate all aspects of the Inquiry. This allowed concurrent investigation of individual lines of inquiry as the Panel worked outwards from the detail of the accident to wider factors, opening and closing lines of inquiry as evidence presented itself. At times, when considering actions of individuals, events, conditions, measures and organisational influences it is easy to draw links to their contribution to the accident. The ability to draw these links is only possible with hindsight bias. That which is obvious now, was not obvious to those involved at the time. It is tempting to consider what alternative courses of action individuals could have taken, but those alternatives may not have been apparent, considered necessary, or seemed sensible at the time. It is certain that nobody believed they were creating the conditions for an accident to occur. Despite this, lessons can be learned from the tragic accident. Many of the lessons are not confined to Tornado or Fast Jet operations, but have a wider impact on Defence Air Safety and are highlighted to provide an opportunity to prevent their recurrence.

1.4.0.2 **Accident Factors**. The Panel classified the factors in accordance with the following definitions[2]:

a. **Cause**. The factor that led directly to the accident.

b. **Contributory Factor**. Factors that did not directly cause the accident, but made it more likely to happen.

c. **Aggravating Factor**. Factors that did not cause the accident but made the final outcome worse.

d. **Other Factor**. Factors that were none of the above but could contribute to, aggravate or cause a future accident.

e. **Observations**. Factors that, whilst not germane to the accident, and not thought likely to influence a future accident, were considered important aviation safety related issues worthy of comment.

1.4.0.3 In simplistic terms the factors can be considered as items that collectively resulted in defensive weaknesses, whereas the cause(s) can be considered to be the trigger(s), on that day, for the resultant accident. For the reasons highlighted in para 1.4.0.1 there were some aspects of this accident that the Panel had to determine upon the balance of probabilities and on the strength of the evidence available.

1.4.0.4 **Available Evidence**. In conduct of the Inquiry, the Panel had access to the following

[1] Decker, S. (1998) *The Field Guide to Understanding Human Error.* Ashgate Publishing, Chap 10.

[2] Aviation Safety Information Management System (ASIMS) User Guide, V3.1.

evidence:

a. **Witness Statements**. 144 witnesses were interviewed by the Panel and recorded statements were taken. Witnesses included: Chief of the Air Staff, Deputy Commander Operations at HQ Air Command, Air Officer Commanding (AOC) 1 Group (Gp), XV(R) Sqn, RAF Lossiemouth, Central Flying School (CFS), 1 Gp RAF, 2 Gp RAF, Civil Aviation Authority (CAA) subject matter experts (SMEs), Air Defence and Air Traffic Services Delivery Team (ADATS), Portsmouth University, Defence Training Estate (DTE), UK AWRs, Ministry of Defence (MoD), EuroControl, Nellis Air Force Base Ranges, Boeing Defence UK (BD UK), British Aerospace Systems (BAE Systems) and Defence Equipment and Support (DE&S) Abbey Wood.

b. **Electronic Data**. The following electronic data was available for exploitation: Air Data Recorder (ADR) files and Cockpit Voice Recordings (CVR) from the two accident aircraft; Rangeless Airborne Instrumented Debriefing System (RAIDS) data from one accident aircraft, Head Up Display (HUD) tapes from two aircraft from the same formations, photographs taken by flying enthusiasts, audio recordings of ATC transmissions, radar video recordings and mobile phone data.

c. **Documentary Evidence and Formal Reports**. The Panel reviewed and considered 463 formal reports, minutes, and policy/regulatory documents during the Inquiry process.

d. **Qualitative Assessment using Simulation Aids**. To validate some aspects of the accident the Tornado GR4 simulator and a Graphical Data Analysis System (GDAS) was used. Pilot's comments and performance were used to assist qualitative judgement.

e. **Reliability of Evidence / Witness Statements.** Subjective evidence can be unreliable as a result of distortion, for example from stress, hindsight bias and/or decay over time. Specifically, subjective evidence may not be considered reliable owing to the probability of such distortion and bias. Nevertheless, subjective evidence still adds qualitative value to the investigation. The Panel conducted more than 60 interviews in the first three weeks in addition to visits and evidence gathering. A number of witnesses referred to notes made on the day of the accident.

1.4.0.5 **Unavailable Evidence**. The following evidence was not available to the Panel:

a. Neither aircraft's HUD tapes were recovered.

b. Owing to the forces involved in the crash sequence and submerged wreckage sites, it was not possible to recover all of the aircraft's structure or recover all human remains. Some items were assessed to have been totally destroyed. The largest unrecovered item was the canopy of ZD812.

1.4.0.6 **Services**. The Panel was assisted by the following personnel and agencies:

a. MilAAIB

b. MAA

c. Centre of Aviation Medicine (CAM)

d. BAE Systems

e. Rolls Royce

f. QinetiQ

g. Portsmouth University, Extreme Environments Laboratory

h. Service Police Crime Bureau

i. STANEVAL, RAF Coningsby

j. EUROCONTROL, Brussels

k. CAA

l. Air Accident Investigation Branch (AAIB)

m. 771 Naval Air Squadron (NAS)

n. 1710 NAS Materials Integrity Group (MIG)

1.4.0.7 **Possible Factors.** The Panel considered a range of historical accident factors and eliminated each when either evidence was gathered that disproved the possibility or where no evidence was found to support that it was a factor. The causes considered were:

a. **Malicious Intent.** Investigation of crews' wellbeing at the time of the accident revealed no psychological problems that indicated a wish to commit suicide or initiate a collision. All crews had long term plans, were in good spirits and had no indications post-mortem that they were suffering from any relevant medical condition. The Panel concluded that a deliberate act to collide with another aircraft was **not a factor** in the accident.

b. **Technical Failure (Single or Both Aircraft).** There is no evidence that either aircraft suffered a technical failure that may have contributed to the accident. The possibility of both aircraft having had concurrent technical failures leading to each aircraft crashing into the sea was considered, but was ruled out by physical evidence of the collision. Technical Failure was **not a factor** in the accident.

c. **Bird Strike.** There is no evidence that either aircraft suffered a bird strike before, during or after the accident, therefore the Panel concluded that it was **not a factor** in the accident.

d. **Controlled Flight Into Terrain (CFIT).** ABBOT 2 entered the sea at a high speed but evidence from the ADR/CVR indicated that the aircraft was not under control. The wreckage from ASTON 1 indicated that it had a much slower speed entry into the sea which would not have supported a CFIT hypothesis in this instance. The possibility of simultaneous CFIT through distraction or disorientation was considered, but technical evidence allowed the Panel to conclude this was **not a factor** in the accident.

e. **Fatigue.** The accident involved two aircraft and four aircrew, it is possible that fatigue could have affected any or all of the crewmembers. The Panel investigated the impact a short sleep window had on the ABBOT 2 FS Pilot, the cumulative effect of poor rest on the ASTON 1 WSO along with the levels of fatigue that the other crewmembers experienced. Fatigue is prevalent on a busy Sqn, especially with student pilots, and was being monitored by the Flying Executive and through careful analysis. The Panel concluded that fatigue was **not a factor** in the accident.

f. **Collision.** Through initial evidence gathering and elimination of alternative causes, collision was identified as the most likely accident mechanism and warranted investigation.

The hypothesis was soon supported by physical evidence and the Panel's analysis is discussed in this section.

Structure of the Analysis and Findings

1.4.0.8 The analysis and findings are grouped in seven sections under the headings:

a. Section 1.4.1 – Pre-existing Conditions

b. Section 1.4.2 – Sortie Planning, Briefing and Outbrief

c. Section 1.4.3 – Sortie (ASTON 1)[3]

d. Section 1.4.4 – ASTON 1 and ABBOT 2 Collision

e. Section 1.4.5 – Collision Aftermath and Follow On Action

f. Section 1.4.6 – Other

[3] Due to ABBOT 2's sortie being approx 5 mins in duration, it is incorporated within the section ASTON 1 and ABBOT 2 Collision. ASTON 1 had a much longer sortie prior to the accident.