SECTION 1.4.4 – ASTON 1 AND ABBOT 2 COLLISION

1.4.4.1 The accident involved two aircraft from different formations. Together, the formations numbered four aircraft and eight crewmembers. The actions of the eight crewmembers, interwoven with the maintenance and Flypro of the four aircraft create a complex picture. Further complication was added by personnel performing multiple supervisory duties due to half of the Sqn having deployed to Cyprus on exercise. The similarity of the formation call signs, ASTON and ABBOT, can create confusion.

1.4.4.2 The crews were allocated as follows. The descriptors in the left hand column will be used to describe each crewmember throughout the report:

a. **ASTON 1 – ZD743**
   - Pilot: Student Pilot. (Deceased)
   - WSO: OC B Flight (Programming), Stand in OC XV(R) Sqn, Qualified Tactics Instructor (QTI). (Deceased)

b. **ASTON 2**
   - Pilot: Student Pilot.
   - WSO: Sqn WSO, QTI. Set the scenario for ASTON sortie.

c. **ABBOT 1**
   - FS Pilot: Student Pilot.
   - RS Pilot: Supernumerary Sqn Ldr on XV(R) Sqn, Qualified Weapons Instructor (QWI), was 1st Duty Authoriser, gave phase brief to student pilot before going flying.

d. **ABBOT 2 – ZD812**
   - FS Pilot: Student Pilot. (Deceased)
   - RS Pilot: STANEVAL(Synthetic). QWI. Led the plan for ABBOT sortie. (Survived)

*Introduction*

1.4.4.3 Section 1.4.4 covers ASTON 1’s sortie from descent into the Moray Firth environs to the collision and ABBOT 2’s sortie in its entirety. It is divided as follows:

a. ASTON 1 Sortie
b. ABBOT 2 Sortie
c. Traffic Information/Secondary Surveillance Radar (SSR)
d. Air Weapons Range (AWR) Usage
e. Weather
f. Final 2 Mins of Flight
g. Collision Warning System (CWS)
h. Summary of Factors leading to the Collision of ASTON 1 and ABBOT 2
Continuing from Section 1.4.3, ASTON 1 had descended over the sea and remained on Tain Secondary frequency with the expectation that they would shortly be cleared to enter Tain AWR. The Tain AWRC, however, believed that ASTON 1 had gone off frequency for their let down to LL with another agency.

This sub-section is divided as follows:

(a) Sortie Events

(b) Analysis

Sortie Events

As ASTON 1 were completing their descent over the sea they heard ABBOT 2 give a joining call to Tain AWR. ABBOT 2 confirmed with Tain that they would be "...joining downwind from Tarbat Ness." Immediately after the joining call, ASTON 1 entered a turn to the left; the WSO commented to the Pilot "just keep it in a left hand orbit here" and later "just continue the left hand orbit... see if we can banter our way in." ASTON 1 Pilot maintained the left turn. AWRC 1 cleared ABBOT 2 into the AWR, at which point ABBOT 2 stated "...and we will be coming in low level from Helmsdale initially." ASTON 1 Pilot stated "interesting" and ASTON 1 WSO transmitted "Tain ASTON 1, still holding between the rigs and Helmsdale at 1000 ft, looking to join for a Brora Op 5 and depart via The Cross if able to deconflict." The crew of ASTON 1 made no further comment, maintained their left hand turn and the two aircraft collided 7 secs later.

Analysis

ABBOT 2's joining call coincided with the end of ASTON 1's descent; ASTON 1 may not have wanted to interrupt the ongoing radio dialogue with an information call of their position and intentions at this stage.

ASTON 1 may have entered a left hand turn as a result of ABBOT 2's joining call, in order to remain clear of them. The vast majority of XV(R) Sqn aircrew interviewed, when given the same joining call (ABBOT 2), assumed that the route would take ABBOT 2 abeam Tarbat Ness on an academic Line Of Attack (LOA) of 249° or 253° (Figure 26), which is routinely used by RAF Lossiemouth crews. The Panel believes it is likely that ASTON 1 had the same mental model due to the joining call and believed that they would maintain separation by turning left. The Panel considered that this assumption was reasonable given the norms associated with local operating procedures.
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1.4.4.9 The facts that ASTON 1 had stayed on Tain’s Secondary frequency and the WSO’s comment of “...see if we can banter our way in.” led to the conclusion that the crew’s intent was to join Tain AWR. In contrast, and without knowledge of the in-cockpit comment, the Tain AWRC assumed that they had switched to a different ATC agency in order to let down to LL.

1.4.4.10 Following ABBOT 2’s radio call of “...and we will be coming in low level from Helmsdale initially”, ASTON 1 Pilot said “interesting”, but his tone of voice did not indicate concern. The WSO’s radio call, following almost immediately after, gave their location along with a request to Tain AWR to deconflict their AWR practices. Tain AWRCs can assist aircrew in establishing deconfliction through the use of height and/or geographical separation, both inside and outside of the AWR. The crew of ASTON 1 did not believe there was an imminent risk of collision. If they had, they would certainly have done something about it. They did, however, recognise that a collision risk might develop. By giving their current location, they made ABBOT 2 aware that if they continued N from E abeam Tarbat Ness, ASTON 1’s mental model, to join “…from Helmsdale initially”, they would need to deconflict with ASTON 1 who were already there.

ABBOT 2 Sortie

1.4.4.11 This sub-section is divided as follows:

a. Sortie Events
b. AWR Join
c. Regulation, Policy and Orders: Moray Firth Deconfliction and AWR
d. Analysis

e. Conclusions

Sortie Events

1.4.4.12 SUTTO. ABBOT 2 did not encounter any problems during SUTTO; the crew were able to complete the SUTTO in an unhurried, yet expeditious, manner. The FS Pilot radioed XV(R) Sqn Ops at 11:47 hrs just prior to taxi to check for updates to the late warnings. The FS Pilot confirmed that the High Intensity Strobe Lights (HISLs) were selected to the day setting of white prior to take off. ABBOT 2 commenced the take off roll at 11:55 hrs, just over 5 mins earlier than planned.

1.4.4.13 Serviceability. The RS Pilot confirmed that the RHWR was selected on. The GMR passed test during taxi and was used during the Pre Attack/Pre Range Checks. The crew did not mention to each other any issues relating to serviceability throughout the sortie.

1.4.4.14 Transit. Once airborne, the RS Pilot contacted RAF Lossiemouth ATC on the Departure frequency and was offered a Basic Service which is standard for departing traffic VMC; during this time the FS Pilot completed the After Take-Off/Departure Checks. Due to a number of omissions by the FS Pilot, the RS Pilot reinitiated the After Take-Off/Departure Checks in the “challenge and response” format. The crew then completed Pre-Low Level Checks and Pre-Attack/Pre-Range Checks. ABBOT 2 was established at an altitude of 450 ft proceeding on a track of 337° towards the Northern boundary of Tain AWR when the departure controller informed them of a change to the QFE. As the new QFE was being passed the crew were carrying out Pre-Attack/Pre-Range Checks for Strafe. The radio call prompted the RS Pilot to inform Lossiemouth Departures that they were en route. The departure controller replied “We’ve just got one track southeast bound at the north tip of Tain range no height information.” That track was ASTON 1; the controller did not know the height of ASTON 1 as the Secondary Surveillance Radar (SSR) was on maintenance. Lack of SSR and the effect on the accident is analysed in para 1.4.4.37. When the departure controller commenced the traffic information radio call, ASTON 1 was in a descent through 5400 ft. At the end of the radio call ASTON 1 was passing through 4600 ft at a range of 15 nm from ABBOT 2. The RS Pilot acknowledged the traffic information by responding “ABBOT 2”. The crew continued to complete the Pre-Attack/Pre-Range Checks. No further reference was made to the traffic information by the crew.

1.4.4.15 The Panel observed a difference between the timing of ABBOT 2’s Strafe Checks and the guidance provided by OC Standards, XV(R) Sqn who stated they should take place within the AWR: “Checks specific to strafe are done immediately prior to the strafe detail; either as part of the other pre-range checks if strafe is the first event, or after bombing/missile events if there are any of those first.” This advice was published in the Standards Flt newsletter in Nov 10; ABBOT 2 RS Pilot was unaware of this advice, stating that the newsletter was an “in-house XV(R) Sqn document” that he had not been privy to. The FCC checks are entitled “Pre-Attack/Pre-Range Checks” which could imply the checks are to be completed prior to joining the AWR. ABBOT 2 RS Pilot stated that: “…they’re written as part of the pre-range checks so I would do them before entering the range...” The Student Study Guide states that “Transit checks are carried out iaw FCCs. Additionally, the slip ball [yaw trim] is centered using the rudder trim at 450 kts. Those checks specific to

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1 After Take-off/Departure Checks consist of 12 monitored checks, Pre-Low Level Checks consist of seven challenge and response checks, Pre-Attack/Pre-Range Checks consist of ten challenge and response checks with an additional four checks for strafe although the fourth (Gun ARM) is not selected until inside an AWR pointing at a target.

2 QFE is a brevity code. In this instance the Departure controller is referring to a change to the altimeter setting that crews must set for operations at RAF Lossiemouth airfield.
Following the strafe checks, the crew discussed which radio frequency was required for Tain Secondary and the RS Pilot updated the aircraft computer to reflect that they were running 6 mins early. The RS Pilot contacted Tain Secondary, one minute 10 secs flying time from the Tain AWR boundary in order to request clearance to join. ABBOT 2 commenced a turn to the right away from the Tain AWR boundary 40 secs later, as they had not yet received clearance to enter. One minute 20 secs after ABBOT 2’s joining call AWRC 1 then cleared ABBOT 2 to enter. ABBOT 2 RS Pilot acknowledged the clearance, adding "...and we will be coming in low level from Helmsdale initially." Five secs later ASTON 1 WSO transmitted "Tain ASTON 1, still holding between the rigs and Helmsdale at 1000 ft, looking to join for a Brora Op 5 and depart via The Cross if able to deconflict." Seven secs later the aircraft collided.

**AWR Join**

1.4.4.17 **Tain AWR Background to Events.** When ABBOT 2 contacted AWRC 2 on Tain Secondary, AWRC 2 was also controlling Tain Primary on which a USAF F-15E, was conducting attack profiles on the 249° LOA. AWRC 1 walked the short distance from his desk to the console, put his headset on and asked AWRC 2 to confirm with ABBOT 2 that he was joining downwind, 04 right hand pattern, via Tarbat Ness. pattern required them to pass 1 nm N of Tarbat Ness. At this stage AWRC 1 was unsure of how ABBOT 2 intended to join but anticipated that it would be a similar LOA to pattern. were commencing their final pass. AWRC 1 obtained visual with , passing abeam Tarbat Ness, and assessed that ABBOT 2 would sequence behind . AWRC 1 took control of Tain Secondary and cleared ABBOT 2 to join. declared that they were complete on Tain Primary and commenced a climb to depart the AWR. Following ABBOT 2’s acknowledgment of the joining clearance and ASTON 1’s radio call of holding between the oil rigs and Helmsdale, AWRC 1 attempted to sequence the join in the order ASTON 1 then ABBOT 2.

1.4.4.18 **ABBOT 2 Joining Radio Call.** Table 4 contains a transcript of the radio calls between ABBOT 2 RS Pilot and AWRC 1 and 2. AWRC 1 stepped in to assist AWRC 2 part way through the dialogue by taking control of Tain Secondary.

<table>
<thead>
<tr>
<th>ABBOT 2 RS Pilot</th>
<th>Tain Range good afternoon ABBOT 2</th>
<th>ABBOT 2 Tain</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABBOT 2 RS Pilot</td>
<td>ABBOT 2 booked traffic, we’re looking initially to use the 04 right pattern for dive and strafe, request join for range rece, join downwind strike time 12:04:30.</td>
<td></td>
</tr>
<tr>
<td>AWRC 2</td>
<td>ABBOT 2 confirm you’re joining downwind from Tarbat Ness</td>
<td></td>
</tr>
<tr>
<td>ABBOT 2 RS Pilot</td>
<td>Affirm ABBOT</td>
<td></td>
</tr>
<tr>
<td>AWRC 2</td>
<td>ABBOT standby</td>
<td></td>
</tr>
<tr>
<td>AWRC 2</td>
<td>ABBOT 2 Tain, booked traffic on the range at this time just turning base on his final pass and then will be departing</td>
<td></td>
</tr>
<tr>
<td>ABBOT 2 RS Pilot</td>
<td>Understood what time is he booked ‘til?</td>
<td></td>
</tr>
<tr>
<td>AWRC 1</td>
<td>ABBOT Tain, he has just completed he’s just over target this time on his last pass prior to depart it’s an F-15E I’m not sure what his departure details are at this time continue inbound join downwind at Tarbat Ness, squawk 7002, QFE is 1009</td>
<td></td>
</tr>
</tbody>
</table>
ABBOT 2 RS Pilot | 7002, 1009 copied ABBOT 2 and we will be coming in low level from Helmsdale initially

Table 4. Transcript of Radio Calls (ABBOT 2, AWRC 2 and AWRC 1)

1.4.4.19 ABBOT 2 Timings. Tain AWRC were expecting ABBOT to join for a TOT of 12:10 hrs. ABBOT 2 had planned to achieve a TOT of 12:10:30 hrs, 30 secs behind ABBOT 1. ABBOT 2 launched just over 5 mins earlier than planned. Once airborne, ABBOT 2 was running 6 mins earlier than planned and would therefore achieve a TOT of 12:04:30 hrs.

Regulation, Policy and Orders: Moray Firth Deconfliction and AWR

1.4.4.20 RAF Lossiemouth FOB. The RAF Lossiemouth FOB states that:

“Aircraft transiting over the Moray Firth heading Northwards between Lossiemouth and the Helmsdale area (including ac leaving Tain AWR to the North) should fly at heights not above 500 ft MSD. Aircraft flying from North to South over the Moray Firth (including ac recovering from Tain AWR to Lossiemouth and ac joining Tain AWR from the North) should fly at heights not below 1000 ft MSD”

1.4.4.21 JSP 403 Handbook Of Defence Land Ranges Safety. JSP 403 mandatory information to be included in an AWR joining call is provided at para 1.4.3.59. JSP 403 states that it is mandatory for AWRC to pass “essential traffic information and precautionary warnings.”

1.4.4.22 ACAWEWROs. ACAWEWROs mandatory information to be included in an AWR joining call is provided at para 1.4.3.60. ACAWEWROs also mandate the “Passing of essential traffic information and precautionary warnings.” ACAWEWROs describe essential traffic information as:

“Essential Traffic Information. AWRC/RSOs are to advise joining, working and departing traffic of:

(1) All other known traffic inside the Air Danger Area.

(2) Significant known traffic adjacent to the range patterns being flown.”

ACAWEWROs also state:

“Joining ac [aircraft] are to establish 2-way Radio Telephony (RT) contact with the range by TOT minus 4 mins or Range Air Danger Area boundary minus 2 mins, whichever is the earlier.”

Analysis

1.4.4.23 On departure, ABBOT 2 received a Basic Service and almost immediately had to climb to avoid a layer of stratus and then returned to 450 ft. Concurrently the crew were completing checks in preparation for joining Tain AWR. The UK Airprox Board for the period Jan to Jun 11 noted that one of the main causes of military crews failing to see other traffic or a late sighting is: “the use of a quiet frequency or the selection of a Basic Service (BS) from ATC when a Traffic Service (TS) would be more appropriate to the flight profile. Frequently this is [done] to minimise the interruption to instructional sorties.”
1.4.4.24 ABBOT 2’s transit height of 450 ft was iaw the RAF Lossiemouth FOB. Weather was a factor in forcing both aircraft to fly in the height band around 1000 ft in the lead up to the accident. The effect the weather had on ABBOT 2’s transit height is analysed at para 1.4.4.51.

1.4.4.25 The Departure Controller passed Traffic Information to ABBOT 2 whilst they were in receipt of a Basic Service. Basic Service is defined in Civil Aviation Publication (CAP) 774 and states that the controller is not required to monitor the flight, pilots should not expect any form of traffic information and the pilot remains responsible for collision avoidance at all times. However, CAP 774 states: “if a controller...considers that a definite risk of collision exists, a warning may be issued to the pilot.”

1.4.4.26 ABBOT 2 contacted Tain Secondary one minute 10 secs before they planned to cross the AWR boundary. ACAWEWROs direct that crews must contact the AWR 2 mins prior to the AWR boundary. ABBOT 2 had planned an extended route to the AWR to complete checks and prepare for entry, but they did not manage to call Tain 2 mins before reaching the boundary. Although ABBOT had planned an extended route to the AWR, the crew did not contact the range in time as they prioritised completing all of their checks as opposed to interrupting their checks with a radio call. ABBOT 2 was forced to turn away from the AWR boundary when they arrived as they were not cleared to enter.

1.4.4.27 It is unlikely that the crew of ABBOT 2 had read JSP 403 recently, if at all. JSP 403 did not appear on the mandatory reading list for aircrew. Only a small section of JSP 403 is relevant to fixed wing aircraft. ACAWEWROs are on the mandatory reading list and crews are expected to have a good working knowledge of the document. The Panel observed that the JSP 403 mandatory joining call information differs from the ACAWEWROs mandatory joining call.

1.4.4.28 ABBOT 2’s joining call did not comply with JSP 403 in that it did not contain the number and type of aircraft. AWRC 2, however, would have known that ABBOT 2 was a Tornado GR4. The callsign ABBOT 2 would imply a single aircraft rather than a formation.

1.4.4.29 ABBOT 2’s joining call did not comply with ACAWEWROs in that it did not contain: Number of aircraft, Personnel On Board (POB) and Line or Sector of Attack. Tain AWRC’s familiarity with XV(R) Sqn and the Tornado GR4 meant that they knew the aircraft would always be operated by two crew. AWRC 2 later confirmed with them that they were joining “...downwind from Tarbat Ness.” although the routing that a crew could take to arrive at Tarbat Ness could vary significantly.

1.4.4.30 The frequency of use of Tain AWB by XV(R) Sqn made the Tain AWRCs familiar with the Sqn callsigns (and even individual voices). Knowing the Sqn callsigns, they felt they did not need to confirm the missing information; the behaviour of passing incomplete information went unchallenged and had become normalised.

1.4.4.31 The handover of Tain Secondary from AWRC 2 to AWRC 1 was brief, yet sufficient for the information that was passed. AWRC 2 believed that ASTON 1 had switched to RAF Lossiemouth to obtain a radar service to let down. As such, he did not believe he had any pertinent information on ASTON 1 to pass to AWRC 1. AWRC 1 was aware that an exchange with ASTON 1 had taken place, but did not know the detail. This would not be unusual as aircraft routinely call the range to obtain information as well as to join. An information call would likely require no further action.

1.4.4.32 Neither AWRC 1 nor AWRC 2 passed traffic information about ASTON 1 to ABBOT 2. Both JSP 403 and ACAWEWROs direct that AWRCs are to pass traffic information, but the AWRCs did not feel that the information they had about ASTON 1 fell...
into the category of information that needed to be passed. Tain AWR does not have any technical means to observe the position of aircraft joining or transiting by the AWR. The AWRCs were unaware of ASTON 1's position, height or intentions apart from joining the AWR once they were at LL. The small amount of information that they were given was only valid at the moment it was received. Throughout training, AWRCs and air traffic controllers are warned against passing expired traffic information. In order to pass current information they must have confirmation of the continued validity of that information by, for example, a radar display.

1.4.4.33 The Panel observed that US AWRCs monitor AWR users by either radar or Mode 3 (squawk) repeater displays. US AWRCs do not offer any ATS other than a Basic Service. However, the Situational Awareness (SA) provided by radar/Mode 3 repeater displays allows US AWRCs to provide traffic information to aircrew if they consider that a conflict could arise.

1.4.4.34 ABBOT 2's initial joining call was insufficient to highlight to ASTON 1 or the AWRCs that their intended routing was different from that which would be considered the norm.

1.4.4.35 AWRC 1 had a mental model that ABBOT 2 would be joining abeam Tarbat Ness from the E. It is routine for crews to join Tain AWR abeam Tarbat Ness on the academic LOAs of 249° and 253° (Figure 26). At this time, ABBOT 2 was actually 4 km N of ASTON 1, approaching the most northerly waypoint, between Helmsdale and the Beatrice oil rigs as shown in Figure 27. OC Standards, XV(R) Sqn considered it the norm to join on the 250° LOA, although he added that crews have the freedom to join from any direction to accomplish the training objectives; although, if he was to join abeam Tarbat Ness from a different direction to the norm he would state it on the radio.
Conclusions

1.4.4.36 The Panel concluded that because:

a. AWRC 2 assumed that ASTON 1 had changed frequency to RAF Lossiemouth in order to let down to LL.

b. ASTON 1 did not clarify that they were remaining on Tain Secondary frequency or provide a timely information call of their position.

c. AWRC 2 felt that he had no pertinent information on ASTON 1 to pass on to AWRC 1 or to ABBOT 2. The AWRCs did not make ABBOT 2 aware of ASTON 1.

d. ASTON 1 reasonably assumed, based upon the content of ABBOT 2’s joining call, that ABBOT 2 would be joining Tain AWR on an academic LOA of 253°. ASTON 1 did not recognise that they were operating in close proximity to ABBOT 2.

e. There was a lack of SA tools available to the AWRCs, ASTON and ABBOT to indicate the actual situation.

insufficient Situational Awareness was a contributory factor.

"Situation assessment is the process of acquiring data to understand or obtain a mental picture of the immediate environment; situational awareness refers to a person’s or mental picture of that environment. Situational assessment and situational awareness are closely related: at any point in time, the two are identical. Endsley (1995) lists 3 elements that form situational awareness, 1) perceiving the status, attributes and dynamics of relevant elements in the environment, 2) comprehending the significance of these elements, and 3) projecting current assessments to future status. Thus an operator would obtain situational awareness after receiving critical system-related information, understanding it and using the information to predict near-term system-state. Endsley (1995, 2000) argues that situational awareness is based upon elements of both operators and equipment..."  

Traffic Information/Secondary Surveillance Radar (SSR)

1.4.4.37 This sub-section is divided as follows:

a. What did the Traffic Information call from Lossiemouth Departures mean to ABBOT 2?

b. Actions of Departure Controller and ABBOT 2 with a Serviceable SSR

c. Analysis

d. Conclusions

What did the Traffic Information call from Lossiemouth Departures mean to ABBOT 2?

1.4.4.38 RAF Kinloss Monopulse Secondary Surveillance (MSSR) provides height and

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\[3\] Investigating Human Error: Incidents, Accidents, and Complex Systems, Barry Strauch, Pg 198

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Mode 3 squawk information for Lossiemouth ATC. Without the MSSR on the day, Lossiemouth departures could not provide height information as part of their ATC services. ABBOT 2 could have treated the traffic information call of “we’ve just got one track southeast bound at the north tip of Tain range no height information” in a number of ways.

1.4.4.39 The Panel considered the most likely option was that the crew were focused on completing the Pre-Attack/Pre-Range Checks for strafe and, despite understanding and acknowledging the radio call, it did not influence their course of action. Although the radio call provided a geographical reference to an area that the crew were intending to fly to, the crew may not have identified a need for action. An option to continue on track with a heightened scan rate for the traffic is a possibility, but the traffic was not mentioned by the crew, either on receipt of the information, nor again during the transit towards the area mentioned. Without height information, it was not specific enough for them to identify a risk. It is possible that the crew may have thought the traffic to be at medium or high level, or following RAF Lossiemouth FOB deconfliction measures (flying S at 1000 ft, whilst they flew N at 500 ft) and therefore would not require deconfliction.

Actions of the Departure Controller and ABBOT 2 with a Serviceable SSR

1.4.4.40 Departure Controller. At 11:58:12 hrs ASTON 1 commenced a descent at an average rate of 6660 ft/min. ABBOT 2 informed departures of their intention to proceed en route, to which the departure controller replied at 11:58:22 hrs “We’ve just got one track southeast bound at the north tip of Tain range no height information.” With a serviceable SSR the departure controller would have been able to recognise that ASTON 1 had commenced a descent and would, most likely, have informed ABBOT 2. For example, the radio call could have been amended to “We’ve just got one track southeast bound at the north tip of Tain range indicating five and a half thousand feet descending.” This amended traffic information call contains standardised content.

1.4.4.41 Crew of ABBOT 2. The actions of the crew of ABBOT 2 may have changed if the departure controller had informed them: “we’ve just got one track southeast bound at the north tip of Tain range indicating five and a half thousand feet descending.” The Panel considered the following options:

a. The crew would have understood the traffic information radio call but would not have changed their course of action. Given the experience, ability and currency of the crew, particularly the RS Pilot, this was unlikely. The geographical reference to the “…north tip of Tain…” coupled with the height information presents a definite conflict which would need to be resolved. The crew would have recognised the conflict if they had understood the traffic information.

b. The crew would have understood the significance of the traffic information radio call and taken a different course of action. As a minimum, the traffic and likely conflict would have warranted in cockpit discussion and heightened lookout. Other courses of action to improve/maintain SA include, but are not limited to, using the GMR to attempt to locate the other aircraft, asking Tain AWR if they were aware of any other traffic, remaining with the departure controller to obtain further information before switching to Tain AWR, or utilising both aircraft radios simultaneously to maintain communication with Tain AWR and RAF Lossiemouth departures.

Analysis

1.4.4.42 Had SSR been available, the departure controller would have included height information in the call. It is considered that traffic information, which had included height information, would have enabled the crew of ABBOT 2 to identify the potential for conflict.
and potentially change their COA.

Conclusions

1.4.4.43 The Panel concluded that:

a. If SSR was available, it is likely that the departure controller would have recognised ASTON 1’s descent and would have passed that information to ABBOT 2 and;

b. ABBOT 2 would have better understood the intentions of ASTON 1 had they been given height information. ABBOT 2 may have changed their COA;

therefore the lack of SSR was a contributory factor.

AWR Usage

1.4.4.44 Procedural drift:

“While a mismatch between procedures and practice almost always exists, it is never constant. The mismatch can grow over time, increasing the gap between how the system was designed (or imagined) and how it actually works. This is called practical drift: the slow, incremental departure from initial written guidance on how to operate a system. This is what lies behind procedural drift:

- Rules that are overdesigned...
- Emphasis on local efficiency or cost effectiveness pushes operational people to achieve or prioritize one goal or limited set of goals...
- Past success is taken as guarantee of future safety...
- Departure from the routine become routine”

1.4.4.45 The review of ASTON 1’s and ABBOT 2’s sorties highlights several omissions and inaccuracies relating to AWR procedures and practices. Both ASTON and ABBOT launched without knowledge of other AWR users. ASTON populated their warout with a different TOT from what they actually planned to achieve. Subsequently, ASTON 1 let down to LL, in Instrument Meteorological Conditions (IMC) for part of the descent, on the boundary of Tain AWR without a radar service and attempted to join during the handover from one user to the next. ABBOT 2 was late in contacting Tain AWR and was forced to turn away from the AWR as they had not received permission to enter the Danger Area. They believed that they had Tain AWR booked until 12:30 hrs, rather than 12:00 hrs.

1.4.4.46 The issues above were not unique to the day of the accident; a wider cultural issue surrounding AWR usage has developed. Although the Panel focused on TGRF (XV(R) Sqn), 1Gp and the AWRCs, it is likely this is not confined to the scope of this Inquiry. The 2nd DA expressed that going to Tain is a “...standard...” event. OC Standards, XV(R) Sqn acknowledged that “...people have not stuck so rigidly to those procedures [for FRA joining times]”. AWRCs commented that AWR usage has decreased over the last five years.

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5 In aviation, holding or flying a hold is a manoeuvre designed to delay an aircraft already in flight while keeping it within a specified airspace. It is usually a racetrack pattern based on a holding fix, which can be a beacon, a GPS position or within VFR it is usually a smaller pattern flown over something easily recognisable on the ground such as a bridge, lake or geographical feature.
since the retirement of Jaguar and Harrier aircraft and reduction in Tornado numbers, and that it is now commonplace for AWRs to go unused for several hours, if not days. In addition to the reduction in aircraft types and numbers of platforms, changes to weapon delivery profiles and the withdrawal of practice weapons have contributed to the decline in usage. Despite this decline, AWRs and the surrounding airspace still have potential to see increased air activity. The relatively short track from both TGRF Main Operating Bases (MOBs) to local AWRs, together with the added security blanket of ATC and AWRCs has allowed a degree of complacency to develop with regard to AWR timings, join/departure procedures and R/T.

8. HQ 1Gp owns the policy and orders relating to AWR usage and, as such, set the conditions for the user culture to develop. The Panel observed that ACAWEWROs do not reflect current operating practices. ASTON 1 sought to join from a locally known reporting point (Bora) and to depart via a feature found only on maps (The Cross), neither of which is mentioned in ACAWEWROs. It is considered that these actions are not unique to the 3 Jul and are symptomatic of a culture that has grown from 1 Gp direction (ACAWEWROs) and their adherence to it (by aircrew). Regarding Tain AWR, ACAWEWROs also states, “Joining Procedures. Entry to the Range is as below. Where appropriate crews are to report passing/abeam Tarbat Ness, Bonar Bridge or Invergordon Pier. a. VFR. VFR via the hold, where appropriate crews should contact Lossiemouth Approach for transit service.” 1 Gp have subsequently informed the Panel that the intent of the Tain AWR Joining procedure is for crews to contact Lossiemouth if they plan to enter the AWR from the VFR Hold, and not that all VFR entries should be via the hold as can be deducted from extant orders. The Panel consider the current language within para 8 Joining Procedures as confusing, do not reflect current operating practices, and should be amended. AWR Governance is discussed further in Part 1.4.6.

Conclusions

1.4.4.47 The Panel concluded that:

a. The AWR environment had changed over the past five years which had led to a general decline in adherence to orders and procedures;

b. AWR users perceive that some orders and procedures are no longer as relevant, and that the orders and procedures are in need of review;

c. Activity within Tain AWR has reduced with numbers of users having diminished. ASTON and ABBOT both launched without knowledge of other Tain AWR user bookings;

d. Range booking times are considered to be flexible, as there are rarely users booked immediately after or before one another. believed their booking ended at 12:30 hrs, rather than 12:00 hrs, and overran their booked time in the range;

e. The standard of information passed to the range has fallen. Records of Flight (warnouts) were inaccurate, and the content had limited relevance to the AWRCs. ASTON’s Record of Flight TOT differed from their actual planned TOT;

f. There are rarely other users in Tain AWR when an aircraft joins for a bootleg serial. The orders regarding when a bootleg can and cannot be requested are considered to be less relevant. ASTON 1 attempted to join Tain AWR via a “bootleg” procedure during the handover from one user to the next;

g. It had become acceptable to omit mandatory elements of AWR joining calls. The
joining calls of ASTON 1 and ABBOT 2 did not contain all of the required information;

h. From recent experience, users now expect AWRs to be inactive when they arrive. ABBOT 2 expected to be cleared to enter Tain AWR despite not giving the AWRC the required amount of notice when calling up. Similarly, ASTON 1 did not expect the AWR to be in use, so had not concerned themselves with whether their “bootleg” request would interfere with another join/departure;

1.4.4.48 Combined, these conclusions led the Panel to believe that degradation of safeguards as a result of procedural drift (of AWR procedures and practices) was a contributory factor.

Weather

1.4.4.49 Numerous sources provided descriptions and imagery of the weather in the Moray Firth environs. The weather picture was complex and it varied significantly between RAF Lossiemouth, Tain AWR and the vicinity of the accident site. A pictorial summary of the weather is at Figure 28.

Figure 28. Pictorial Summary of Weather at 12:41 hrs (the green dot represents the approximate position of the collision).

How Did the Weather Affect ASTON 1?

1.4.4.50 ASTON 1 had descended into the Moray Firth environs through layered cloud and fog at the Helmsdale coast. The WSO had made comment expecting the poor weather to extend down to the surface, yet both crew had identified that the weather in Tain AWR looked suitable for their FRA. ASTON 1 descended from ML to a height of approx 700 – 1000 ft initially through poor weather, which then improved and, as the aircraft did a 270°
turn, headed back into deteriorating weather once more. Visibility was reduced at times.

**How Did the Weather Affect ABBOT 2?**

1.4.4.51 ABBOT 2 had departed from Lossiemouth, which was enjoying improving weather conditions. Their planned route took them towards the fog bank which extended from the Helmsdale coast, and their transit height of 500 ft AMSL was not sustainable in VFR with the deteriorating weather on track. ABBOT 2 FS Pilot commented on the horizon which indicates that he had reduced visibility, and a height was selected to maintain VMC. The aircraft flew almost a 270° turn through the poor weather back towards the better weather.

**Final 2 Mins of Flight**

1.4.4.52 The final 2 mins of flight is broken down into three distinct periods (Figure 29). The effects of the geometry of the accident were considered together with the weather conditions. All timings given are with reference to the moment at which the aircraft collided. It is divided as follows:

a. Possible Factors Common to Periods 1, 2 and 3

b. Period 1 (-120 secs to -70 secs): ASTON 1 crossed in front of ABBOT 2

c. Period 1: Analysis

d. Period 2 (-70 secs to -40 secs): ASTON 1 and ABBOT 2 progressed to the NE

e. Period 2: Analysis

f. Period 3 (-40 secs to Collision): ASTON 1 and ABBOT 2 tracked inwards towards each other

g. Period 3: Analysis

h. Summary

i. Conclusions
Figure 29. Last 2 mins of Flight Broken Down into Periods 1 to 3.

Possible Factors Common to Periods 1, 2 and 3

1.4.4.53 Lookout Performance. Lookout performance could have been reduced during Periods 1, 2 and 3 due to:

a. Personal Readiness. ASTON 1 WSO's fatigue related to his medical condition (Section 1.4.1.107) and ABBOT 2 FS Pilot's short window available for sleep (fatigue) (Part 1.3.13) could have affected lookout performance:

(1) ASTON 1 WSO had recently conducted 15 sorties in which he experienced reduced anticipatory anxiety. There was no evidence from either colleagues or his Next of Kin (NOK) that indicated fatigue either on the days preceding the accident or on 3 Jul. Although he stated that he suffered from broken sleep due to anxiety of flying, there is no evidence to prove this had occurred prior to 3 Jul and this was, therefore, discounted.

(2) ABBOT 2 FS Pilot had a short window available for sleep, which was normal for him within his daily routine. Although 1Gp ASOs require aircrew to have 11 hours available for rest, of which eight hours must be available for uninterrupted sleep, it is the individual's responsibility to manage rest in order to achieve their tasks. Five hrs 30 mins is a short window available for sleep, however individuals have different rest requirements and it is their responsibility to manage it appropriately. There is no evidence that ABBOT 2 FS Pilot was suffering from fatigue or cumulative (chronic) fatigue from his sleep pattern. His trend of incorrect aircraft checks could be attributed to fatigue affected concentration; however on the balance of evidence the Panel has discounted fatigue as having affected ABBOT 2 FS Pilot's lookout.
b. **Workload.** The crews of ASTON 1 and ABBOT 2 completed a number of in cockpit tasks during the final stages of flight. As students with limited Tornado GR4 experience, ASTON 1 Pilot and ABBOT 2 FS Pilot could have had a perceived high workload. This could have reduced their capacity to conduct effective lookout.

c. **Experience.** Due to their lack of Tornado GR4 experience, ASTON 1 Pilot and ABBOT 2 FS Pilot may not yet have developed fully effective lookout. However, a review of both student pilots’ training folders showed no significant trends of poor lookout during previous sorties.

d. **Attention focused on Head Up Display.** Even though the pilots could have been “heads out”, they may not have seen the other aircraft due to focusing on information displayed in the Head Up Display (HUD).

e. **Diffusion of responsibility.** It is possible that the crews of both aircraft relaxed their lookout scan to an extent because they believed that the responsibility for avoidance was diffuse from them. In particular, this includes the assumption that Tain AWRCs would know of and warn them of any other traffic joining the range.

f. **Expectation.** The crews’ mental model, belief/reliance upon the Big Sky Theory⁸, and the crews’ knowledge of the local airspace and its users could have negatively affected their scan. The crews may have considered it unlikely that they would encounter any other aircraft. ASTON 1 had an expectation that ABBOT 2 would be joining Tain AWR on a 253° LOA abreast Tarbat Ness.

g. **Visual obscuration.** Each aircraft could have been obscured from view by canopy arches, wings, engine intakes, cockpit instruments and the FS Pilot. ABBOT 2’s aircraft also had a chip in the left hand windscreen quarterlight, which could have obscured the other aircraft or acted as a focal trap. It is possible that cloud may have completely obscured the other aircraft, or that poor visibility may have reduced the opportunity to acquire the other aircraft.

h. **Corrective Flying Spectacles and Contact Lenses.** ABBOT 1 FS Pilot had been issued with Corrective Flying Spectacles and contact lenses. ASTON 1 WSO had also been issued with Corrective Flying Spectacles. It was not possible to ascertain whether or not the aircrew were wearing Corrective Flying Spectacles or contact lenses during the accident sortie. The absence of Corrective Flying Spectacles and/or contact lenses at Post Mortem does not necessarily indicate that they were not worn. It is more likely that both aircrew were separated from their Corrective Flying Spectacles or contact lenses as a result of the accident.

**Period 1 (-120 secs to -70 secs): ASTON 1 crossed in front of ABBOT 2**

1.4.4.54 During Period 1, ASTON 1 crossed from right to left in front of ABBOT 2. The aircraft closed to within 3.6 km of each other before starting to diverge. Period 1 is illustrated in Figures 30 through 33.

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⁸ The “Big Sky Theory” is that two aircraft flying independently of each other are very unlikely to collide, as the three dimensional space in which they are operating is so large compared to the space which each aircraft occupies.
ASTON 1 descended from 1000 ft (-120 secs) to 700 ft (-111 secs).

Figure 30. Period 1 - ASTON 1 in the Descent.

ABBOT 2 RS Pilot established radio contact with Tain AWR at -114 secs and was in constant dialogue with the AWR until -83 secs. ABBOT 2 rolled out of a left turn at a height of 450 ft; ASTON 1, at 700 ft, crossed from right to left in ABBOT 2's 12 o'clock (clock code) at a distance of 6.3 km.

Figure 31. Period 1 - ASTON 1 Crossed in Front of ABBOT 2.

ASTON 1 Pilot commenced a turn to the left (-83 secs), to the NE. ASTON 1, at 685 ft, was in ABBOT 2's left 9.30 at 3.6 km; ABBOT 2 was at a height of 430 ft.

Figure 32. Period 1 - ASTON 1 and ABBOT 2 Close to 3.6 km.
ABBOT 2 FS Pilot climbed the aircraft from 400 ft (-95 secs) to 890 ft (-73 secs). ABBOT 2 FS Pilot commenced a turn to the right (-70 secs), to the NE. ASTON 1 was in ABBOT 2's left 7.30 at a range of 7.1 km. ASTON 1 was established in a turn to the NE. ABBOT 2 commenced a turn to the NE.

Figure 33. Period 1 - ASTON 1 and ABBOT 2 Divergent Flight Paths.

**Period 1: Analysis**

1.4.4.55 This analysis of Periods 1-3 is based upon the balance of evidence available to the Panel as, without experiencing the exact weather conditions at the time, it is impossible to take a definitive position on weather conditions, visibility and actions of the two aircraft and crews. This can therefore appear subjective, however the analysis is based upon ADR and CVR data that give impressions of the weather and the dynamic decisions that were being made at the time. There were no HUD tapes recovered, however the Panel could interrogate a HUD tape of an aircraft that arrived at the scene 14 minutes after the collision. The Panel has a high level of confidence of the weather picture. What should be taken into consideration whilst analysing this section is:

   a. There was a complex weather picture, which has been built from several different reports but which support the Panel's analysis;

   b. fast moving aircraft can move in and out of different weather conditions very quickly;

   c. the geometry of the two aircraft was also changing at a fast rate;

   d. the only surviving crewmember of the accident aircraft has no recollection of events.

1.4.4.56 ASTON 1 WSO stated “throw a 90 right in and we'll just see what the weather is going to be like”, the Pilot turned ASTON 1 to the right. During the initial stages of Period 1, the crew of ASTON 1 could have been looking right towards Tain AWR to assess the weather; at this time ABBOT 2 was out to the left of ASTON 1.

1.4.4.57 At the same time, ABBOT 2 rolled out of a left hand turn. If the crew of ABBOT 2 had checked their “dead wing”, as would be expected following a turn, then the crew of ABBOT 2 would have looked to the right; at this time ASTON 1 was out to the left of ABBOT 2.

1.4.4.58 ABBOT 2's RHWR could have provided the crew with a visual cue, alerting them to the presence of ASTON 1. During a simulation of the collision, ABBOT 2's RHWR briefly displayed a visual cue at the start of Period 1. The crew of ABBOT 2 did not comment on the RHWR during Period 1.
1.4.4.59 The Tornado GR4 simulator always displays a "T tag" for Tornado; in reality, it is much more likely that an ambiguous threat symbol would be displayed. However, it is highly likely that that staff instructors would know which threat emitters are ambiguous with the Tornado GMR or could have interrogated the warning to identify Tornado amongst the ambiguous emitters.

1.4.4.60 ASTON 1's RHWR was unserviceable. Given a serviceable RHWR and the geometry of Period 1 it is considered likely that ASTON 1's RHWR would have either displayed a visual cue or a visual and audio cue. However, aircrew have reported that the RHWR often presents information that is erroneous or irrelevant. Nevertheless, a RHWR cue could have been sufficient for ASTON 1 to have changed their COA from that of the accident sequence. Courses of action could have included increasing lookout (alerted search) or immediately transmitting a radio call.

1.4.4.61 The CAM Human Factors Report noted that "It was reported that the RHWR was often unserviceable and often presented information that was erroneous or irrelevant. Thus, aircrew reported that they did not scan the RHWR very often unless in a threat or electronic warfare training situation... As a result, the RHWR may not have been fulfilling its role as mitigation for deconfliction and its failure to be used would have reduced the likelihood of target detection." The Panel considered that although a serviceable RHWR could have aided either or both crews, it might not have been scanned and cues could have been ignored or discounted.

1.4.4.62 It was considered likely that during some part of their descent, ASTON 1 was IMC which would have limited the opportunity for either crew to obtain visual contact. At a height of 900 ft, ASTON 1 WSO stated "it is going to be on the deck". It is considered likely that a short time after ASTON 1 had levelled they emerged into an area which was suitable for flight using visual references.

1.4.4.63 Paras 1.4.1.17 and 1.4.1.86 discuss a chip in the left quarterlight windscreen of ZD812, ABBOT 2's aircraft. ASTON 1 crosses ABBOT 2's left hand quarterlight from right to left into the chip. It could have obscured the view of ASTON 1 as it crossed the chip. Given the high crossing rate, it would have been a momentary obscuration.

1.4.4.64 ASTON 1 descended over the sea in accordance with the MMATM and 1Gp ASOs, with the possible exception that they levelled at 700 ft. The crew may have been intending to level at 750 ft, but overshot. The MSD for a Radalt descent (in IMC) is 750 ft. Levelling at 700 ft, rather than descending further towards 250 ft, could indicate that ASTON 1 was IMC. However, it could also indicate that the crew may have considered that they would have a short hold before entering Tain AWR and wanted to remain at a more comfortable altitude. The Panel believes that it is more likely that ASTON 1 levelled at 700 ft as they overshot the 750 ft target in poor weather.

1.4.4.65 The crew of ASTON 1 checked height in the descent every 100 ft below 1000 ft, iaw the TGRF Handbook. The crew of ASTON 1 could have been focused on aircraft instruments to the detriment of their lookout.

1.4.4.66 ABBOT 2 RS Pilot commenced a radio call to Tain AWR just prior to the aircraft rolling out of the turn to the left. The radio dialogue lasted for 31 secs, during which time ASTON 1 and ABBOT 2 closed to a distance of 3.6 km. It is likely that ABBOT 2 RS Pilot looked in cockpit during some of this time as a TOT was passed which might have involved ABBOT 2 RS Pilot looking down at his mission materials or interrogating the aircraft Main Computer. In their analysis on the effectiveness on "See and Avoid", CAM documents that

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7 "on the deck" referring to cloud or fog all the way down to the surface/ground.

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tasks, such as speaking on a radio, can also adversely affect lookout.

1.4.4.67 The crew of ASTON 1 remained silent during ABBOT 2 FS Pilot’s radio dialogue with Tain AWR. It is possible that the crew concentrated on the radio dialogue, which could have adversely affected their lookout. Conversely this could have cued their lookout to the direction they thought ABBOT 2 were attempting to enter the range from, which differed from their actual location and direction.

1.4.4.68 As previously discussed in para 1.4.4.8, it is likely that the crew of ASTON 1 believed ABBOT 2 to be further to the S. Therefore, the crew of ASTON 1 could have biased their lookout to the front sector while ABBOT 2 was in the left sector to rear sector.

1.4.4.69 At the same time, ABBOT 2 FS Pilot may have focussed his lookout directly ahead and to the right; ASTON 1 was in the left sector to rear sector of ABBOT 2. ABBOT 2 FS Pilot may have focussed his attention directly ahead due to the fog and stratus bank. It is considered that ABBOT 2 FS Pilot commenced a climb to avoid the fog and stratus bank. Furthermore, as ABBOT 2 had not yet been cleared to enter Tain AWR, ABBOT 2 FS Pilot could have biased his lookout to the right anticipating that he may have to turn away from the AWR boundary. ABBOT 2 FS Pilot stated “we won't enter the range before we're cleared” and commenced a turn to the right.

1.4.4.70 One or more of the aircrew may have visually acquired the other aircraft during Period 1 but did not say it due to the aircraft trajectories. This was discounted as it was considered that had a crew member visually acquired the other aircraft they would certainly have brought it to the attention of the other crewmember.

**Period 2 (-70 secs to -40 secs): ASTON 1 and ABBOT 2 progressed to the NE**

1.4.4.71 During Period 2, ASTON 1 and ABBOT 2 progressed to the NE at a distance of between 7.1 km and 13.2 km from each other. Period 2 is illustrated in Figures 34 and 35.

Figure 34. Period 2 – Start (-70 secs).
ASTON 1 commenced a roll out from a left turn (-54 secs), then established a further left turn (-40 secs). At -49 secs, once ASTON 1 had rolled out of the first left turn, ABBOT 2 FS Pilot stated "ok, still happy with the horizon at the moment."

Figure 35. Period 2 – ABBOT 2 FS Pilot “OK, still happy with the horizon at the moment”.

**Period 2: Analysis**

1.4.4.72 It is likely that as the aircraft progressed to the NE, ABBOT 2 was in an area of poor weather. During this time the aircraft were predominately between 9 km and 13 km apart. It was considered that poor visibility or the tops of the fog and stratus bank could have prevented the crews of ASTON 1 and ABBOT 2 from visually acquiring each other.

1.4.4.73 ABBOT 2 FS Pilot stated “OK, still happy with the horizon at the moment.” The Panel understood this to mean that ABBOT 2 FS Pilot was still content to fly visually but the weather conditions were marginal. ABBOT 2 RS Pilot did not make any comment on the weather conditions. Visibility may have been less than the 5 km minimum of VMC\(^a\) required to fly VFR. It is also possible that ABBOT 2 was not 500 ft clear of cloud vertically. The crew may have considered that the weather conditions were transient and that they were about to turn back to the E to an area of better weather.

1.4.4.74 It was likely that ABBOT 2 crew’s focus was on entering Tain AWR. The RS Pilot was in communication with Tain AWR whilst the FS Pilot flew the aircraft and was heard to be focusing on external cues. The Panel believes that ABBOT 2’s workload, although not excessive, given their uncued attention to traffic in the vicinity and their focus on the AWR, was sufficient, on the balance of probabilities, to affect their lookout priority.

1.4.4.75 ASTON 1 rolled out of the left turn at -54 secs. If the crew of ASTON 1 checked their “dead wing” on roll out, as would be expected following a turn, the crew of ASTON 1 would have looked to the right; at which time ABBOT 2 was out to the left of ASTON 1.

1.4.4.76 For a proportion of Period 2 the aircraft appear to be on a constant relative bearing. This would mean that as the aircraft were 13 km apart, and given the weather conditions, with little or no relative movement each aircraft would have been very difficult to detect.

**Period 3 (-40 secs to Collision): ASTON 1 and ABBOT 2 tracked inwards towards each other**

1.4.4.77 During Period 3, both ASTON 1 and ABBOT 2 maintained very similar angles of bank, height and speeds towards each other as illustrated in Figures 36 through 39.

\(^a\) For Class G airspace, at or below 2000 ft in the UKLFS weather minima required is 5 km visibility, 1500 m horizontally and 500 ft vertically clear of cloud.
ASTON 1 and ABBOT 2 turned inwards towards each other from a range of 13 km.

Figure 36. Period 3 – Start (-40 secs) ASTON 1 and ABBOT 2 are turning inwards towards each other.

Between -40 secs and -28 secs AWRC 2 cleared ABBOT 2 to join Tain AWR.

Figure 37. Period 3 – Positions at the end of AWRC’s joining clearance radio call.

Between -26 secs and -19 secs ABBOT 2 RS Pilot replied to the joining clearance: "...and we’ll be coming in low level from Helmsdale initially."

Figure 38. Period 3 – Positions at the end of ABBOT 2’s radio call “...Helmsdale initially.”
Between -16 secs and -7 secs ASTON 1 WSO transmitted an information call: "...still holding between the rigs and Helmsdale at 1000ft..."

Figure 39. Period 3 – Positions at the end of ASTON 1’s radio call “...still holding between the rigs and Helmsdale at 1000ft...”

1.4.4.78 The aircraft collided 7 secs later. ASTON 1 was in a 48° angle of bank turn at 384 kts. ABBOT 2 was in a 57° angle of bank turn at 448 kts.

Period 3: Analysis

1.4.4.79 The Panel believes that ABBOT 2 FS Pilot did not roll out during the initial stages of Period 3, to check the “dead wing”, due to being cleared to enter Tain AWR and a desire to expedite the AWR detail. They may also have wanted to route to an area of better weather without delay given the weather conditions.

1.4.4.80 During the inwards turn both aircraft maintained approximately 800-1000 ft. The Panel considered that both crews may have attempted to fly at 1000 ft as it is a whole number above the fog and stratus bank and aircrew constantly strive to fly to accurate and often whole number parameters.

1.4.4.81 Aircraft in the area following the accident reported the cloud tops to be at 800-1000 ft. The fog and stratus bank may have obscured both ASTON 1 and ABBOT 2 from each other for a large proportion of Period 3. Aircraft also reported that there was no cloud immediately above the fog and stratus bank where the aircraft collided. The Moray Firth Hindcast reported cumulus cloud with bases of 1500-2000 ft in the SW of the area and cumulus cloud could be seen over the Helmsdale region. Cloud could have had a funnelling effect, causing both aircraft to fly at a similar height above the fog bank and below the cumulus cloud, even if the cumulus cloud was not in the immediate vicinity of the collision.

1.4.4.82 It was considered that ABBOT 2 RS Pilot’s radio call (-20 secs) “...and we will be coming in low level from Helmsdale initially” is the first time that the crew of ASTON 1 and Tain AWRCs realised that ABBOT 2 was joining the range from the NE, rather than on a 253° LOA abeam Tarbat Ness.

1.4.4.83 The Panel believes, based on the previous communications from ABBOT 2 about joining the AWR, the crew of ASTON 1 had a mental model that ABBOT 2 was to their S, abeam Tarbat Ness, routing to the N. But ABBOT 2 was actually 7.2 km to their W; the aircraft were 20 secs from collision. ASTON 1 Pilot stated “interesting” and ASTON 1 WSO gave an information call stating their position (-12 secs), FRA profile, departure details and requested that Tain AWR deconflict their range practises (-7 secs).

1.4.4.84 ASTON 1 WSO’s radio call: “...still holding between the rigs and Helmsdale at 1000ft...” was the first time that ABBOT 2 and the Tain AWRCs had an awareness of...
ASTON 1’s position, height and that they were on Tain Secondary frequency. The aircraft were 7 secs from collision. This was sufficient information to refocus ABBOT’S priority to lookout, but without any specific cues, it was reasonable not to expect emergency control inputs to avoid potential collision.

An assessment of cockpit obscuration suggests that the last time that it would have been possible, excluding the effects of weather, for ASTON 1 to see ABBOT 2 would have been at -15 secs shown in Figure 40. The distance between the aircraft was 5.5 km.

Figure 40. Period 3 – Last Opportunity for ASTON 1 to see ABBOT 2.

It is assessed that the last time that ABBOT 2 would be able to see ASTON 1, excluding the effects of weather, would have been -13 secs as shown in Figure 41. The distance between the aircraft was 4.5 km.

Figure 41. Period 3 – Last Opportunity for ABBOT 2 to see ASTON 1.

1.4.4.85 The chip in ZD812’s quarterlight was not a factor in Period 3. ASTON 1 does not appear in the left hand quarterlight during this period.

1.4.4.86 During the final stages each aircraft was “belly up” to the other. Both aircraft were obscured from the view of the other for the last 13 secs of flight.

1.4.4.87 In the last 7 secs, both crews remained silent and both aircraft’s flightpaths remained unchanged. It is likely that both crews attempted to acquire the other aircraft visually. ABBOT 2 had remained in a turn for 265°; ASTON 1 had remained in a steady turn for 151°. During the later stages of Period 3, if either crew had performed a “dead wing” check, with weather permitting, they may have been able to visually acquire the other aircraft. This would, in hindsight, also have altered the geometry of the turn but the acquisition of the other aircraft could have occurred during Period 3 from a “dead wing” check within 5 km. As it was, obscuration meant that both aircraft were not visible to each other for the final 13 secs of flight.
Summary

1.4.4.88 Period 1 provided the best opportunity for the crews to visually acquire each other but there is no evidence that they did. Both crews' lookout is likely to have been affected by workload and the weather. The lookout of the crew of ASTON 1 was cued to the S due to an incorrect mental model of the location of ABBOT 2.

1.4.4.89 The only "alerted search" available to the crews could have been a brief cue from ABBOT 2's RHWR. The crew of ABBOT 2 did not comment on the RHWR. Given a serviceable RHWR and the geometry of Period 1 it is considered that had ASTON 1's RHWR been serviceable, it could have either displayed a visual cue or a visual and audio cue. However, the Panel also considered that although a serviceable RHWR could have aided either or both crews, it might not have been scanned, cues could have been ignored or discounted due to the often "erroneous or irrelevant" information displayed and the RHWR would have to be "coincidentally" scanning the right frequency at the time of illumination. Therefore cueing from the RHWR in this instance is unlikely, but possible.

1.4.4.90 The weather reduced the opportunity, and at times prevented the crews from visually acquiring each other during the final 2 mins of flight. The weather may also have provided a distraction for the crews, affecting their lookout scan.

1.4.4.91 Both aircraft remained in steady turns, "belly up" to each other during the final stages of flight. Each aircraft was obscured from each other during the final 13 secs of flight.

1.4.4.92 The crew of ASTON 1 had a mental model that they were laterally spaced from ABBOT 2 until the collision occurred.

1.4.4.93 The crew of ABBOT 2 became aware of ASTON 1's approximate position and height from ASTON 1 WSO's radio call between -16 secs and -7 secs, but did not alter their flightpath.

Conclusions

1.4.4.94 The crews did not see the other aircraft for the following reasons:

a. The effectiveness of their lookout was reduced by workload and a flawed mental model.

b. The geometry of the collision meant that the aircraft were physically obscured from view for significant periods.

c. There was poor weather in the area of Helmsdale that would have precluded VFR flight.

d. The weather limited the opportunity for the crews to visually acquire each other during Period 1.

e. The weather prevented the crews from visually acquiring each other during Period 2.

f. The weather limited the opportunity for the crews to visually acquire each other during Period 3.

g. The weather proved a distraction throughout Period 1 to 3, thereby affecting the
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crews’ lookout.

1.4.4.95 The Panel concluded that because there is no evidence that the crews managed to visually acquire one another and consequently took no avoiding action, the limitations of “See and Avoid” are a contributory factor.

1.4.4.96 The Panel also concluded that due to reduced visibility and conspicuity, the meteorological conditions in the Moray Firth were a contributory factor.

1.4.4.97 Furthermore, the Panel considered that although:

   a. mitigation of mid air collision is not the prime purpose of the RHWR;

   b. when fitted, the RHWR often displays “erroneous or irrelevant” information which could be ignored or discounted by crews;

   c. although the TGRF Handbook details the use of the GMR and RHWR to aid conspicuity and SA, it is considered that crews do not often use the RHWR outside of Electronic Warfare training; that

a. had ASTON 1 received a visual, or audio and visual, cue from a serviceable RHWR they could have changed their COA from that of the accident sequence;

therefore the Panel concluded that ASTON 1’s lack of RHWR was a contributory factor.

Collision Warning System

1.4.4.98 This sub-section is divided as follows:

   a. Description of CWS/ACAS II/TCAS II

   b. EUROCONTROL

   c. Means of Analysis

   d. Results

   e. Conclusions

Description of CWS/ACAS II/TCAS II

1.4.4.99 Airborne Collision Avoidance System II (ACAS II) is an airborne avionics system that acts as a last resort safety net to mitigate the risk of mid air collision. ACAS II is designed to work both autonomously and independently of the aircraft navigation equipment and any ground systems used for the provision of air traffic services. It also compensates for many of the limitations of “See and Avoid”.

1.4.4.100 TCAS II (Traffic alert and Collision Avoidance System II) is the only commercial implementation that meets the standards and recommended practices for ACAS II. Therefore the term ACAS II is typically used when referring to the standard or concept, whilst TCAS II is used when referring to the implementation. In military parlance, the term Collision Warning System (CWS) is used to describe an embodiment of a collision avoidance system. Over the years, this description has been applied to bespoke military systems as well as those based purely upon the ACAS II specification. In this report, the terms ACAS (the standard), TCAS (the commercial implementation) and CWS (the product)
are used synonymously unless specifically noted.

1.4.4.101 ACAS II compliant systems can issue two types of alerts:

a. Traffic Advisory (TA). These aim to help the pilots in the visual acquisition of an intruder aircraft, and to alert them to be ready for a potential Resolution Advisory.

b. Resolution Advisory (RA). These are instructions to perform avoidance manoeuvres. When an intruder aircraft is also fitted with an ACAS II compliant system, both systems coordinate their RAs in order to provide complimentary resolution instructions.

1.4.4.102 CWS track aircraft in the surrounding airspace through interrogation of Identification Friend or Foe (IFF) transponders. If the system diagnoses a risk of impending collision it issues a RA to the flight crew which directs how best to regulate or adjust their vertical speed so as to avoid a collision. Experience, operational monitoring and simulation studies have shown that, when followed promptly and accurately, the RAs issued by CWS significantly reduce the risk of mid air collision.

1.4.4.103 European Union Mandate. The carriage of ACAS II Ver 7.0 compliant TCAS has been mandated in Europe since 1 Jan 05 for all civil fixed-wing turbine-engined aircraft having a maximum take off mass exceeding 5700 kg or a maximum approved passenger seating configuration of more than 19. The Tornado GR4 maximum take off mass is 28,500 kg. The rule applies only to civil aircraft.

1.4.4.104 ACAS Display. The ACAS display depicts the position of nearby traffic, relative to the aircraft in which it is fitted. It indicates the relative horizontal and vertical position of other aircraft based on the replies from their transponders.

1.4.4.105 The normal altitude band for display of traffic is ±2700 ft from own aircraft. A selectable mode may be provided to display traffic ±9900 ft the equipped aircraft. TCAS II can simultaneously track 30 aircraft within a nominal range of 14 nm, or 30 nm for Mode S IFF equipped aircraft.

1.4.4.106 In order to limit Radio Frequency pollution, TCAS II performs active interrogation in two ways:

a. Once every TCAS II cycle (every second) if criteria indicate an increased risk of collision.

b. Once every 5th TCAS II cycle (every 5 secs) known as "reduced surveillance" if criteria indicate a reduced risk of collision. Aircraft subject to "reduced surveillance" are not displayed as "Other Aircraft".

1.4.4.107 Figure 42 illustrates Other Aircraft, Proximate Aircraft, Intruder Aircraft and Threat Aircraft as displayed on TCAS II.
Traffic display symbology
On the TCAS traffic display both colour and shape are used to assist the pilot in interpreting the displayed information.

The background to the display is dark.

Own-aircraft is depicted as a white or cyan (light blue) aircraft-like symbol. The location of own aircraft symbol on the display is dependent on the display implementation.

Targets are displayed by different symbols, according to their threat status:
- **hollow cyan (light blue) or white diamond**\(^1\) – for other traffic.
- **solid cyan (light blue) or white diamond** – for proximate traffic.
- **solid yellow or amber circle** – for Intruders (i.e. aircraft which trigger a TA).
- **solid red square** – for threats (i.e. aircraft which trigger an RA).

Traffic display symbology is shown in Figure 11.

Non-intruding traffic, which are within 6 NM and 1200 feet from own aircraft, are called proximate traffic and are differentiated from other traffic by a solid white or cyan (light blue) diamond. In the event of an advisory, this symbol indicates that the aircraft is not the Intruder generating the advisory, when the closest traffic may not necessarily be the most threatening. Each symbol is displayed according to its relative position to own aircraft. The display accuracy depends on the selected scale. When the 10 NM scale is in use the positional accuracy is approximately \(\pm 1\) NM in range and approximately \(\pm 10\) degrees in bearing.

\(^1\) The colour is distinct from the own aircraft symbol, i.e. if one is cyan the other is white, and vice versa.

Figure 11. Standardised traffic display symbology.

Figure 42. TCAS II Symbology.

1.4.4.108 The traffic display (Figure 43) depicts the position of nearby traffic, relative to the equipped aircraft. It indicates the relative horizontal and vertical position of other aircraft based on the replies from their transponders. Displayed traffic information also indicates Other, Proximate, TA, and RA status. The primary purpose of the traffic display is to aid the flight crew in the visual acquisition of transponder equipped aircraft.
1.4.4.109 **ACAS II Limitations.** ACAS II has been designed for civil aircraft and the surveillance requirements are based on typical performance envelopes of such aircraft. For example, vertical closing rates of 10,000 ft/min or closing speeds of 1200 kts are not supported. In general, the probability of detection depends on horizontal and vertical closing speeds, pitch and bank angles as well as traffic density. UK FJs routinely manoeuvre outside the design parameters.

1.4.4.110 The display of “Other Traffic” is a recommended rather than required functionality, and is not governed by stringent criteria. The lack of audible annunciation and subdued display means that unless the screen is being monitored, crew are unlikely to notice the arrival of “Other Traffic” immediately.

1.4.4.111 **Alert Inhibitions.** Aircrew attention can become saturated by spurious warnings and the design of ACAS II compliant systems takes into account the requirement to suppress spurious warnings by inhibiting RAs whilst close to the ground (for take off, and landing). Civil aircraft are generally not required, nor authorised, to fly at LL and therefore the inhibition of CWS during these phases conforms to normal usage. RAs are inhibited based on Radalt reported heights. All RAs are inhibited below 1000 ft (+/- 100 ft) and all aural alerts are inhibited below 500 ft (+/- 100 ft).

1.4.4.112 **Sensitivity Levels.** Linked to spurious warnings and aircrew saturation, there is a trade off between the protection that collision warning logic must provide and the unnecessary alarms linked to the predictive nature of the logic. This balance is provided by
a sensitivity level which adjusts the time before a potential collision at which a warning of potential intruders is produced.

1.4.4.113 The sensitivity level applied is dependent on the height of the TCAS II equipped aircraft, as the pilot would want the highest sensitivity in the region where there is the greatest risk of collision, and most notice to effect a change whilst minimising spurious alerts. Sensitivity level 2 (with 7 being the most sensitive) would apply to an aircraft in the height band of 0 ft to 1000 ft and the nominal time a warning would be presented would be 20 to 40 secs before the point where the two aircraft enter each others’ collision area, as shown in Figures 44 and 45.

1.4.4.114 The sensitivity level would also affect the criteria for displaying “Other Traffic”, with aircraft below 1000 ft displaying little or no traffic due to them being in the “reduced surveillance” sensitivity level.

Figure 44. ACAS II defined Horizontal Collision, Warning and Caution Areas.

Figure 45. ACAS II defined Vertical Collision, Warning and Caution Areas.

1.4.4.115 The system works on predictive logic. If headings, heights and speeds change, the prediction changes, and the system constantly reassesses potential intruders. If, within the time to the Closest Point of Approach (CPA) either aircraft were to alter course, this could negate the requirement for a warning, or conversely elevate the warning from a TA to
an RA. This means that, the more benign and predictable each aircraft’s flight path is, the more accurate the prediction, warning and advisory evasion manoeuvre is.

EUROCONTROL

1.4.4.116 EUROCONTROL is an organisation comprising of EU and Non-EU Member State stakeholders that supports them in achieving safe, efficient and environmentally-friendly air traffic operations across the European region. Until 2006, EUROCONTROL monitored CWS data, but the EUROCONTROL Experimental Centre has been discontinued and the CWS monitoring function is now part of the European Safety Programme. EUROCONTROL still collects CWS data from manual reporting, and have a simulation tool that analyses aircraft encounters from real aircraft data.

1.4.4.117 This simulation tool used is the Interactive Collision Avoidance Simulator (InCAS) and allows the user to prepare encounters from a number of standard radar tracks, configure CWS scenarios, run or playback CWS simulations, view a CWS encounter through simulated pilot or controller displays, analyse ACAS II specified behaviour requirements per scenario, and produce hard copies of the views of a CWS simulation. The InCAS results are based on a perfect ACAS II embodiment.

1.4.4.118 InCAS indicates when TAs or RAs would have been generated and it permits the building of scenarios to see how pilot responses to RAs could have changed the outcome of the situation. The Replacement Aircraft Data Recorder (RADR) data from this accident was used with InCAS to predict how an ACAS II compliant CWS would have performed.

Means of Analysis

1.4.4.119 The InCAS simulation was used to determine whether or not a ACAS II compliant CWS, fitted to both accident aircraft, would have produced traffic information, TAs or RAs in the course of this accident. It cannot be proven that the production of traffic information, TAs or RAs would have prevented the accident, but gives an understanding of what information could have been produced and how the crews could have reacted to it. Even had a CWS been fitted to each aircraft, questions remain as to whether or not the systems would have been serviceable on the day, switched on, and monitored.

1.4.4.120 The InCAS scenario was created using barometric altitude from both accident aircraft. It should be noted that both aircraft were, at the time leading to the accident, below 1000 ft AGL (i.e. below the altitude at which all RAs are suppressed).

Results

1.4.4.121 As one or both aircraft were below 1000 ft for the majority of the last phase of flying before the accident, their altitudes affected the timing of TAs and RAs and put each aircraft into the “reduced surveillance” criteria.

1.4.4.122 12:00:23 hrs (-39 secs9). The TCAS interrogated each aircraft every 5 secs, until the TCAS system identified a potential threat and thus a requirement for a faster update. This occurred approx -39 secs before impact where the interrogation adjusted to every TCAS II cycle (one second). This would have meant that the traffic could have been displayed as “Other Traffic” although there would not have been any audio indication of this. This point is displayed in Figure 46.

1.4.4.123 The simulation results showed that neither aircraft would have had any awareness of each other prior to this point, due to possible aerial blanking, the number of

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9 Time --n secs. indicates the time remaining until the collision.
tracks (there could have been many other tracks), and the overriding factor that one or both of them were below 1000 ft.

![Figure 46. Other Traffic Display at -39 secs.](image)

1.4.4.124 **InCAS Decode.** The generic CWS screens display the own aircraft in the centre of the circle, with traffic shown in relation to that position to aid visual acquisition. The figure above the hollow diamond shows the other aircraft’s height in relation to own aircraft.

1.4.4.125 The chart on the left is a plan view of the tracks of both ASTON 1 and ABBOT 2. The CWS logic has predicted that as both aircraft are maintaining a turn towards each other, and that the CPA could result in collision, the update rate has been upgraded to every TCAS II cycle.

1.4.4.126 The chart on the right is a horizontal plane view of the height profiles of ASTON 1 and ABBOT 2 showing the descent from ML for ASTON 1 and the climb from the 500 ft transit altitude of ABBOT 2.

1.4.4.127 **12:00:32 hrs (-31 secs).** If the aircraft had been displayed as Other Traffic at -39 secs, they would now alter to Proximate Traffic (solid cyan diamond symbols) when the criteria for Proximate Traffic generation was met.\(^\text{10}\) The aircraft are 6.0 nm laterally and 129 ft height separated. The corresponding TCAS II traffic displays are shown within Figure 47. There is no audio warning to this change in status.

\(^{10}\) The proximate aircraft is within 6 nm and 1200 ft from own aircraft.
1.4.4.128 12:00:40 hrs (-23 secs). A TA (announced "Traffic, traffic") is generated for each aircraft. The aircraft are 5.1 nm laterally and 132 ft height separated as shown in Figure 48. The TA remains displayed on the cockpit instruments until the collision occurs.
Conclusions

1.4.4.129 Had both aircraft been equipped with TCAS II, the crews could have been alerted of each other's presence at least 39 secs before the collision through the display of Other Traffic and then at 31 secs as Proximate Traffic. InCAS displays the worst case logic and Other Traffic could have been displayed earlier, but it is not possible to simulate how early. ASTON 1 and ABBOT 2 would have been given a TA, 23 secs before impact and an audio warning. Neither oral nor visual RA alerts would have been generated, since both aircraft were below 1000 ft AGL (where the generation and announcement of RAs is suppressed by TCAS II logic).

1.4.4.130 The latter stages of the aircrafts' flight path was benign and predictable, therefore the logic of the CWS could identify a possible conflict. A CWS based upon ACAS II has limitations as it was designed for CAT parameters. Fast Jets (FJs) often fly outside of such design parameters, in which current ACAS II embodiments may not be relied upon to make accurate predictions, or in which such predictions are inhibited. The simulations for this accident show that had ASTON 1 and ABBOT 2 been fitted with a ACAS II compliant CWS, they would have had improved SA, better cued lookout, and more accurate mental models.

1.4.4.131 During the analysis, the Panel identified that had both aircraft been above 1000 ft, the TCAS II logic would have displayed Other Traffic at -120 secs (during Period 1) and generated a TA at -115 secs at the point prior to ASTON 1 passing right to left in front of ABBOT 2 at 6.3 km. The reason that this was not generated from the accident data is because of the sensitivity level reduction below 1000 ft. If, however unlikely, the aircraft had continued upon the same COA, there would have been Proximate Traffic indication at -31 secs, a TA at -25 secs and a RA (ASTON 1 with announced “Climb, Climb” ABBOT 2 with an
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announced "Descend, Descend") at -19 secs. TCAS II assumes that both aircraft respond within 5 secs and pass each other at 0 secs with a vertical separation of 754 ft.

1.4.4.132 The Panel concluded that because:

a. a CWS would have indicated Other Traffic at -39 secs giving SA to both crews on the whereabouts and altitude of each other;

b. a CWS would have indicated Proximate Traffic at -31 secs had the same COA taken place, however unlikely;

c. a CWS would have indicated a TA at -23 secs had the same COA taken place, however unlikely;

d. policy from SDR 98 directed MoD to fit a CWS and a costed, effective and feasible solution could have been fitted by 2010;

a lack of CWS on Tornado GR4 was a contributory factor. The reasons for the lack of fitment of this particular system are considered in Section 1.4.6.

1.4.4.133 The Panel observed that the resolution and generation of traffic information for TCAS II equipped aircraft is markedly increased above 1000 ft and should be considered during sortie planning and execution.

Summary of Factors leading to Collision of ASTON 1 and ABBOT 2

1.4.4.134 This sub-section is divided as follows:

a. Factors affecting both aircraft

b. Factors affecting ASTON 1

c. Factors affecting ABBOT 2

d. Conclusion

Factors affecting both aircraft

1.4.4.135 The following factors influenced both crews:

a. SSR was unavailable, which meant ABBOT 2 did not receive height information on ASTON 1 and ASTON 1 WSO may have considered the lack of SSR in his decision to descend without a radar service into the Moray Firth environs.

b. The weather was marginal in places, affecting visibility and resulting in both aircraft following flight paths to minimise or avoid IMC conditions.

c. The culture surrounding the use of AWRs had encouraged procedural drift from published safeguards. This raised the level of risk.

d. Limitations of "See and Avoid" are well documented and the risk is mitigated through training and some equipment solutions; however there are many situations where such barriers remain ineffective.

e. A CWS was not available to either aircraft; it would have warned both aircraft of
each others' location and aided visual acquisition had the visibility allowed it.

f. Lack of an Electronic Planning (Deconfliction) Aid.

g. Shortcomings of the ergonomics and information display of the Auth's Desk and Ops Desk.

h. Poor supervision and deconfliction processes meant that neither aircraft knew of each others' intentions during an event that would guarantee their close proximity.

i. Geometry of the last 13 secs of flight resulted in neither aircraft being able to visually acquire each other.

Factors affecting ASTON 1

1.4.4.136 The following factors influenced ASTON 1:

a. Ineffective authorisation allowed ASTON 1 to embark on a sortie that did not deconflict with ABBOT.

b. ASTON 1 WSO was still suffering from flying anxiety, and although treatment was progressing the Panel could not rule out its influence on ASTON 1's airmanship decisions.

c. Had ASTON 1 received a visual, or audio and visual, cue from a serviceable RHWR they could have changed their COA from that of the accident sequence.

d. The ambiguous nature of ABBOT 2's radio call informing Tain AWR of their entry intentions gave ASTON 1 an incorrect mental model of his location.

e. Focus of attention on descent checks, monitoring weather in Tain AWR contributed to reduced lookout.

f. Not wanting to interrupt ABBOT 2's radio call, the security of the "Big Sky Theory" and their incorrect mental model of ABBOT 2 approaching the AWR from a different direction than expected contributed to them performing an alerted but un-cued search for ABBOT 2.

Factors affecting ABBOT 2

1.4.4.137 The following factors influenced ABBOT 2:

a. Focus of attention on pre-AWR checks, giving a joining call, monitoring weather conditions to the NE (when ASTON was to the W) and not hearing any transmission from or about ASTON 1, contributed to a situation where ABBOT 2 was totally unaware another aircraft was in the same vicinity.

b. Alerted and un-cued search in marginal weather conditions.

Conclusion

1.4.4.138 The Panel concluded that the cause of the accident was a lack of recognition of converging flight paths resulting in the controlled flight of both aircraft into the same airspace at the same time.