Ministry of Defence

Air Command Secretariat
Spitfire Block
Headquarters Air Command
Royal Air Force
High Wycombe
Buckinghamshire
HP14 4UE

[redacted]

Ref: FOI 2018/04400

By Email: [redacted]

26 April 2018

Dear [redacted]

Thank you for your email of 27 March 2018 requesting the following information:

*'A link or an e-mail copy of the Board of Inquiry or Service Inquiry for Tucano ZF44 on the 12 March 2009 at RAF Linton-on-Ouse.'*

I am treating your correspondence as a request for information under the Freedom of Information Act 2000 (FOIA).

A search for the information requested has now been completed within the Ministry of Defence (MOD), and I can confirm that information in scope of your request is held. Please see attached the Board of Inquiry (BOI) report into the Tucano ZF344 accident on 12 March 2009.

Under section 40 of the Freedom of Information (FOI) act, any personal data within the BOI has been redacted and is exempt from disclosure. Section 40 is an absolute exemption, therefore there is no requirement to consider the public interest in making a decision to withhold the information.

If you have any queries regarding the content of this letter, please contact this office in the first instance.

If you wish to complain about the handling of your request, or the content of this response, you can request an independent internal review by contacting the Information Rights Compliance team, Ground Floor, MOD Main Building, Whitehall, SW1A 2HB (e-mail CIO-FOI-IR@mod.gov.uk). Please note that any request for an internal review should be made within 40 working days of the date of this response.

If you remain dissatisfied following an internal review, you may raise your complaint directly to the Information Commissioner under the provisions of Section 50 of the Freedom of Information Act. Please note that the Information Commissioner will not normally investigate your case until the MOD internal review process has been

completed. The Information Commissioner can be contacted at: Information Commissioner's Office, Wycliffe House, Water Lane, Wilmslow, Cheshire, SK9 5AF. Further details of the role and powers of the Information Commissioner can be found on the Commissioner's website at https://ico.org.uk/.

Yours sincerely,

*[Original signed]*

Air Command Secretariat

~~RESTRICTED-STAFF~~

Copy No 1 of _____

Volume 1 of 3

# ROYAL AIR FORCE

# SERVICE INQUIRY
## INTO AN
# AIRCRAFT ACCIDENT OR INCIDENT

| | | | | | |
|---|---|---|---|---|---|
| DATE | 12 MAR 09 | LOCATION AND GRID REFERENCE | RAF LINTON-ON-OUSE | | |
| AIRCRAFT TYPE(S) | | MARK(S) | SERIAL NUMBER(S) | PARENT UNIT(S) | |
| TUCANO | | T1 | ZF344 | 1FTS, | |
| | | | | RAF LINTON-ON-OUSE | |
| NAME(S) OF PILOT(S) | | Fur G [redacted] | PARENT UNIT(S) | | |
| | | | | | |

| NUMBER OF CASUALTIES | | | | | |
|---|---|---|---|---|---|
| KILLED | | | INJURED | | |
| CREW | PASSENGERS | OTHERS | CREW | PASSENGERS | OTHERS |
| / | / | / | 1 | / | / |

~~RESTRICTED-STAFF~~

DAS/SIA/140/80/09/04

30 Jul 09

AOC 22 (Trg)Gp

**PART 1.1 - SERVICE INQUIRY INVESTIGATING THE ACCIDENT TO TUCANO T1 ZF344 ON 12 MAR 09**

1. The Service Inquiry panel assembled at Air Cmd on the 13 Mar 09 by order of AOC 22 (Trg)Gp for the purpose of investigating the accident involving Tucano T1 ZF344 as detailed in the convening order 20090313GPSI-U dated 13 MAR 09. The Panel has concluded its inquiries and submits the provisional report (including the record of proceedings and supporting paperwork) for the convening authority's consideration.

PRESIDENT

Signed ... [redacted] .....

MEMBERS

Signed ..... [redacted] ....

Signed ..... ....

2. The following inquiry papers are enclosed:

Part 1 (The Report)

| | |
|---|---|
| Part 1.1 | This Covering Note |
| Part 1.2 | Convening Order & TORs |
| Part 1.3 | Narrative of Events |
| Part 1.4 | Findings |
| Part 1.5 | Recommendations |
| Part 1.6 | Convening Authority Comments |
| Part 1.7 | Reviewing Authority Comments |

Part 2 (The Record of Proceedings)

| | |
|---|---|
| Part 2.1 | Diary of Events |
| Part 2.2 | List of Witnesses |
| Part 2.3 | Witnesses Statements |
| Part 2.4 | List of Attendees |
| Part 2.5 | List of Exhibits |
| Part 2.6 | Exhibits |
| Part 2.7 | List of Annexes |
| Part 2.8 | Annexes |
| Part 2.9 | Schedule of Matters not germane to the Inquiry |
| Part 2.10 | Master Schedule |

20090313-22GPSI-U

13 Mar 09

**CONVENING ORDER FOR SERVICE INQUIRY INTO ACCIDENT INVOLVING TUCANO**

1. A service inquiry is to be held under section 343 of AFA 06.

2. The purpose of this inquiry is to investigate the circumstances of the accident involving Tucano ZF 344 at RAF Linton-on-Ouse on 12 Mar 09.

3. The Inquiry Panel is to assemble at HQ 22 Gp, RAF High Wycombe on 13 Mar 09 at 1000 hrs.

4. The inquiry panel comprises:

President: Sqn Ldr [redacted].
Members: Flt Lt [redacted]
Flt Lt [redacted]

5. The legal advisor to the inquiry is Sqn Ldr [redacted]

6. The inquiry is to investigate and report on the facts relating to the matters specified in its Terms of Reference (TOR) and otherwise to comply with those TOR (attached at Annex A). It is to record all evidence and express opinions as directed in the TOR.

7. The following advisors/observers may attend the inquiry subject to the following conditions:

Sqn Ldr [redacted] and Sqn Ldr [redacted] DARS SI (Advisors) – unrestricted attendance.

Wg Cdr [redacted] RAFCAM Accident Investigator (Advisor) - unrestricted attendance.

Ms [redacted] RAFCAM HF Accident Investigator (Advisor) - unrestricted attendance.

8. Stn Cdr RAF Linton-on-Ouse is to provide facilities, equipment and assistance suitable for the nature and duration of the inquiry.

9. Costs are to lie where they fall.

[redacted]

R F GARWOOD
AVM
AOC 22 GP

ANNEX A TO
20090313-22GPSI-U
CONVENING ORDER
DATED 13 MAR 09

**TERMS OF REFERENCE FOR SI INTO ACCIDENT INVOLVING TUCANO ZF344**

As the nominated Inquiry Panel for the SI into the accident involving Tucano ZF344 you are to:

a. Investigate the circumstances of the accident to Tucano ZF344 at RAF Linton-on-Ouse on 12 Mar 09.

b. Determine the cause or causes of the accident and examine contributory factors.

c. Investigate and comment on relevant fatigue implications of those involved prior to the accident.

d. Ascertain if personnel involved were acting in the course of their duties.

e. Examine what orders and instructions were issued and whether they were complied with.

f. Determine the state of serviceability of relevant equipment.

g. Establish the level of training, relevant competencies and qualifications of the individuals involved.

h. Ascertain the value of loss/damage to the service and to civilian property.

i. Ascertain if aircrew escape and survival facilities were fully utilized and functioned correctly.

j. Identify if the levels of planning and preparation met the activities objectives.

k. Review the levels of authority and supervision covering the task during which the accident occurred.

l. Make appropriate recommendations.

20090416-22GPSITucano-U

16 Apr 09

**ADDENDUM TO CONVENING ORDER FOR SERVICE INQUIRY INTO ACCIDENT INVOLVING TUCANO ZF 344**

1. New TOR item (i) at Annex A.

[redacted]

R F GARWOOD
AVM
AOC 22 GP

ANNEX A TO
20090416-22GPSITUCANO-U
CONVENING ORDER
DATED 16 APR 09

**TERMS OF REFERENCE FOR SI INTO ACCIDENT INVOLVING TUCANO ZF344**

As the nominated Inquiry Panel for the SI into the accident involving Tucano ZF344 you are to:

a. Investigate the circumstances of the accident to Tucano ZF344 at RAF Linton-on-Ouse on 12 Mar 09.

b. Determine the cause or causes of the accident and examine contributory factors.

c. Investigate and comment on relevant fatigue implications of those involved prior to the accident.

d. Ascertain if personnel involved were acting in the course of their duties.

e. Examine what orders and instructions were issued and whether they were complied with.

f. Determine the state of serviceability of relevant equipment.

g. Establish the level of training, relevant competencies and qualifications of the individuals involved.

h. Ascertain the value of loss/damage to the service and to civilian property.

i. Ascertain degree of injury suffered by persons both Service and civilian.

j. Ascertain if aircrew escape and survival facilities were fully utilized and functioned correctly.

k. Identify if the levels of planning and preparation met the activities objectives.

l. Review the levels of authority and supervision covering the task during which the accident occurred.

m. Make appropriate recommendations.

## Part 1.3 Narrative of Events

All times local (Z)

### BACKGROUND

1. **Introduction**. On 12 Mar 09 at 1159 hrs, the Pilot took off from RAF LINTON-ON-OUSE in Tucano ZF344 to conduct a pre display season work-up sortie; comprising a Flat Display sequence followed by a Rolling Display sequence. The Flat Display was flown without incident and was followed by a 10 minute break. At 1219 hrs the ac was cleared to run in for the Rolling Display practice. The ac ran in for a low-level arrival before pulling up for a reverse stall turn. The initial pitch-up and initiation of the reverse stall-turn appear normal but the ac is then seen to enter a brief tail-slide followed by auto-rotation from the vertical. The aircraft recovered by falling on its back with the brief development of a spiral dive. As speed increased the aircraft was pulled out of the dive but a level attitude was only achieved extremely close to the ground and coincided with the pilot initiating ejection. The ejection was successful although the Pilot suffered injuries [redacted] The ac continued on heading across the airfield making several contacts with the ground at a low grazing angle before it impacted a fire extinguisher and came to rest on an area of grass within the bounds of RAF LINTON-ON-OUSE and was very badly damaged. [redacted]

Exhibit 25
Witness 1,3
Witness 1
Exhibit 25
Exhibit 1
Annex F
Annex C,I
Witness 4

2. **Aircraft History**. On the morning of 12 Mar 09, ZF344 had been flown for 1:30 fg hrs by an experienced QPNI performing close formation and tail chasing manoeuvres before descending to low level to practice fighting wing formation. When interviewed, the QPNI did not recall any abnormal handling characteristics and the aircraft returned serviceable and a Turn-Round servicing was performed by VT Aerospace (VT Aero) personnel. During this servicing the engine oil indication appeared over-full so a tradesman removed approximately a pint of engine oil.

Annex A
Witness 2
Exhibit 7
Witness 16

3. **Pilot Background**. The Pilot had been in post as a QFI at 1FTS since May 08 and was selected as the 2009 Tucano Display Pilot in Sep 2008. He was a multi-tourist pilot with over 1800 hrs total flying experience including just under 500hrs Harrier, just over 600hrs Tornado GR4 and just over 450hrs Tucano experience. At the time of the accident he had flown 16hrs in the previous 30 days and he was current to practice all of his displays.

Annex B
Witness 1,3
Exhibit 4,5

4. **Pre-Accident Events**. The display work-up began on 05 Jan 09 and the first 500ft MSD practice of the Full display was flown on 20 Jan 09. Work-up on the Rolling sequence commenced on 04 Feb 09 with

Exhibit 12

the first 500ft MSD practice on 17 Feb 09. At the time of the accident a total of 68 sequences had been flown below 5000ft; 23 of these were Rolling sequences, 10 of which were practiced at an authorised 500ft MSD.

5. **Previous 24 Hours**. The previous day the Pilot had flown one instructional sortie and then spent the evening at home with his family; he was well rested from previous duty and had consumed no alcohol during the previous 24 hrs. On the day of the accident he had completed a routine physiotherapist appointment and display administration. Witness 1,3

6. **Sortie Brief and Authorisation**. The Pilot had attended the Stn Met Brief and following a Sortie Brief with his Display Supervisor, he was authorised to conduct 'Aeros NB 500ft MSD' with the intention of practicing his Flat sequence followed by his Rolling sequence. During the Sortie Brief the Pilot and the Display Supervisor had discussed a problem with the Noddy Stall Turn from the previous practice and they had decided to revert to a previously practiced 2-Nod rather than 3-Nod manoeuvre. They had also discussed the on crowd wind and the adjustments required to the sequence to ensure that the ac did not infringe the crowd line. To assess this, the Display Supervisor decided that he would position himself on the 230 Metre line to watch that day's display practices. As was standard practice at 1FTS, the Pilot conducted his own Outbrief, which was monitored by the Duty Authoriser, before signing the Authorisation sheets and walking to the flight-line. Witness 1,3 Exhibit 3 Witness 1,3 Witness 1 Witness 10

7. **Sortie Pre-Accident Events**. The Pilot walked for the sortie prior to the allocation of his ac and waited at the flight-line. 1FTS were short of ac that day and the delay was further compounded by a requirement to remove over-filled engine oil found during the ac servicing. Consequently, the Pilot signed for ZF344 only 15 minutes before the start of his display slot. However, although this meant that he would need to make a 'rapid start' there is no evidence that this placed undue pressure on him prior to his display practice. VT Aero personnel assisted him to strap in, and after start-up, see-off checks were completed but only after the flight line mechanic had reminded the Pilot to remove his Ejection Seat Pin prior to the removal of the chocks. The ac taxied the short distance to Rwy 28 and took-off on time. After completing an inverted flight check and 'G' warm-up the Pilot was cleared to run in for his Flat Display practice which was completed uneventfully. He then held at approximately 3000ft at Initials for Rwy 03 for his planned 10 minute break during which time he conducted a short debrief with his supervisor on the ground and, as he had not flown ZF344 recently, he practiced a Reverse Stall Turn to check the ac handling characteristics. The Pilot was then cleared to run in for his Rolling Display practice. Witness 16 Exhibit 7 Witness 3,12 Witness 15 Exhibit 25 Witness 1,3 Exhibit 1 Witness 3 Exhibit 25

## ACCIDENT SEQUENCE

8. **Accident Events.** The Pilot began the first manoeuvre of his Rolling Display, a Reverse Stall Turn, close to his desired entry parameters of 100ft agl (ADR 158ft) and 180kts (ADR 172kts). With the intention of limiting the apex of the manoeuvre to just below his simulated cloud base of 1500ft agl, he selected the Throttle to Idle and the Airbrake Out on the pull-up. The Pilot then made an assessment of his speed and height gain once in the vertical and decided not to add power as he assessed he would achieve close to his planned apex height. The ac was then yawed to the right followed by a roll of 180 degrees prior to the intention of completing the Stall Turn with the aid of engine power. The ac achieved an actual apex, according to ADR Data, of 1,194ft (± 30ft) and at this stage the Pilot recognised that he had lost control of the ac and centralised the flying controls and selected the throttle to idle; the Airbrake remained Out throughout. The ac recovered by completing a short tail-slide before falling on its back and entering a brief spiral dive. The Pilot regained control of the ac as it passed approximately 900ft in a very nose low attitude and on recognising that the ac was well below the normal recovery height for the manoeuvre, he contemplated ejecting. The Pilot then saw his Display Supervisor on the ground directly in front of the ac and elected to initiate a maximum performance pull to avoid the ground. As the speed and available 'G' increased the aircraft was pulled out of the dive but a nose high attitude was only achieved extremely close to the ground and still sensing a descent, the Pilot initiated ejection.

Witness 3
Annex C,D
Witness 3
Annex C,D
Exhibit 1
Witness 3
Exhibit C,D
Witness 3
Exhibit 1

9. **Escape, Survival and Aircraft Impact.**

a. **Ejection.** The Tucano ADR does not record pitch angle or roll angle but video evidence indicates that the Pilot ejected with the ac in a wings level, slightly nose high attitude with no rate of descent; the speed was approximately 133kts and the height is estimated at ≤15ft AGL, which is within the safe survivable ejection envelope for the Mk 8LC Mk1 ejection seat. The Pilot remained conscious throughout the ejection and recalled looking down at the ac before feeling a sharp tug as the parachute canopy opened. He quickly became aware of the ground rushing up and of then hitting the ground. He had no time to prepare for the parachute landing or complete post-ejection drills; the time from ejection initiation to landing was approximately 5 secs and computer simulations predicted that he would have had an impact velocity of just under 9m $s^{-1}$; with 9m $s^{-1}$ or less being assumed as a survivable parachute landing velocity. After landing the Pilot tried to release himself from his harness as he was starting to be dragged by the parachute. At this point he became aware of significant pain from his left wrist and back and he had to release his harness by using

Exhibit 1
Exhibit C,D,E
Annex F
Witness 3
Exhibit 1
Annex F
Witness 3

only his right hand. He then elected to move no further and awaited assistance.

b. **Aircraft Accident Site**. The ac was pitched down by the ejection and impacted the ground several times at a low grazing angle as it headed across the grass, ac dispersal and taxiway before impacting a fire extinguisher and coming to rest on an area of grass approximately 150 m inside the airfield boundary. From initial impact to its final resting place ZF344 travelled over 400 m and was very badly damaged but no post crash fire was observed. The propeller, propeller hub and half of the engine gearbox had separated from the ac but the remainder of the airframe, including the fuel tanks, was largely intact.

Annex C
Exhibit 1
Annex 1
Annex I
Witness 20,21
Annex C,D

c. **Survival Aspects**. VT Aero personnel from the nearby flight-line ran to the aid of the pilot and they also deflated the parachute. The Crash Crews, who had been on standby for the display practice, were also quickly on the scene. Shortly afterwards personnel from the RAF LINTON-ON-OUSE Medical Centre arrived. A civilian ground and air ambulance also attended but the decision was made by the SMO to evacuate the Pilot by RAF SAR helicopter to Nottingham University Hospital; and which departed the scene 72 minutes after the accident.

Exhibit 1
Witness 20,21
Witness 4,18
Exhibit 25

10. The Panel concludes that:

a. The Display Supervisor and the Pilot were on duty at the time of the accident.

Witness 1,3

b. The flight was properly authorised by the Display Supervisor.

Exhibit 2,3

c. The flight was correctly and adequately briefed in accordance with the 207(R) Sqn briefing guide.

Witness 10

d. The pilot was competent to undertake the flight.

Witness 1,10

e. The aircraft was serviceable to undertake the flight.

Exhibit 7

f. The weather was suitable for the flight.

Exhibit 8

**DEGREE OF INJURY**

11. The Panel finds that:

a. **Service Personnel**. [redacted]

Annex F

[redacted]

[redacted] The video evidence of the ejection sequence indicated that the main parachute canopy was only just reaching full inflation as he impacted the ground; so he would still be decelerating as he impacted. [redacted]

Exhibit 1

b. **Civilian Personnel**. There were no injuries to civilian personnel.

## AIRCRAFT ESCAPE AND SURVIVAL FACILITIES

12. The Pilot ejected within the safe ejection envelope of the Martin Baker Type 8LC Mk1 ejection seat and all the escape systems functioned correctly. Although not germane to the cause of this accident, the Panel did request RAFCAM to investigate the canopy fragmentation of ZF344 following their investigation of the wreckage. The findings of that investigation are included in this report as an Observation.

Annex F

## DAMAGE TO AIRCRAFT, PUBLIC AND CIVILIAN PROPERTY

13. **Aircraft**. ZF344 was assessed as having suffered Category 5 (Comp) damage with the value of loss provisionally set at £175,000.

Exhibit 9

14. **Public Property**. Damage to Public Property was limited to a taxiway light (£100), a flight-line fire extinguisher (£442) and impact marks on the grass, taxiway and dispersal. The estimated value of loss was £542.

15. **Civilian Property**. There was no damage to Civilian Property.

## Part 1.4 Findings

1. **Introduction**. A considerable amount of evidence was available to the Panel, which has enabled it to reconstruct an accurate account of events leading up to the accident. Evidence included video of the display practice, statements from the pilot and the supervisors, the ADR from ZF344, formal eye-witness statements and evidence from the crash site. All relevant aircraft systems were examined for integrity. The Panel also took into consideration Human Factors (HF), the organization and supervision of the display work-up and the guidance provided in the relevant Orders and Instructions.

2. **Available Evidence**. To assist the Panel in their deliberations the following evidence was available:

a. Statements from the pilot and the supervisors.

b. Video evidence.

c. Eyewitness statements.

d. Expert witness statements and reports.

e. ADR Data from ZF344.

f. The wreckage of ZF344.

g. Display work-up documentation.

h. Engineering documentation for ZF344.

3. **Services**. To assist the Panel in their deliberations the following services were available:

a. The RAF Centre of Aviation Medicine (RAFCAM).

b. QinetiQ – RAF BOSCOMBE DOWN.

c. RAF LINTON-ON-OUSE Senior Medical Officer.

d. Joint Aitcraft Recovery and Transportation Sqn (JARTS).

e. Air Accident Investigation Branch (AAIB) Senior Inspector of Accidents (Engineering).

f. RAF LINTON-ON-OUSE Meteorological Office.

g. JARIC – RAF WYTON.

h. AS SIA 1.

i. Tucano IPT.

j. Martin Baker.

**FACTORS CONSIDERED BY THE PANEL**

4. The Panel considered the following factors:

a. Ac serviceability.

b. Weather.

c. Selection, suitability and configuration of ac.

d. Selection and suitability of personnel.

e. Training, competencies and qualifications.

f. Planning and preparation.

g. Authority and supervision.

h. Human Factors.

i. Orders and Instructions.

**DISCUSSION OF FACTORS**

5. **Aircraft Serviceability.** The Panel considered whether the ac had suffered any system malfunction or component failure. Although the Pilot did not report any abnormality prior to the reverse stall turn, the Panel considered an individual or combined failure of the instruments, flying controls and engine during the manoeuvre. The Panel had invaluable data from the ADR and the assistance of the AAIB, QinetiQ and Honeywell during the initial technical investigation. Having analysed key ac systems there was no evidence to suggest that the accident was caused by a birdstrike or ac mechanical/systems failure. The Panel did note a Fuel in-balance of approximately 50kg at the time of the accident but this was within normal limits and they do not believe this to be a factor in the accident. Likewise, the front cockpit main altimeter was found, when tested by QinetiQ, to under-read by up to 40 feet when the aircraft was climbing; but this was in the safe sense and was not considered to be a factor. Annex C Annex C Annex D

6. **Aircraft Serviceability – Escape Facilities.** The Panel considered the serviceability and use of the Aircraft Escape Facilities and had the assistance of RAFCAM for the technical investigation. The Annex F

Pilot had ejected just within the safe ejection envelope and the escape system had worked correctly but he had sustained [redacted] injuries during the ejection and parachute landing. RAFCAM used computer simulations to assess the ejection and the injuries sustained and found the following.

a. The computer simulations predicted the pilot would have impacted the ground approximately 5.5 seconds after initiating ejection and the forces acting on the pilot, during the ejection, were within the limits of human tolerance. The computer simulation programme used defines an ejection to be within the safe ejection envelope when the parachute descent velocity has reduced to $9ms^{-1}$; a parachute landing velocity which is considered likely to be survivable. At the estimated speed and altitude at which the ejection was initiated the computer simulation predicted the ejection was only just within the safe ejection envelope. At the point of ground impact the parachute descent velocity was only just falling below $9ms^{-1}$. The Pilot therefore landed with a relatively high impact velocity. As a comparator, using similar ejection parameters of 15ft and 133kt, a simulation using the Hawk ejection seat data was made. This seat is essentially similar to a Tucano ejection seat, but with a rocket pack fitted to give a zero-zero capability, and would have given a parachute landing velocity of $7.1ms^{-1}$ and a Hawk pilot would have landed on the ground approximately 12 seconds after initiating ejection.

b. The pilot's [redacted] were a likely reflection of this high landing velocity. He was fortunate that he landed on the grassed area at the side of the runway as the relatively softer ground would have partially cushioned his impact; had he landed on the runway or taxiway tarmac it is likely that [redacted] The computer simulations suggest that it is almost inevitable that the use of ejection seats which are not fitted with a rocket motor and hence do not have a zero-zero capability are likely to result in high parachute landing velocities when the ejections are initiated close to the ground.

As the Tucano ejection seat does not have a zero-zero capability and is not rocket assisted the Panel consider the Aircraft Escape Facilities to have been an Aggravating Factor in this accident. Annex F

7. **Weather**. The Panel considered what effect the weather could have had on the accident. Both the forecast and actual weather conditions at RAF LINTON-ON-OUSE were good. The cloud base was well above limits for the detail, the visibility was good and the wind was 260 Degrees at 12kts (gusting 23kts). The display line used was Runway 21/03 giving an on crowd wind with a component to crowd left. The Panel found no evidence that the weather was a factor in the accident. Exhibit 8 Witness 3

8. **Selection, Suitability and Configuration of Aircraft.** Until 2008, previous display pilots had taken advice from the UTP on the selection and suitability of ac and where possible, they had flown suitable ac prior to providing a short-list of preferred ac to the engineers for the work-up and display season. This is because the handling characteristics can vary between aircraft; although all Tucanos are capable of performing aerobatics. The Panel found that the Pilot had only done this for his Display season ac. For the work-up period, availability of preferred ac could not be guaranteed by VT Aero and the Pilot gave evidence that he was content with that situation and was happy to fly any ac provided. Advice found in DARS Display Flying Notes states: '*It is fundamental to have flown the aircraft before the display to discover any hidden quirks.*' Witness 24 Witness 5 Exhibit 13,14 Witness 3 Exhibit 15

9. The Panel also looked into the configuration of the ac and in particular, why the previous practice of reducing the standard fuel load for display flying from full to partial fuel, whenever possible, had also been discontinued. The Pilot had decided that fuel weight was not a significant factor and that he would occasionally need to be able to fly his displays with full fuel during the season and that he was therefore content to practice with full fuel. Advice from a previous Tucano display pilot contained in DARS Display Flying Notes states: '*Higher fuel weights do not significantly degrade aircraft performance but must, nevertheless, be taken into account e.g. add 100ft to gate heights and apply power from stall turns earlier*'. The Panel could find no evidence that the pilot had taken fuel weight into consideration in this manner. Witness 3 Exhibit 15

10. Both of these factors had been discontinued by the 2008 Display Pilot and during his work-up he was content to fly any aircraft and at full fuel weight; although during the display season he had normally flown his preferred aircraft and on occasion, had also reduced the fuel weight. This years Pilot was aware of this approach but was otherwise unaware of previous practice. The Panel found that the difference in handling characteristics between Tucanos and the performance difference of a Tucano with a full fuel load should normally have a small effect on display flying; but that both factors had been deemed significant by the majority of previous display pilots and both could erode safety margins. The Panel consider that the selection, suitability and configuration of aircraft to be a Contributory Factor. Witness 5 Witness 3 Witness 14

11. **Selection and Suitability of Personnel.** TGOs states that '*the Stn Cdr may appoint the display pilot or select the display pilot by means of a competition*' and that '*the Stn Cdr is to nominate an individual to supervise the display pilot*'. In Sept 2008 the selection of the display pilot and supervisors was made, like previous years, by the previous Chief Instructor (CI), in concert with the then Stn Cdr. Although both the CI and the Stn Cdr had changed at 1FTS shortly after the selection, a comprehensive handover of personnel had taken place and the incoming supervisors were content with the selections detailed Exhibit 30 Witness 22 Witness 8,23

below.

a. **Display Pilot**. The selection consisted of the initial applicants being short-listed to 3 candidates, who then completed a fly-off and an interview with the CI. During this process the F5000s were reviewed and the CI gave evidence that the Pilot's file had not caused him any concern; although he had noted that the Pilot had had an incident on the Harrier and that he had then moved to the Tornado GR4 where he had performed very well. The Pilot was assessed by the CI as having done extremely well at all stages of the selection process and to be a very strong candidate for solo display flying. Witness 22

b. **Display Supervisor**. In command for approximately 12 months when selected; the Display Supervisor was also the Display Pilot's Sqn Cdr and consequently, he knew him well and they had a good working relationship. He was highly thought of as a 1FTS flying supervisor and on selection he was adjudged to have the capacity and ability to take on the task. The Panel did note that the Display Supervisor had no previous related experience; either as a display pilot or as a supervisor of display flying. Witness 1 Witness 22,8 Witness 23 Witness 1

c. **Deputy Display Supervisor**. A Sqn Cdr at 1FTS, he was selected as the Deputy Display Supervisor because he had supervised the previous years display pilot. The CI had made the selection so that he could provide continuity, experience and advice to this year's supervisor. Witness 9 Witness 8

d. **Senior Display Supervisor and Approving Officer**. The Senior Supervisor had been in post for 2 months when the display work-up began. As the new CI at 1FTS, the role of Senior Display Supervisor was included in his TOR but he gave evidence that he was unaware of any requirement for him to be the Display Pilot's Approving Officer. Although he had no previous experience of supervising the Tucano Display, he was a highly experienced flying supervisor and had previously been a FJ display pilot. Witness 8

12. The Panel conclude that the selection of the pilot and the supervisors, which was based on the process undertaken in previous years, was considered and appropriate and that there should have been sufficient experience and ability within that group of personnel for the display season to be a success; provided any weaknesses, such as a lack of knowledge or capacity, were identified and suitable mitigation put in place. Whilst the Panel have no evidence that the choice of personnel was a contributory factor, they did find that 1 Gp ASOs provide significantly more guidance for the selection of personnel than TGOs and that they also mandate individual duties and responsibilities more clearly. For example, 1 Gp ASOs provide advice to the Approving Witness 22,8 Exhibit 30 Exhibit 31

Officer with regard to the appointment of a suitably qualified and experienced 'Mentor' for the display pilot. Both the position of Approving Officer and Mentor are not included in TGOs. Furthermore, TGOs states that 'the Stn Cdr is to nominate an individual to supervise the display pilot' and makes no mention of the role or responsibilities of any Senior Supervisor other than the Stn Cdr. Consequently, with respect to the Selection and Suitability of Personnel, the Panel consider that the guidance provided in TGOs should be reviewed and expanded and that the limited guidance currently contained in TGOs made the accident more likely and was a contributory factor.

13. **Training, Competencies and Qualifications**. The Panel considered the Training, Competency and Qualifications of the personnel involved and made the following findings:

a. The Panel found no evidence of any TOR or written guidance being provided to the Display Supervisor, Deputy Display Supervisor or the Display Pilot. — Witness 1,9 Witness 3

b. Neither the Pilot nor the Supervisor had attended the Post-Display Season Symposium for 2008 as they had been mistakenly informed by a member of the DARS staff that attendance had been restricted due to numbers. — Witness 1,3 Witness 5

c. The Pilot and the Supervisor were unaware of the publication 'Display Flying Notes', which is produced by DARS. The Panel found that TGOs mandate 'Display Flying Notes' as one of the documents that is to be read by display aircrews and flying display organisers. As the name indicates, 'Display Flying Notes' provides valuable background information and advice on Display Flying. The Panel also found that 1 Gp ASOs provide more extensive guidance on the required reading for display flying. — Witness 1,3 Exhibit 15 Exhibit 31

d. JSP 550 advises the incorporation of the Simulator into a display pilot's work-up. Previous Tucano Display pilot's had used the Simulator to good effect but the Pilot was unaware of this previous practice and stated that he believed this facility to be of only limited use for display flying. However, after 6 weeks of work-up flying and following advice from a previous display pilot, he had used the Simulator to practice emergency handling whilst display flying; a sortie which he had found very useful. — Exhibit 32 Witness 5 Witness 3 Witness 3

e. There is a section in 1 Gp ASOs that provides guidance for Display Crew Flying Training. The Panel found no such section in TGOs and although some of the subjects covered in 1 Gp ASOs are contained within those Orders, they do not provide guidance, for example, for the content and required signatures for the Display Aircrew Training Folder. — Exhibit 31 Exhibit 30

All of these factors were found to reduce the effectiveness of the training and diminish the competency and qualifications of those involved. Whilst these findings did not directly cause this accident, the Panel consider them all Contributory Factors

14. **Planning and Preparation**. The Panel considered the following aspects:

a. **Orders and Instructions**. '*The primary method of managing the risks associated with Display Flying is to ensure that there are adequate, robust and appropriate controls in place to ensure that the risks are kept as low as reasonably practicable. These controls are clearly defined in extant regulations, in particular JSP 550, TGOs and the Air Navigation Order, and it is assumed that display crews and their supervisors will be fully compliant*' HQ 22(Trg) Gp Singleton Display Flying – 2009 Generic Risk Assessment. The Orders and Instructions that affected this accident are covered now, whilst those not considered factors are covered later. Exhibit 33

b. **Detailed Findings**.

(i) **TGO – TG335.000.1 DASC(IFS) Display Notes**. Display aircrew and flying display/special event organisers are to read DASC(IFS) Display Notes and JSP 550 Regulation/Directive 335. The Panel found no evidence that the Pilot had read DASC(IFS) Display Notes and also believe that the Supervisor was unaware of this requirement. This document provides extensive advice on the safe conduct of display flying and this lack of awareness was considered a Contributory Factor. Exhibit 30 Witness 3

(ii) **JSP 550 - D335.130.4 - Minimum Heights**. The Panel found that during his Rolling Display the Pilot had linked aerobatic manoeuvres, which have a minimum base height of 500ft MSD, by descending or 'easing' to a lower height. Initially this height was planned to be 100ft MSD; which is the minimum height for Straight and Level Flypasts. Having re-read the Order and before the Pilot had worked down to a base height of 500ft MSD, the Supervisor had changed this 'ease' to 300ft MSD; which is the minimum height for non aerobatic manoeuvres. This technique had been passed on from previous display pilots and was used to enable manoeuvres, such as the ½ Horizontal and Stall Turn, to be flown within the compressed airspace limits (minimum1500ft cloud base) of the Rolling Display. The JSP does allow a Pilot to descend to a lower minimum height between manoeuvres but only when sure of capturing the minimum height for that aerobatic manoeuvre. The Panel are of the Exhibit 12 Exhibit 32 Exhibit 12 Witness 1,3 Witness 5 Exhibit 30 Exhibit 32

opinion that this technique is designed to ensure a safe transition between an aerobatic and a non-aerobatic manoeuvre and that 2 consecutive aerobatic manoeuvres should not be linked in this way. The intention of the Pilot on the day of the accident was to link his Reverse Stall Turn (the accident manoeuvre) to a Hesitation Reverse Wing-over via an 'ease' to 300ft MSD and this technique effectively allowed the Pilot to fly these aerobatics with a 300ft rather than a 500ft base height. The Panel conclude that this technique did not comply with the intention of the Order and that, as it further eroded safety margins, it was a Contributory Factor. Exhibit 12

(iii) **TGO - TG335.130.4a, TG335.130.7 and Annex A to TGO 335 - Display Types, Weather Minima and the Display Pilot Directive**. A Rolling Display is defined as a display that contains manoeuvres with limited vertical component that can be flown when the cloud base is lower than 3000ft but equal to or better than 1500ft. Included in the Display Pilot Directive are Weather Limitations which state that when conducting a display, pilots are not to fly any manoeuvre that risks entering cloud. The Panel considered the inclusion and suitability of Stall Turn manoeuvres in the Pilot's Rolling Display, when taking into account the prescribed weather limits, the risk of entering cloud and the vertical component required to fly the manoeuvres. Previous display pilots had flown Stall Turn manoeuvres during their Rolling Display when the weather precluded the flying of their Full Display but only when the weather was better than the minimum limits for the Rolling Display; the interchange between display sequences to allow for variations in the weather during a display is an approved technique contained within TGOs. To achieve this flexibility previous Tucano Display Pilots had normally devised their Displays to follow the same ground track and flow of manoeuvres and had either: Exhibit 30 Witness 5 Exhibit 17 Exhibit 30

Devised a Rolling Display which could not always be flown with the poorest allowable weather but which contained vertical manoeuvres that could be substituted for manoeuvres from the Flat Display when the weather required. Exhibit 17

Or

Devised a Rolling Display which could always be flown with the poorest allowable weather but which contained flat manoeuvres that could be substituted for vertical manoeuvres from the Full Display when the weather allowed. Exhibit 17

This years Rolling Display was the former and both the Pilot and Supervisor had stated that they would operate in that way during the display season but during the work-up things were found to be different. Firstly, the Panel found that the Pilot was operating under the 'perceived pressure' that he would be expected to fly all the vertical manoeuvres in his Rolling Display to obtain PDA; even if the weather was on the limits. Secondly, he wanted to give himself the best chance of winning the Wright Jubilee Trophy and so he wanted to make the display as impressive as possible. This focus had been reinforced by the guidance provided by the Senior Supervisor to the Pilot that he '*needed to establish a Rolling Display that he could consistently produce with a 1500ft cloud base*'. To achieve these aims, the Pilot had made significant changes to his flying techniques to 'squeeze' the manoeuvres with vertical extent, such as Stall Turns, into the limited airspace available. The Panel consider the selection of Stall Turn manoeuvres to be inappropriate for a Rolling Display that was being flown in the poorest allowable weather and that their employment did not adhere to the Display Pilot Directive. The Panel consider the inclusion and the execution of Stall Turns in this years Rolling Display to be a Contributory Factor.

Witness 1,3

Witness 3

Witness 8

Witness 3

(iv) **TGO - TG335.130.4d - Safety Gate**. A Safety Gate is defined as a combination of height and speed that must be achieved at a particular point in a manoeuvre to allow the safe completion of that manoeuvre by the minimum authorised height. The display pilot is to define a gate height and speed for each display manoeuvre with a vertical component. This requirement is a key element of the safety framework that surrounds display flying and is one of the things which differentiates low-level aerobatics from those flown at medium-level. The Panel found that this Order was never fully complied with and conclude that the Pilot and the Supervisor did not fully understand this requirement or more importantly, the practical employment of this safety measure.

Exhibit 30

Exhibit 30

Exhibit 10,12

Witness 1,3

(v) Although the Supervisor had reported to the CI that the Pilot's 'gate height and base height awareness were exemplary', the Panel found that from the outset, the Pilot had only a limited understanding of what an actual Safety Gate was and that the Supervisor did not have the appropriate knowledge to recognise this lack of understanding. Consequently, they were both unaware of how Safety Gates should be calculated, promulgated and employed. What the Supervisor was seeing and hearing, both in the cockpit and at the sortie briefings, was the Pilot's awareness of achieving the technique heights and speeds that he had published;

Exhibit 12

Witness 1

rather than the actual employment and awareness of Safety Gates for speed and heights. The majority of the information found under the heading 'Gate' in the debrief forms and sortie sequences referred to technique heights or the desired apex of a manoeuvre. Very few manoeuvres had an actual Safety Gate height and speed and nominated heights for recovery from the vertical were described by the Pilot as expected action heights rather than safety minimums. Exhibit 10,12

(vi) The Panel include the following 2 examples to illustrate the understanding and compliance with this Order. Firstly, the Panel found that apart from the Stall Turn manoeuvres in the Rolling Display, the Pilot had only declared and published an entry speed Safety Gate for one other manoeuvre in all of his displays. When the Pilot was questioned about his understanding and employment of speed Safety Gates he had stated that *'he did not really look at the speed'* and that as long as he entered a manoeuvre within his expected speed band he would continue the manoeuvre and that he *'did not think about the speed reference the gate height over the top'.* When asked how he was achieving base height he said that he would use more or less 'g'. This differed from the technique used by previous display pilots; which was to change the Gate Height to reflect the entry speed. For example, most display pilots had used a figure of '100ft for every 10kts' e.g. if the planned entry speed Safety Gate for a Loop was 200kts with a Gate Height of 1900ft to continue the manoeuvre, then for an entry of 210kts the Gate Height would then change to 2000ft. Exhibit 10,12 Witness 3 Witness 3 Exhibit 17

(vii) The second example looks at the employment of a Safety Gate in the vertical to recover to base height. The Panel found that the flying techniques that the Pilot had developed for the Stall Turn manoeuvres in his Rolling Display, and which differed from his full display, did not take into account the requirement to nominate and use a Safety Gate height that would allow the safe completion of that manoeuvre by the minimum authorised height. When asked about his nominated '1200ft pull' figure for the Reverse Stall Turn on the debrief sheet, which had changed from a previous figure of 1400ft, the Pilot had answered: *'I don't know... I think I wrote that down when I put down the cleared heights.... as a pull out from the stuff I'd seen in the previous practices at 1000ft MSD, but I didn't wait for a gate height in the rolling display, I literally did pull out of the manoeuvre as soon as I was pointing nose down once I was flying the display at 500ft MSD. That's how I was flying it... It was just a figure that was there from the practices at 1000ft as a reliable gate but the proximity of the ground meant that I* Witness 3

*never waited for it."*

(viii) The Pilot had also stated that '*the pull out height on the form was 1200ft, but that felt too low'*. The Pilot was asked how he had worked out that 1200ft was too low and had answered that whilst practicing '*with a base of 1500ft MSD, any long pauses in the stall turns was causing me to come out below (nominal) 500ft MSD. So it was a case of just flying and as soon as you completed the stall turn just pulling straight away. This gave me an easier recovery where I could ease to base if needed. So there was no gate height 'per se', it was just literally pull at the top of the manoeuvre.*' Witness 3

(ix) The Panel conclude that the understanding and compliance with the requirement for a Safety Gate was Contributory Factor.

c. **Use of Best Practice**. A verbal handover by the previous years display pilot, manager and flying supervisor had occurred and had included the handover of an electronic training folder. However, there was a delay in this year's team gaining access to the previous year's paper training folders and this did not occur until after the start of the display practices. The documents in the Tucano Display training folders had been virtually unchanged for many years and represented the 'Use of Best Practice' for the compliance with Group and Higher Document Orders. In particular, they had provided templates for: Witness 1,3 Witness 5,7 Witness 9,11 Witness 3 Exhibit 17

(i) The recording of the display pilot's sequences including the defining of safety gate heights and speeds.

(ii) The recording of signatures by the Supervisor and Approving Officer when clearing the sequences to a lower height.

d. The Panel found that this years display team had produced their own training folder, the contents of which had eroded some of the previous practice by omitting 2 of the key elements above. When asked what use had been made of previous documentation, the Pilot had stated that the electronic files were unavailable at the beginning of the work-up due to the RAF wide IT failure and that there had been a delay in receiving the Display Folders. Consequently, the Pilot had produced his own paperwork which he and the Supervisor believed to contain the required information. When they had received the previous folders in Feb 2009 the Pilot stated that he had taken a 'quick look' at the contents of the 2008 Folder but had not had time to look at the 2007 Folder; but he believed his documentation to be similar. He had then passed the folders to the Supervisor and had not referred to them again; Exhibit 10,11 Exhibit 12 Witness 3 Witness 1,3 Witness 1

believing that the Supervisor would check the folders and point out any differences from previous practice. The Supervisor had noted that the 2008 Folder contained a statement of safety gates that was far more robust than anything on their file but he did not see that as significant; although he did subsequently ask the Pilot to put his 'key heights and speeds' on the debrief forms. The Panel consider the lack of knowledge and use of previous best practice to be Contributory Factors. Witness 1 Exhibit 12

e. **Display Sequence Design and Approval**. A Tucano display pilot is expected to design a Full, Rolling and Flat Display which should be capable of being flown in increasingly restrictive weather conditions. As the workload of a display will depend on the complexity of that display and the restrictions within which it is being flown, the complexity of the manoeuvres selected would normally be reduced to match the increasingly restrictive conditions. In addition, display pilots are required to incorporate into their sequence design due account for the crowd line, minimum base heights for manoeuvres and safety gates. The Panel looked in detail at display sequence design and the approval process and found the following. Exhibit 30 Exhibit 30,32

(i) **Full Display**. Having had the benefit of flying with the 2008 display pilot, and of discussing sequence design with him, the Pilot had then designed a sequence for the selection process. The CI had required the pilots in the fly-off to provide him with a copy of their display sequence; which was to include their nominated Safety Gate Heights and Speeds. The Pilot believed that he had done this but, on examination by the Panel, they found that the majority of the information provided described technique, such as a desired apex or action height, rather than Safety Gates. This sequence was then adapted and became the basis for his Full Display which, the Panel found, only contained the required height information for 7 of the 12 manoeuvres with vertical extent. For the information that was provided, the Pilot had not followed the TGO definition of Safety Gates; with the majority of the information in the sequence referring to technique. Witness 3,5 Witness 22 Witness 3 Exhibit 10 Exhibit 10 Exhibit 30

(ii) This sequence was presented to the pilot's Supervisor and Senior Supervisor who verbally approved it for the work-up. Statements from both the Supervisor and the Senior Supervisor suggest that, having seen the sequence and spoken with the Pilot, they were both content that he would be working to Safety Gates. The Panel found that the Supervisor, who was responsible for the approval of the sequences, had flown on the initial sorties with the Pilot but had not been party to the formulation of the sequence or Safety Gates. He understood this to have been done in Witness 3,8 Witness 1

consultation with the previous Display Pilot, although the Panel found that they never formally discussed 'gates' and that what was published came solely from the Pilot. The Supervisor had never discussed or checked the Pilot's understanding of gates, stating: *'I trusted him, when he talked about heights, I must admit, because he had put so much work into his display and figured it all out, I didn't feel in a position to query the work that he had done but I admit that was naive. He was the handling pilot who had built up this repertoire of expertise and who new, well thought he knew how he was going to fly it. So unless I had gone and done that myself it was unclear to me how I was going to make that any different so I thought – well, OK, if you're happy with that, you've spoken to the previous display pilot – that was about the extent of my input then'.*

Witness 5,3

Witness 1

(iii) Once the work-up had started the Supervisor had asked for more visibility of the 'Key Heights and Speeds" that the Pilot was working to and more information was entered on the Full Display sortie debrief form under the title 'Gate'. The Panel found that the majority of this information referred once more to action or expected heights and, except for one manoeuvre, they found no inclusion of any declared Gate Speed for the Full Display.

Witness 1,3

Exhibit 12

(iv) **Rolling Display**. The Pilot had developed his Rolling Display from the Full Display and due to an initial misunderstanding about the weather limits for display types, it contained several looping manoeuvres. These were removed prior to the start of the work-up although the sequence that was approved and flown did contain 5 Stall Turn manoeuvres of various types. The Panel found that the guidance offered about the employment and suitability of those manoeuvres in a Rolling Display had been confused. The Pilot and the Supervisor were both aware that the 2008 Rolling Display had included basic but not advanced Stall Turn manoeuvres and that the previous display pilot had practiced these using a simulated 1500ft cloud base during his work-up. They also knew that, following an experience when he had inadvertently entered cloud, he had only flown Stall Turns during the display season when the weather had precluded the flying of his Full Display (3000ft minimum cloud base) but was better than the limits for the Rolling Display (1500ft minimum cloud base). He had also told them that if there was any risk of entering cloud at the apex of the manoeuvre, then Stall Turns should not be flown. The Senior Supervisor had also provided guidance about the Rolling Display; advising that it should be capable of being flown consistently within the minimum weather limits of a 1500 ft cloud base. During

Witness 3

Witness 1,3

Witness 3

Witness 3,5

Witness 8

Witness 3

interview, the Pilot stated that having discussed this with the Supervisor, he would have acted on the previous display pilot's advice and would not have included Stall Turns during the display season if the weather was close to the limits and there was a risk of entering cloud. The Pilot justified practising to the worst case scenario, and acknowledged it as 'a self perceived pressure', by stating that he was preparing for Public Display Authority (PDA). He believed that if there was a 1500ft cloud base at PDA and he had Stall Turn manoeuvres nominated in his sequence, he would then be expected to fly them to get his clearance. The Panel also found that the Pilot had a desire to win the Wright Jubilee aerobatic competition, which coincided with the completion of PDA, and conclude that this was also why he wanted to be able to perfect the stall turns within the limited airspace.

Witness 3

Witness 3
Annex H

(v) The Pilot's Training Folder showed that the initial Rolling Display consisted of a list of manoeuvres, the majority of which had an apex height annotated against them, but no Gate Heights or Speeds. A revised Rolling Display sequence and a Rolling Display debrief form were published by the Pilot prior to the commencement of the Rolling Display work-up. Both documents contained more detail than the initial sequence but again the Panel consider that the majority of this information referred to action or expected heights and, bar 4 manoeuvres, there was no inclusion of any declared Gate or Entry Speed. As included for comment under 'Orders and Instructions', both of these documents included aerobatic manoeuvres that were linked by an 'ease to 100ft'; which subsequently changed to an 'ease to 300ft' when the pilot stepped down to a 500ft base height.

Exhibit 10

Exhibit 10,12

Para 14.b.(1)

(vi) **Flat Display**. The Panel have no observations about the sequence design or content of the Pilot's Flat Display and found that the work-up of that display had gone well.

Exhibit 10

f. The Panel found no evidence of any formal approval process for the content or design of the display sequences. TGOs requires the Supervisor to 'approve the display sequences' but the Supervisor had no relevant experience with which to complete this process and the corporate knowledge and 'previous best practice' that did exist was not used effectively. In contrast, the Panel found that 1Gp ASOs provide the following guidance in the section entitled Display Content – '*Display crews are to read the advice provided by the DASC Display Flying Notes before constructing their display sequences. Display sequences should be devised in close consultation with their Display Supervisor. The display sequence must be approved by AOC 1Gp before practicing below 5000ft MSD*'. The Panel consider that the display sequences were

Exhibit 30

Witness 1

Exhibit 31

incorrectly designed and approved and that this was a Contributory Factor.

g. **Display Sequence Development**. The Panel considered development of the Full and Rolling Displays and made the following findings.

(i) **Full Display**. The Full Display originated from the Pilot's medium level sequence which he had developed and practiced for the selection process. He was therefore well practiced at flying the manoeuvres in this sequence and it only needed to be lengthened slightly for it to be ready for the work-up. Statements from all those who had supervised or watched the Full Display stated that the Pilot had made good progress and that he was ahead of schedule. Indeed, they felt that he was flying the aircraft accurately and safely and that the work-up of that sequence had gone very well.

Witness 3
Exhibit 10

Witness 1, 8
Witness 9,14

(ii) **Rolling Display**. The Rolling Display was developed from the Full Display and included 5 Stall Turn Manoeuvres of various types. The inclusion of these manoeuvres, coupled with the restrictive weather limits for the Rolling Display, made this sequence far more challenging to fly than the Full Display. This fact had surprised the Supervisor when he had flown the sequence with the Pilot and had triggered 'alarm bells'. When the Supervisor was asked about this he stated that, although the Pilot was working very hard to fly the sequence, he had flown the manoeuvres very well on that day and, knowing that the previous display pilot had flown Stall Turns in his Rolling Sequence and that he was himself inexperienced in this environment, he decided that '*this is the way it is*' and did not take any action.

Exhibit 10

Witness 1

(iii) When the Panel looked into how the Pilot was flying the sequence they found that he had made significant changes to his techniques for flying the Stall Turn manoeuvres when compared to the Full Display; where he had largely used the traditionally taught techniques. When asked how the work-up had gone with respect to the limited airspace that would be available if the cloud base was at its minimum allowable of 1500ft MSD, the Pilot had answered: '*Initially I was apexing too high. I was apexing between 1500 and 1700ft and that was why we then had to really fine tune my entry parameters to make sure I was generally apexing at just below 1500ft in every one. The previous display pilot would say that sometimes if the cloud was exactly 1500ft he wouldn't do the stall turn because ultimately, if you end up in cloud in a stall turn you're in a really bad situation. I was of the same mindset. That if you've got a Rolling Display where you're*

Exhibit 10,12
Witness 3

Exhibit 19

*working to a cloud base, I'm expected to produce that at PDA, to make sure that I get my clearance. There is no point going to PDA with a sequence that you can't fly'.* The Panel consider that this statement demonstrates the Pilot's focus and approach to the development of the Rolling Display.

(iv) The Panel flew the Reverse Stall Turn manoeuvre in the Simulator and consulted previous display pilot's sequences and found that, rather than being too high, achieving an apex of between 1500 and 1700ft was actually what the Pilot needed to achieve, in order to complete that manoeuvre. He would then be able to achieve a Gate Height for the vertical recovery of between 1300 and 1500ft; heights that had previously been used by the 2008 and 2007 display pilots. As this amount of height gain could put the Pilot into cloud during the Wright Jubilee Trophy and PDA, the Panel found that the Pilot had developed the following techniques to fly the Stall Turns below a 1500ft cloud base.

Exhibit 17
Witness 5

Exhibit 17

A. **Entry Parameters.** The Pilot would either arrive or take-off to display and his first manoeuvre for the Rolling sequence was a Reverse Stall Turn. His published sequence stated: 'Performance take-off' followed by a 'Wing-over' with the following 'Gate' information: 'Apex 1200ft ease to 300ft' followed by the 'Reverse Stall Turn'. No 'Gate' speed was published for this manoeuvre but the Pilot stated that he was actually using variable entry parameters, which differed from those published, of 100ft and 180kts and that if he could not achieve 180kts after take-off then he had the option to change to a 500ft and 160kts entry to achieve the same height gain. The Supervisor was unaware of this and believed that the Pilot always started his first manoeuvre from 300ft and 160kts. The Panel found that previous display pilot's had always had fixed entry parameters. When the Senior Supervisor was asked whether he thought this technique was appropriate, he said that this would *'ring big alarm bells, as a constant height with a speed which you know will get you the right energy, but if you now change that height you're changing your top height which now changes many parameters'*; but he was unaware that the Pilot was using such techniques.

Exhibit 10,12

Witness 3

Witness 1

Exhibit 17

Witness 8

B. **Vertical Recovery Gate Height**. The nominated 'pull height' used by the Pilot for the vertical recovery from Stall Turn manoeuvres had been progressively lowered; from the 1600ft (AGL) used in the Full Display, to 1400ft for the initial part of the Rolling Display work-

Exhibit 10,12

Para14.b.(iii)

up, to a final height of 1200ft. The Panel found that these 'pull heights' were not Safety Gates but heights where the Pilot expected to be initiating the pull. The Pilot stated that he did not use a gate height for the vertical recovery in the rolling display – he would *'literally pull out of the manoeuvre when pointing nose down'* and that he relied on achieving the entry parameters for the success of the manoeuvre. Witness 3

C. **Use of Idle and Airbrake**. The Pilot had introduced the use of Idle Power and Airbrake during the initial part of the manoeuvre to limit his height gain. This technique was not normally used during the Full Display work-up as height gain was not critical but the technique had been passed on to him by the previous years display pilot for use in the Rolling Display. As stated by the UTP and shown later in the comparison at Para 15, the Panel found that this technique can cause the height gain to be unpredictable due to the variation in Drag. This is due to the difference in Drag that each Tucano engine produces at Idle; the timing of the selection of Idle Power and from what power setting that originates; and lastly, the timing of the selection of Airbrake. Witness 3 Witness 3,5 Witness 24

D. **Descending between aerobatics**. As previously discussed, the Pilot would descend between aerobatic manoeuvres by 'easing' to 300ft from his 500ft base height prior to the more demanding and energy critical Noddy and Reverse Stall Turns. This was to give himself more time to complete these demanding manoeuvres before he reached his nominated maximum apex of 1500ft. Para 14.b.(i) Exhibit 10,12 Witness 3

E. **Change to Noddy Stall Turn**. The Noddy Stall Turn had been changed to a 2 Nod from a 3 Nod manoeuvre on the day of the accident. This resulted from the previous sortie when the Pilot had run out of energy to complete the 3rd Nod of the Stall Turn. He had concluded that, if he had lost control of the ac and entered a tail-slide during the subsequent recovery, he would have had insufficient height to recover and would have had to eject. Witness 1,3

(v) The Panel could find no evidence that whilst developing these techniques there was any awareness that this could be eroding safety margins. As the change to the Noddy Stall Turn demonstrated – the solution was to change the manoeuvre to make it work rather than address the lack of recovery height if it didn't, by planning a contingency. Witness 3

(vi) The Panel found no evidence that any of the changes made during the entire work-up had triggered the standard practice of proving that change at a higher base height; although they did find that they had completed 10 practices at 1000ft, rather than the minimum of 2, to work on these changes. All the changes had been made by the Pilot in consultation with the Supervisor and without the involvement of the Senior Supervisor. The Panel consider that Display Sequence Development, and in particular the techniques developed in the Rolling Display to enable Stall Turns to be flown below a 1500ft cloud base, was inappropriate and that this was a Contributory Factor. Witness 3 Witness 1,3

15. **Execution of the (accident) Reverse Stall Turn**. Evidence provided by the Pilot for the techniques employed in the execution of the Reverse Stall Turn was as follows. With an entry Gate of 180kts and 100ft MSD and following the initiation of the Pull the Pilot would select the Throttle to Idle and the Airbrake Out. He would then check his height gain and speed in the vertical and if required, he would make an adjustment to the power and/or select the Airbrake In to achieve a height just below his planned apex of 1500ft. He would then fly the manoeuvre, aiming to note his height gain as the nose passed through the horizon during the final stages of the Stall Turn, with his next positive check of height occurring once he had commenced the pull to achieve base height. On being sure of achieving a 500ft base height he would then ease his recovery to 300ft. Witness 3

16. On the day of the accident the Pilot had flown 2 Reverse Stall Turns, one whilst waiting at 3000ft between practices and the manoeuvre involved in the accident. He believed that the entry technique for both manoeuvres was as described above and were the same. Having achieved close to his desired Apex of 1500ft during the practice he was very surprised when told that he had only achieved 1200ft in the vertical during the second manoeuvre. When asked about the maximum height that he had seen during the accident Stall Turn there was some confusion. Initially the Pilot stated that his technique was to check the trend of the ac whilst in the climb to ensure it would achieve 1500ft and that he thought he had seen the altimeter '*approaching 1470ft and still going up*' but that he was not sure if he had done that on this manoeuvre and whilst he could remember seeing this height, he was not sure if it was during this manoeuvre. He later amended that statement to read that he was sure that he remembered seeing 1470ft during that manoeuvre. In considering this conflicting evidence, the Panel found that the weight of evidence showed that the aircraft was lower than expected by the Pilot and had only achieved 1200ft in the vertical and that the altimeters in the aircraft would have reflected close to this height. During his HF interview the Pilot had rated his 'Success Confidence' for various stages of the accident Annex C,D Witness 3 Witness 1 Annex C,D Annex H

manoeuvre as 'very high'; this included at the entry gate, at the apex and also after the brief loss of control, and indicates that he was not aware of his limited height gain.

17. The evidence provided by the ADR for the 2 Reverse Stall Turn manoeuvres flown on that day was compared and the following differences in entry technique and parameters were found: Annex C,D

| **Rev Stall Turn Parameters Rolling Display 12 Mar 09** (All heights based on QFE) | **Nominated** | **Practice** *(Simulated Ht above Ground)* | **Accident** |
|---|---|---|---|
| Entry Speed at Pull-up | 180kts | 181kts | 172kts |
| Entry Height at Pull-up | 100ft | 2800ft *(100ft)* | 158ft |
| Entry TQ | Power Applied | 80 TG | 20 TQ |
| Idle Selection | On Pull-up | On Pull-up | On Pull-up |
| A/B Selection - Out | On Pull-up | 2 secs after Pull | On Pull-up |
| Speed @ 500ft of Height Gain | Not known | 131kts | 108kts |
| Apex Height | <1500ft Cloud Base | 4150ft *(1450ft)* | 1194ft |
| Height Gain from Entry Height | <1400ft | 1350ft | 1036ft |
| Speed at Apex | Not known | 36kts | 0kts |
| Pull-out Altitude | 1200ft | 4000ft *(1300ft)* | 900ft |
| A/B Selection - In | As Required | 1 sec after apex | Not Selected |
| Base Height achieved | 500ft easing to 300ft | 3000ft *(300ft)* | ≤15ft |

18. This analysis demonstrates that the manoeuvre could be flown within the parameters that the Pilot had set himself but that there was no margin for any error. The height gain on the practice would have put the ac at a height of 1450ft MSD, only 50ft below a 1500ft cloud base. The height used in the recovery from an apex of 1450ft puts the ac back level at 300ft MSD; and this assumes that the Pilot was able to capture 500ft MSD in the recovery and had eased to 300ft. This also confirms that the 1300ft Gate Height used by last years Display Pilot for a recovery from the vertical following a Stall Turn was appropriate.

19. The accident profile demonstrates that changes to the entry parameters, ac configuration or indeed the performance of an individual ac, could cause the Pilot to either, enter cloud at 1500ft or, as in the

accident profile, to have insufficient height to recover the ac by a 500ft base height. During the accident manoeuvre this lack of height gain (300ft short of the nominated 1500ft apex) was further compounded by a brief loss of control which, despite the prompt recovery action of the Pilot, used the remainder of the recovery height available (approximately 200ft from ADR analysis) and resulted in the ac almost hitting the ground. Although the Airbrake was left Out for the recovery during the accident profile the Panel consider that this would not have significantly increased the height required to recover the ac as the Tucano Airbrake has very limited effect at slow speed.

20. It is the variation in entry techniques and the subsequent difference in height gain that deserves the most analysis. The Panel considered the effect of the Pilot being below his nominated Gate Speed and of being higher than his nominated entry height but found the primary factor in reducing the height gain was the difference in aircraft Drag. By selecting the Throttle to Idle Power from a much lower power setting, the Tucano propeller was providing Drag at an earlier stage. When coupled with the earlier selection of the Airbrake to Out, the differential in the aircraft speed after 500ft of height gain can be explained. This lack of airspeed caused the ac to gain significantly less height than the practice and also left the pilot with no airspeed with which to complete the Stall Turn; resulting in the loss of control. Witness 24

21. The Panel consider that the techniques developed by the Pilot to fly the Reverse Stall Turn in his Rolling Display made the accident more likely and that they were a Contributory Factor. They consider that the technique used to fly the accident Reverse Stall Turn, which resulted in the limited height gain and the subsequent loss of control during the manoeuvre, to be the Causal Factor.

22. **Authority and Supervision**. The display pilot's decision making and performance is one of the 'first lines of defence' to ensure the safety of an aerobatic sortie. The effectiveness of the Pilot and Supervisor's supervision is one of the 'second lines of defence' to ensure the safety of a sortie; the effectiveness of the supervisor's supervision is the 'third line of defence'. The Panel considered the authority and supervision of the following personnel:

a. **Tucano Display Pilot**. The Tucano Display Pilot is routinely afforded Powers of Authorisation for his display season following Public Display Authority (PDA), as he will normally operate away from home base and be self-supervised. In order to minimise the risks involved with display flying and be able to self-supervise, Display Pilots are expected to have a detailed knowledge of, and accurately employ, all extant regulations. During the work-up period this responsibility is shared by the supervisory team but the Panel would expect the Pilot, as effectively the only full-time member of the team, to have a detailed knowledge of all orders Exhibit 33

from the outset and to ensure his display flying was fully compliant. The Panel found that the Supervisory team believed that the Pilot was meeting these requirements as *'the work-up was going very well'* but although he may have given that impression, the Panel's findings, contained in the Human Factors (HF) and Orders and Instructions sections, illustrate that this was not the case. The Panel consider that the Pilot's part in the supervision of the work-up to be inappropriate and that this was a Contributory Factor.

Witness 1,8,9

Para 14.b.
Para 23.c.(ii)
Para 24

b. **Tucano Display Supervisor**. The Supervisor has a shared responsibility with the display pilot to minimise the risks of display flying, as detailed above, and he was also the designated Authorising Officer for the work-up. As the Pilot's Sqn Cdr and an established senior supervisor at 1FTS, the Supervisor had been appointed by the previous CI and Stn Cdr as having the appropriate authority and supervisory skills to act as the Display Supervisor. The Panel found that he had no previous experience of display flying or its supervision and had not been issued with any TOR for this role. The CI had recognised his lack of relevant experience and had put measures in place to mitigate this risk but the Panel found that this had only partially worked and, due to the success of the initial work-up, had largely been withdrawn at the time of the accident. The CI had 'backed-off' his supervision and the Deputy Supervisor and the Tucano Examiner had effectively ended their participation.

Witness 8,22
Witness 23
Witness 1

Witness 8
Annex H

Witness 8,9

Witness 14

c. The Panel found that, from the outset, the Supervisor's lack of display flying experience had caused him to relinquish some of his authority and supervisory responsibilities to the Pilot, who was an experienced fast-jet pilot. For Example, the design of the sequences and the supporting paperwork had been left to the Pilot. Despite the Supervisor experiencing several *'alarm bells'* during the work-up, the Pilot was still trusted to do *'the right thing'* and responsibility for the conduct of the display was increasingly devolved to him; effectively levelling the authority gradient which reduced the Supervisor's ability to play his part in the supervisory 'safety framework'. This approach had worked for the Full Display work-up and, according to all involved, things had *'gone very well'*. The Panel consider that this provided all the supervisors, but in particular the Pilot's main supervisor, with a false sense of security and this increased his trust in the Pilot's ability prior to the work-up of the Flat and Rolling Displays.

Witness 1

Exhibit 10,12

Witness 1
Annex H

Witness 1,8
Witness 9

Annex H
Witness 1

d. At this time the Panel found that the Supervisor's workload had increased and that he had several issues to contend with, both as a Sqn Cdr and [redacted] Consequently, when the demands and difficulties of the Rolling Display work-up occurred, the Supervisor had now become distracted and the supervisory 'safety framework' which had now evolved gave increasing

Witness 1
Annex H

authority to the Pilot for the development and execution of his Rolling Display. The Panel consider the Supervisor's limited experience of display flying and subsequent distraction on the ground had caused his authority to become degraded and his supervision inappropriate, and that this was a Contributory Factor.

e. **Tucano Display Deputy Supervisor**. The Deputy Supervisors main role was to provide cover as an alternative supervisor and to allow the Pilot to continue his work-up in the Supervisors absence, although he had not been issued with any specific TOR. As the Display Supervisor from the previous year, the Deputy Supervisor was also selected to provide continuity and experience to the supervisory team. This he did, especially at the early stages of the Pilot's work-up, when he was actively involved in the supervision of flying and the provision of advice, particularly to the Supervisor. The Panel also found that he had specifically told the Pilot and Supervisor that he intended to provide ideas and advice but not interfere and make alterations to the display when he was supervising. Witness 9 Witness 8 Witness 1,8 Witness 9

f. The Deputy Supervisor had attended the hand-over meeting but he had not been given the opportunity to influence this years team about the use of established 'best practice'; particularly for the publishing of display sequences with Gate Heights and the recording of the Approval Officers clearance to lower the Pilots display height. And although he had the knowledge of previous practice, the Panel could find no requirement or opportunity for him to have changed this years display administration, which he believed to be '*better than last year*'. The Panel do not consider the authority and supervision of the Deputy Supervisor to be a factor. Witness 3,9 Witness 9

g. **Tucano Display Senior Supervisor**. Included in the TOR of OC Fg Wg and CI, was the responsibility for the safe conduct of all flying at 1 FTS, which included the specific task of overseeing the supervision, management and safe conduct of the display work-up and the season. The Senior Supervisor had not selected this years Pilot or Supervisors, as that process had occurred prior to his arrival; although he had endorsed their appointment well before the start of the work-up, in concert with the new Stn Cdr. He had played a very active part in the supervision of the work-up for the Full Display; having regularly attended sortie briefings and display practices. At the time of the accident, in preparation for PDA and the forthcoming season, he had deliberately reduced his involvement and moved into the background as he believed both the Supervisor and the Pilot had demonstrated their ability to supervise display flying. This had not been done in any formal way and, although the work-up of the flat and rolling displays had been left largely to the Pilot and the Supervisor, the Senior Witness 8 Witness 8 Witness 23 Witness 8

Supervisor still expected to be informed of problems, to provide advice and to be updated on their progress. The Panel found that he had not been informed of or been aware of any problems with the Rolling Display. Witness 8

h. From the outset, the Senior Supervisor had not intended to delve into the detail of the Pilot's display flying; preferring to devolve that responsibility to the Supervisor. In particular, the Panel found that he had devolved the responsibility for the supervision of Gate Heights and Speeds to the Supervisor; although, as a previous FJ Display Pilot, the Senior Supervisor was the only member of the supervisory team who had previous experience of flying low-level aerobatics and of using Gate Heights and Speeds. When questioned about their use, the Senior Supervisor believed, having spoken to the Pilot and seen the information entered on the initial sequences and later the debrief forms, that they were being incorporated and used correctly. When the Panel looked at these documents they found convincing evidence that this was not the case. Witness 8 Witness 8 Exhibit 10,12

i. **Approving Officer**. Moving on to the Senior Supervisor's role as the Approving Officer. There is a requirement in JSP 550 for an Approving Officer, normally of wg cdr rank or higher, that has one mandated duty for Display Flying which is, *'to annotate and sign the Pilot's Training Folder whenever the Pilot is cleared to a lower height'*. Over the preceding years a template for the approval of a new height clearance, which included the attachment of the display sequence with nominated Gate Heights and Speeds, had been developed and become the established 'best practice'. This duty had always previously been filled by the Senior Supervisor; although there was no evidence of the inclusion of this in the CIs TOR. The Panel found that this responsibility had not been handed on and that the Senior Supervisor, Supervisor and the Pilot were all unaware of this requirement. Consequently, although there was evidence that the Senior Supervisor had received Email 'info' copies of the clearances from the Supervisor and that he had been included verbally in the decisions to clear the Pilot to a lower height; the use of previous 'best practice' had stopped. Therefore, the opportunity for the Senior Supervisor, in the role of the Approving Officer, to have regular visibility of the Pilot's display sequences with nominated Safety Gates, and then sign them off, had been lost. Exhibit 32 Para 24.b.(i) Exhibit 17 Witness 8 Witness 8,1 Witness 3 Exhibit 12 Witness 1,8

j. The Senior Supervisor had the experience to oversee the supervision, management and safe conduct of the display work-up and it is the Panel's opinion that more could have been done to mitigate the inexperience of those below him. The Panel consider the supervision of the Senior Supervisor to have been inappropriate and that this was a Contributory Factor.

23. **Human Factors**. In considering HF, the Panel consulted the RAF LINTON-ON-OUSE Senior Medical Officer and the RAFCAM Aviation Behavioural Psychologist. The HF report provided by RAFCAM was comprehensive and the Panel concentrated their findings in the following areas: Witness 4 Annex H

a. **Physiological and Psychological Fitness**. Although the pilot was [redacted] he was well rested before the accident. In addition, the pilot's testimony did not indicate [redacted] Post Incident Drug and Alcohol Testing (PIDAT) was not invoked. Based upon available evidence, the Panel concluded that the Pilot's physiological fitness was not a factor in the accident. Findings of the Pilot's psychological fitness are made in 'Condition of the pilot' below. Witness 3 Witness 23

b. **Fatigue**. The workload in recent months at 1FTS had been high, in particular for the Display Supervisor, but the Panel had no evidence to indicate that fatigue was a factor. The Pilot had been shielded from the high workload on the Sqn and his flying had concentrated almost entirely on his work-up. Annex H Exhibit 4,5

c. **Condition of the Pilot**. One of the expected mitigations to reduce the risk of display flying is the selection of a suitable display pilot and that the pilot's decision making and performance is one of the 'first lines of defence' to ensure the safety of an aerobatic sortie. When selected, the Pilot was considered a strong candidate for the display pilot role. In considering the condition of the pilot to perform those duties, the Panel made the following findings in consultation with the HF Report: Annex H

(i) **Selection of the Display Pilot**. Both of the CIs and the Supervisor had demonstrated knowledge of the Pilot's flying record (F5000) and whilst they recognised his inexperience as a display pilot, the Panel did not consider that they had a full appreciation of his background. The Panel found that whilst flying the single-seat Harrier, reports in the F5000 referenced limitations to the pilot's situational awareness, decision making and contingency planning. His subsequent twin-seat Tornado tour had gone well, but he had now been selected as the single-seat Tucano Display Pilot; an aircraft he was still relatively new to and a flying task that had a significantly higher workload than his normal duties and his previous tour. Notwithstanding the benefit of hindsight, the Panel conclude that the risks associated with the Pilot's experience and background could have been detected and that the vulnerabilities could have been managed by: a Witness 8,22 Witness 1 Annex H Annex H

sufficient hand-over; appropriate guidance from a technically competent supervisor; absolute adherence to rules and regulations; a suitable display sequence design that considered workload and margin of error; and maximum effect from the Approving Officer.

(ii) **The Pilot's Focus and Motivation**. The Pilot had demonstrated a significant motivation towards being the Tucano Display Pilot and despite the limitations of the aircraft, he wanted to provide the public with an impressive display. The Panel also found that he had a desire to win the Wright Jubilee Trophy at PDA. To that end, the Pilot had designed technically demanding, complex and high workload sequences to ensure the impressiveness of the display and in particular, to ensure that the Rolling Display was also impressive should he have to revert to this for PDA. During this process, the Pilot was so focused on PDA and the Wright Jubilee trophy that he did not fully adsorb the safety procedures and more readily accepted those rules he interpreted as allowing him greater flexibility with his display; indicative of someone with a strong focus on a fixed objective.

Witness 1,3

Annex H

Witness 1

Exhibit 10,12
Witness 3

(iii) **Display Sequence Design**. One of the expected mitigations to reduce the risk of display flying is to manage the workload of the pilot to enable good decision making and the activation of contingency plans. As the Rolling Display is flown in more demanding weather conditions than the Full Display the Rolling sequence would be expected to be easier to execute. The Panel found that, to ensure that the Rolling Display was impressive for the public and PDA, the Pilot had included several advance stall turn manoeuvres in his sequence that had not previously been used by display pilots in their sequences. He also planned to fly these manoeuvres in the worst conditions allowable for a Rolling Display. This had the effect of making the Rolling Display far more demanding to fly than his Full Display; and required the Pilot to operate with minimal margin for error. The Supervisor had recognised this fact but due to the gradient that had developed, he did not feel it appropriate to intervene, provided the Pilot felt his workload was manageable. The Pilot's perception that his workload, decision making and contingency planning were all manageable was continually being reinforced by those on the ground providing positive feedback and by each successful display that he flew. The Panel consider that the selection of manoeuvres for the Rolling Display and the self imposed limitations for there execution had directly influenced the pilot entering a hazardous scenario and that this should have been detectable.

Annex H

Exhibit 10
Exhibit 17

Witness 1

Annex H

The Panel consider the condition of the Pilot to be a Contributory Factor.

d. **Condition of the Supervisor**. One of the expected mitigations to reduce the risk of display flying is the selection of a suitable technical display supervisor. The effectiveness of the display pilot's supervision is one of the 'second lines of defence' to ensure the safety of an aerobatic sortie; the effectiveness of the supervisor's supervision being the 'third line of defence'. The Panel made the following findings in consultation with the HF Report: Annex H Exhibit 31

(i) **Selection of the Display Supervisor**. The Supervisor was selected as 'the best man for the job' although he had no related experience and as he himself stated, he '*didn't fully appreciate the challenge'* and was not confident about his suitability. The CI had recognised the Supervisors inexperience and in mitigation had provided advice and supervision himself, as a previous FJ display pilot. He had also appointed the previous years supervisor as his deputy and made the Tucano examiner, a previous Hawk display pilot, available for advice. The Panel found that this system had only partially worked due to the fact that the assistance was provided on a 'when requested and available' basis and often neither the Supervisor nor the pilot had the knowledge to recognise when further advice or validation should have been sought. Indeed, as the work-up of the Full Display had 'gone well', they proceeded with the Rolling Display work-up relatively independently and often ignorant to any decision errors, procedural omissions or risk taking. The Panel conclude that the Supervisor's level of knowledge influenced his effectiveness as a display supervisor and that despite attempts to mitigate this situation by the CI, this influenced the pilot entering a hazardous scenario by not preventing some of the Pilot's behaviours and actions; such as the Pilot's awareness and use of Safety Gates and the techniques he developed for the Stall Turn manoeuvres in the rolling display. Witness 8,22 Witness 1 Witness 8 Witness 3,9 Witness 8,9 Witness 14 Annex H

(ii) **The Supervisor's** [redacted] The Supervisor [redacted] had felt under 'unreasonable' pressure when conducting his many primary and associated tasks but because he felt this was the 'norm', and that others around him were the same, he had accepted his new role. Following the arrival of the new CI he had been asked to take on another Stn task but having now considered his workload 'unmanageable', had declined the task with the CI's agreement. The Supervisor also provided Annex H Witness 1 Witness 1,8 Witness 1

evidence of further difficulties once the display work-up had started, concerning management pressures and personnel issues on his Sqn. The Panel believe that the success of the initial work-up and the onset of these distractions had influenced the degree of trust the Supervisor had in the Pilot and thus the degree of attention he afforded him. The Panel consider that [redacted] that it was recognisable that his Sqn was under pressure, [redacted] have been detected as a potential hazard to his supervisory effectiveness.

Witness 1
Annex H
Witness 8,23

(iii) **Crew Gradient**. The Panel found that a 'crew gradient' had developed between the Supervisor and the Pilot. This had influenced the effectiveness of the display supervision and such an effect had influenced the Pilot entering a hazardous scenario. Specifically, the gradient provided the Supervisor with a false sense of security concerning the Pilot's ability and the Supervisor's acceptance of the Pilot's decisions provided the Pilot with mutual security; it is unlikely that either party had a full appreciation of the dynamics of this relationship.

Annex H
Witness 1
Witness 3

The Panel consider the condition of the Supervisor to be a Contributory Factor.

e. **Distractions**.

(i) **Ground Distractions (Pilot)** Whilst the Panel found no evidence of the pilot being distracted from the task of display flying during his work-up, they did find that he had been distracted during the time following his selection but prior to him starting his work-up, causing his focus to be misplaced. The Panel found that he had put a lot of work into the design and risk assessment of the aircraft colour scheme and that he had written a Paper outlining his proposals to reduce the fatigue used during the Tucano Display; this introduced the concept of procuring a Smoke Generation System or flying a Pairs Tucano Display. In contrast, the Panel found little evidence that the Pilot had put the same level of research or attention to detail into the preparation of his own Flying Display and in particular, the incorporation and understanding of the controls and fundamental principles that are in place to reduce the risks of display flying.

Exhibit 28
Exhibit 27

(ii) **Ground Distractions (Supervisors)** The Panel found that the remainder of the supervisory team had been concentrating on other tasks in the later stages of the work-up. The training for the Full Display had gone very well and

Witness 1,8
Witness 9,14

had passed without incident; this had allowed their priorities to change during a time of increased workload and that they had been distracted by this success. The Panel found that following the successful work-up of the Full Display, the supervision by all parties had effectively been reduced for the work-up of the Flat and Rolling Displays. The involvement of the Deputy Supervisor and the Tucano Examiner had virtually ended and the Senior Supervisor had adjudged that the Pilot and the Supervisor were doing well in their roles and he had 'backed-off' his involvement. Evidence from the Pilot and his Supervisor about the difficulty level of flying the Rolling Display, and in particular the advanced stall turn manoeuvres within the weather limits that they had imposed on themselves, gave the Panel reason to believe that this was just the time when a reduction in effective supervision could become critical and exposed.

Witness 8,9

Witness 9,14
Witness 8

(iii) **Air Distractions (Pilot).** The display practice was being flown at the Pilot's home airfield and immediately prior to the accident there were no R/T communications. All available evidence indicates that the ac systems were functioning normally and that the weather was within limits. There was a significant on-crowd wind but the Pilot had flown in these conditions before and had planned for this; it was therefore not considered to be a distraction. The Panel had no evidence that distraction in the air was a factor.

Exhibit 25
Annex C,D
Exhibit 8

Witness 3

The Panel consider that the distraction on the ground of the Pilot and all of the supervisors to have been a Contributory Factor.

24. **Orders and Instructions**. *'The primary method of managing the risks associated with Display Flying is to ensure that there are adequate, robust and appropriate controls in place to ensure that the risks are kept as low as reasonably practicable. These controls are clearly defined in extant regulations, in particular JSP 550, TGOs and the Air Navigation Order, and it is assumed that display crews and their supervisors will be fully compliant'* HQ 22(Trg) Gp Singleton Display Flying – 2009 Generic Risk Assessment.

Exhibit 33

In considering Orders and Instructions, the Panel analysed all relevant areas and made the following findings:

a. **Availability of Documents**. When interviewed about his knowledge and understanding of pertinent Orders and Instructions, but in particular JSP 550, the Pilot stated that he had read JSP 550 before the work-up had begun but as the document had gone 'electronic', he had not referred to it as often as TGOs because he had found access to the document difficult as *'it took a lot of time to call up the relevant sections'*. He also stated that they had lost

Witness 3

access to the Defence Intranet (due to the RAF wide IT failure on 06 Jan 09) on the day he had started flying on the work-up and that from then, he only had TGOs to refer to. He also believed that as TGOs was a lower-level document than JSP 550, that TGOs would either be more restrictive or the same. The Panel investigated the availability of this document and found that a paper copy of JSP 550 was available on 207(R)Sqn until 28 Jan 09. It had then been replaced by a CD copy held in Sqn Ops to back up the on-line electronic documentation; the Stn network had been returned to all users on 21 Jan 09. The Panel therefore discounted the availability of documents as a Contributory Factor. Exhibit 21

b. **Detailed Findings**. The Orders that contributed to this accident were included under Planning and Preparation. Non-compliance with the following Orders and Instructions was found by the Panel but they are considered not to be contributory factors: Para 14

(i) **JSP 550 – D335.130.9 Pre-Season Display Practices**. There is a requirement for both the Approving Officer and the Supervisor to annotate, and sign, the training folder whenever the pilot is cleared to a lower height. The Panel found that the Pilot, the Supervisor and the Senior Supervisor were all unaware of the role of the Approving Officer and in particular this requirement. However, there was evidence that the Senior Supervisor had been Emailed 'info' copies of the clearances by the Supervisor and that he had been consulted verbally about the decisions to clear the Pilot to a lower height. Exhibit 30 Witness 1,3 Witness 8 Exhibit 12 Witness 8

(ii) **TGO - TG335.145.2 Supervision**. The Supervisor is required to fly at least one practice with the display pilot at 5000ft agl and for all work-up sorties the display pilot should be the aircraft commander. The Panel found that the initial 5000ft practices, which had been flown Dual with the Supervisor, had also been flown with the Supervisor as the Captain of the ac. Witness 3 Exhibit 30 Exhibit 3

(iii) **TGO – TG335.145.6 Currency**. This Order outlines the requirements for a display pilot to be considered current. The Panel found that the Pilot had completed a Full Display practice at 500 ft MSD 11 days after his last Full Display at that height. His currency had lapsed after 8 days, after which he should have regained Full Display currency at 1000ft MSD. Exhibit 30 Exhibit 3

(iv) **TGO – TG335.150 Carriage of Passengers**. For aerobatic displays the only individuals that may fly as a passenger during a display practice are the display supervisor and the display pilot's successor. It was noted that, although Exhibit 30 Exhibit 3

authorised as SCT rather than 'Aeros NB 5000ft MSD', a holding officer had flown on a 5000ft Rolling Display work-up sortie and on a 5000ft Flat Display work-up sortie. The Panel also found that the Pilot had authorised one of these passenger sorties himself; although he did not have the Powers of Authorisation to do so. Exhibit 22,23

**SUMMARY OF CAUSES AND FACTORS**

25. **Cause**. The technique used to fly a Reverse Stall Turn, which resulted in a limited height gain and a subsequent loss of control during the manoeuvre, left the pilot with insufficient height to recover the ac safely. Para 21

26. **Contributory Factors**.

a. The selection, suitability and configuration of the display aircraft reduced safety margins. Para 10

b. There is limited guidance provided in TGOs for the Selection, Administration and Responsibilities of Display Aircrew and their Supervisors. Para 12

c. The Display Pilot and Supervisors had not been provided with TOR or written guidance. Para 13.a.

d. The Display Pilot and Supervisor's had not attended the previous years Post-Display Season Symposium. Para 13.b.

e. The Display Pilot had made limited use of the Tucano Simulator for his work-up. Para 13.d.

f. There is limited guidance provided in TGOs for Display Crew Flying Training. Para 13.e.

g. The Display Pilot and Supervisor were unaware of the DARS publication 'Display Flying Notes'. Para 14.b.(i)

h. The lack of compliance with the Order defining the minimum heights for display flying. Para 14.b.(ii)

i. The lack of compliance with the Orders defining appropriate inclusion and execution of manoeuvres in a Rolling Display. Para 14.b.(iii)

j. The lack of compliance with the Order requiring the display pilot to define and use Safety Gates. Para 14.b.(iv)

k. The lack of knowledge and use of previous best practice. Para 14.d.

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| l. The display sequences were incorrectly designed and approved. | Para 14.f. |
| m. The development of the Rolling Display sequence was inappropriate. | Para 14.g.(vii) |
| n. The techniques developed to fly the Reverse Stall Turn manoeuvres in the Rolling Display. | Para 21 |
| o. The Pilot, Supervisor and Senior Supervisor's supervision was inappropriate. | Para 22 |
| p. The Condition of the Pilot – Selection, Focus and Motivation, and Display Sequence Design. | Para 23.c. |
| q. The Condition of the Supervisor – Selection, [redacted] and Crew Gradient. | Para 23.d. |
| r. The Pilot's initial focus was misplaced and this distracted him from the fundamental principles of display flying. | Para 23.e. |
| s. The supervisors were distracted by other tasks during the work-up; particularly during the period immediately prior to the accident. | Para 23.e. |

27. **Aggravating Factor**.

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| a. The Tucano MBA Mk 8LC Mk1 ejection seat is not rocket assisted and does not have a zero-zero capability. | Para 6 |

**OBSERVATIONS**

28. **Canopy fragmentation of ZF344**. The front canopy transparency of the Tucano is fitted with a Linear Cutting Cord (LCC) fracturing system and on ejection initiation the LCC system detonates to cleave the canopy in two. The front canopy is not fitted with a separate windshield and the canopy transparency extends forwards to the edge of the canopy frame without interruption from a canopy arch. The pattern of the LCC is such that on ejection initiation the LCC explosive charge should disrupt the canopy, but leave an area at the front of the canopy intact to act as a windshield. The Panel found in this ejection that the transverse fracture line across the area where a conventional canopy arch would be sited did not occur cleanly. This resulted in a large jagged protrusion of canopy transparency extending into the ejection pathway. The failure of the canopy to fracture predictably across the transverse line is potentially injurious should the seat occupant's lower limb contact the jagged protrusion. The Pilot of ZF344 had a buttock-knee measurement of [redacted]; the upper anthropometric limit for the Tucano is 670mm. An ejection seat pull out test using an

anthropomorphic test dummy, also with a buttock-knee measurement of [redacted] indicated the Pilot would have missed colliding with the canopy transparency by approximately 1.5cm. Therefore, had the Pilot had a longer buttock-knee measurement, potentially up to the anthropometric limit, serious lower limb injuries would have been likely to have been sustained.

29. A review of previous UK Tucano ejections identified two previous accidents. In one fatal ejection accident the pilot sustained [redacted] over an area protect by his flying boot. Investigation of this accident was inconclusive as to the precise causation of the [redacted] and it was presumed to have been caused by collision with unspecified cockpit structures during the ejection sequence: it was not due to the parachute landing as the landing occurred into the sea. [redacted] are not typical ejection injuries and do not occur commonly on ejecting. Where collisions with cockpit structures have occurred the injuries tend to occur more from blunt trauma leading to bruising, abrasions or fractures rather than distinctly defined wounds and deep cuts from sharp, cutting edges.

30. In reviewing this earlier accident it is possible [redacted] could have been caused by collision with an incompletely fragmented canopy similar to that observed in ZF344. However, details for the canopy's fracture pattern of the earlier fatal ejection accident are inconclusive as the aircraft suffered damage on impact with the water. Nevertheless, there is a concern that the canopy fragmentation system of the Tucano front cockpit may not fracture the transparency as effectively as may be expected.

31. **Aircraft Servicing Procedures**. During the aircraft servicing of ZF344 the engine oil had been over-filled and some oil was removed. At the time of the accident there was no evidence of the recording of such Minor Servicing action but VT Aero were very quick to react to the findings of the Panel and procedures were put in place to rectify this observation immediately.

32. **Tucano ADR Recording**. The ADR pitch and roll acceleration parameters are not adequate for deriving pitch and roll information. The accuracy specification of the ADR height transducer is also excessively large for the purposes of accident investigation. The Panel believe the lack of ADR recorded pitch and roll information and/or the lack of accurate height information could seriously impede a future Tucano accident investigation where video evidence was not available.

33. **Availability of HF Psychologist**. There is only one HF Psychologist employed on Accident Investigation at RAFCAM. This became a limiting factor for the Panel in its aim to complete the SI as expeditiously as possible; as her availability was often restricted by her workload and the requirement to support other inquiries.

34. **RAF LINTON-ON-OUSE PCM**. The PCM conducted by RAF LINTON-ON-OUSE was commended by the Panel. Clearly benefiting from a recent Practice Crash Exercise, the initial reaction to this accident by all involved was exemplary and the Panel found nothing during their investigation to change that view. Indeed, the assistance and flexibility of RAF LINTON-ON-OUSE personnel throughout the inquiry enabled the Panel to work in the most diligent and efficient manner.

## Part 1.5 Recommendations

### RECOMMENDATIONS

1. The Panel recommends that:

a. Consideration should be given to the review and expansion of the TGOs responsible for the supervision and conduct of Display Flying and recommend the following:

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| (i) Supervisor appointments should be expanded to include the role of an Approving Officer, a Deputy Display Supervisor and a Display Mentor. | Pt 1.4 Para 26.b. |
| (ii) Guidance should be provided on the selection and responsibilities of display supervisors and aircrew. | Pt 1.4 Para 26.b. |
| (iii) The Approving Officer or higher should be required to provide TOR or written guidance to display supervisors and aircrew. | Pt 1.4 Para 26.b. |
| (iv) An expanded list of required reading should be provided for display aircrew, supervisors and event organisers. | Pt 1.4 Para 26.g. |
| (v) Formal advice should be provided for Display Crew Flying Training. This should include templates of best practice for the administration and content of the Display Crew Training Folder. | Pt 1.4 Para 26.f. |
| (vi) The approval of display sequences should become the responsibility of the Approving Officer or higher. | Pt 1.4 Para 26.k. |

b. Consideration should be given to the inclusion of Display Flying Supervision into Flight Safety Courses.

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| c. The Display Aircrew and the Supervisor should attend Display Season Symposiums. | Pt 1.4 Para 26.d. |
| d. The appropriateness of the Wright Jubilee Trophy occurring at PDA should be reviewed. | Pt 1.4 Para 23.c.(ii) |
| e. To ensure that display flying is conducted as safely as possible an individual Risk Assessment should be conducted and all assumed mitigations should be reviewed to ensure that they can be available and implemented. | Pt 1.4 Para 23.d.(i) |
| f. To improve the mitigation of display flying supervision the workload of display aircrew and supervisors should be regularly reviewed to ensure enough capacity is made available to facilitate | Pt 1.4 Para 23.d.(ii) |

a safe display work-up.

g. Clarification should be provided, and if necessary the JSP changed, with respect to Minimum Heights and the linking of aerobatic manoeuvres. — Pt 1.4 Para 26.h.

h. In order to reduce the risk of parachute landing injuries, and to increase the overall safe ejection envelope, consideration should be given to establishing if a zero-zero capability of the Tucano ejection seat is required. — Pt 1.4 Para 27.a.

**OBSERVATION RECOMMENDATIONS**

2. The Panel recommends that:

a. A review of the Tucano canopy fragmentation should be undertaken to ensure the continued safety to aircrew. — Pt 1.4 Para 30.

b. Consideration should be given to the retrofitting of suitable equipment to the Tucano to enable pitch angle and roll angle to be accurately recorded by the ADR. Furthermore, the accuracy of the Tucano ADR height transducer should be improved. — Pt 1.4 Para 32

c. Consideration should be given to the expansion of the HF staff at RAFCAM that support accident investigation. — Pt 1.4 Para 33

**PART 1.6**

**CONVENING AUTHORITY COMMENTS**

**INTRODUCTION**

1. This accident occurred in good weather during a Tucano flying display work-up sortie for the 2009 display season. Following a low-level arrival and pull up for a limited height gain reverse stall turn the ac entered a brief tail-slide followed by auto-rotation before falling on its back and entering a spiral dive. During recovery from this manoeuvre impact with the ground was considered to be highly likely and a successful ejection was initiated. The pilot was the only person to sustain any injuries, classified as [redacted] and the ac crashed within the bounds of RAF Linton-on-Ouse.

**THE CAUSE**

2. Although I agree with the Service Inquiry Panel's cause of the accident, I believe this could be more simply stated in that the cause of the accident was that the pilot lost control of his ac during a low-level aerobatic manoeuvre with insufficient height to recover the ac safely.

**THE INVESTIGATION**

3. As this accident took place on an active airfield there were a significant amount of material evidence and eye witness accounts for the Panel to consider and thankfully, the pilot was able to provide evidence in person. I am content that the Narrative of Events at Part 1.3 of this Report, provides an accurate picture of the events prior to and during this accident. Furthermore, I am also satisfied that the aircraft was fully serviceable and that there were no engineering causal factors in this accident.

**RECOMMENDATIONS**

4. I concur with all the Panel's Recommendations, at Part 1.5 of this report, but will focus my comments on areas that I consider to be of crucial importance in particular, where I consider that had there been better individual performance the accident would almost certainly not have occurred; specifically the level of supervision, compliance with extant regulations, orders and instructions and finally distraction. My comments on these areas of the Panel's report are as follows:

a. **Supervision**. The supervisor's lack of display flying experience had caused him to relinquish some of his authority and supervisory responsibilities to the pilot and this was reflected in the completion of the pilot's work-up documentation and the planning and execution of his aerobatic manoeuvres. This was further compounded by a lack of display experience in some areas of the supervisory chain although I do believe that overall there was sufficient knowledge and advice available to complete a successful work-up and display season. Acceptance at face value is not a robust method of supervising aviation; supervisors at all levels must be incisive and diligent in discharging their responsibilities in order to ensure that all procedures and regulations have been adhered to.

b. **Regulations, Orders and Instructions**. It is evident from the Panel's findings that at the time of the accident some extant regulations, orders and instructions were not complied with. I am most disappointed that the Display Pilot (a QFI) and Supervisor (also a QFI) were unaware that 'Display Flying Notes' were mandated in TGOs to be read by flying display aircrew and organisers. Not having the 'how to' knowledge, advice and good practice recommended by 'Display Flying Notes' no doubt contributed to the accident. Furthermore, even if there had been no specific directive to read this document, I would still have expected all involved to be aware of it. It is my expectation that, as part of the professional approach I require from my QFIs and Supervisors, such an individual should, on their own initiative, gather as much information as possible to assist them in their task; it should not always be necessary to tell well qualified and experienced aircrew exactly what they have to do to perform a task safely. A comprehensive review of No 22(Trg) Gp orders for display flying has already been completed; the revised order also includes what I consider to be a list of "required reading" for all those involved in display flying.

c. **Safety Gates**. A comprehensive understanding of safety gates is a key requirement in ensuring that individual manoeuvres are flown safely during low-level aerobatics; crucially, the employment of this process is essential. Had this process been employed correctly the viability and inclusion of a reverse stall turn in a Rolling Display would have been questioned more thoroughly.

d. **Display Sequence Planning** JSP 550 R35.130.1 states "*Flight Safety, spectator safety and the safety of anyone living or working in the area is to be the paramount consideration in the planning and conduct of Flying Displays. Any manoeuvre likely to jeopardise the safety of spectators in the event of any aircraft malfunction, or through misjudgement, is to be avoided*". The inclusion of an advanced vertical manoeuvre in a Rolling Display went against advice from the 2008 Display Pilot. This indicates to me that there may have been a level of complacency following the successful earlier Full Display work-up and that the focus at this stage may have been on producing a Rolling Display designed to win the Wright Jubilee Trophy rather than concentrating on ensuring that safety remained paramount. Furthermore, there is a requirement for Rolling Displays to only contain manoeuvres with "limited vertical extent"; another reason to question the inclusion of stall turns of any description.

e. **Wright Jubilee Trophy.** As recommended by the Panel I have reviewed the appropriateness of holding the Wright Jubilee Trophy competition at the same time as PDA and have directed that the two events are to be disassociated to remove any potential distraction during the display work-up period.

f. **Governance of Display Flying.** Although not highlighted by the Panel, there is no individual nominated as SRO for display flying within Air Cmd; consequently there is little evidence of pan-Gp coordination to determine best practice. Therefore, I recommend that a high level review of display flying and the respective orders is conducted by COS Ops; this review should include the participation approval process and the supervision, management and training of display crews. In the meantime, I have tasked Cmdt CFS with reviewing the feasibility of establishing a focal point within his AoR who could act as a 'tactical level' repository for display flying best practice. This person would not be a specialist in the specifics for

individual displays; they would be a provider of generic advice and guidance as well as a gateway into the wider display flying community.

**OBSERVATION**

5. **Canopy Fragmentation**. The RAFCAM report on this accident made comment on the fragmentation of the canopy and as a result recommended that *Consideration be given to investigating the need for possible modifications to the pattern of the LCC (Linear Cutting Cord) coverage of the front canopy*; this gave me particular cause for concern. Consequently, I directed action in support of this recommendation and subsequently have been advised by the Tucano SA that the canopy fragmentation during ejection was as predicted by the manufacturers and the escape system worked successfully. However, the risk of injury during ejection as a direct result of the canopy fragmentation pattern remains and is to be subject to further risk assessment and, if required and appropriate, mitigation. This work, along with the other RAFCAM report recommendations concerning a zero-zero Tucano ejection seat and the potential consequences of bulking out the lower leg pockets of flying suits, should be considered in addition to the list of SI recommendations.

**CONCLUSION**

6. The Panel have been thorough in conducting this Inquiry and I am content that they have comprehensively examined all the available evidence. Display flying inherently carries more risk and consequently the degree of pilot skill and discipline, and the level of supervision exercised have to be of the highest order. Participating in flying displays carries a heavy responsibility and the safety of spectators and participants has always to be paramount; therefore only the highest standards are acceptable and our crews and supervisors are to be accountable for those standards. Consequently, when we select our display pilots and supervisors from the QFI cadre, I expect them to be responsible and accountable for meticulous design and planning of the displays on the ground, conscientiously executing them in the air within parameters that provide an acceptable level of risk while enjoying close supervision at all stages. Unfortunately in this case, these qualities were not displayed to the level that I would have expected. As the Aircraft Operating Authority I will ensure that we learn as much as we can from this accident and, where practicable, implement the SI's recommendations.

[redacted]

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**PART B – REVIEWING AUTHORITY COMMENTS**

1. I agree the cause of this accident, as re-stated by the Convening Authority, and I support all of the recommendations made by the Panel, who have completed their task conscientiously; I also wholeheartedly support the amplifying remarks by the Convening Authority.

2. At the core of this Inquiry is the need to ensure that flying, which is an inherently risky activity, is pursued, supervised and assured to the highest professional standards. The additional hazards associated with display flying are well understood, and much has been written to ensure that the lessons we have learned in pursuing this discipline are widely available. We then depend upon those entrusted with display flying to apply this distilled wisdom. Sadly this was not done in the case of Tucano T1 ZF344. Whilst the necessary building blocks were in place to have conducted a safe and successful display season, for the reasons articulated by the Panel, this was not the case in this instance. Specifically, full use was not made of available resources, be it the experience of either local actors or those from further afield through, for example, the Display Symposium, and the advice contained in relevant publications, including Display Pilots Notes. In short, the evidence clearly indicates that the activity was not as professionally pursued by the display pilot nor overseen by a supervisory chain to the standards that I would expect; we are fortunate that this did not have fatal consequences.

3. A few wider issues have also caught my eye in this Service Inquiry. Firstly, I note again the workload on the Behavioural Psychotherapist. Secondly, I accept AOC 22 Gp's recommendation to nominate an Air Rank Officer to co-ordinate best practice across Air Command units for display flying. I have directed my staff to pursue these issues.

4. Display flying has, and will remain, a discipline that requires the highest standards of skill, supervision and above all safety. There is nothing new in this incident that has not been identified before. All those involved in the execution and supervision of such activity have a responsibility to apply these lessons without exception.

Sir Chris Moran
Air Chief Marshal
Commander-in-Chief
Air Command

Date 27 JAN 10