Ministry of Defence

Air Command Secretariat
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[redacted]

[redacted]

Ref: FOI 2017/09430

18 October 2017

Dear [redacted],

Thank you for your email of 29 September requesting,

'Please can you let me know where this report is [Tornado F3 ZE962] and if it is publically available report? If it is publically available, where can I find and reference it?'

I am treating your correspondence as a request for information under the Freedom of Information Act 2000 (FOIA). I can confirm that we hold information on the subject that you have requested, and that this is attached. You will notice that redactions have been applied under Section 40, for information that is personal data whose release is governed by the Data Protection Act.

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Yours sincerely,

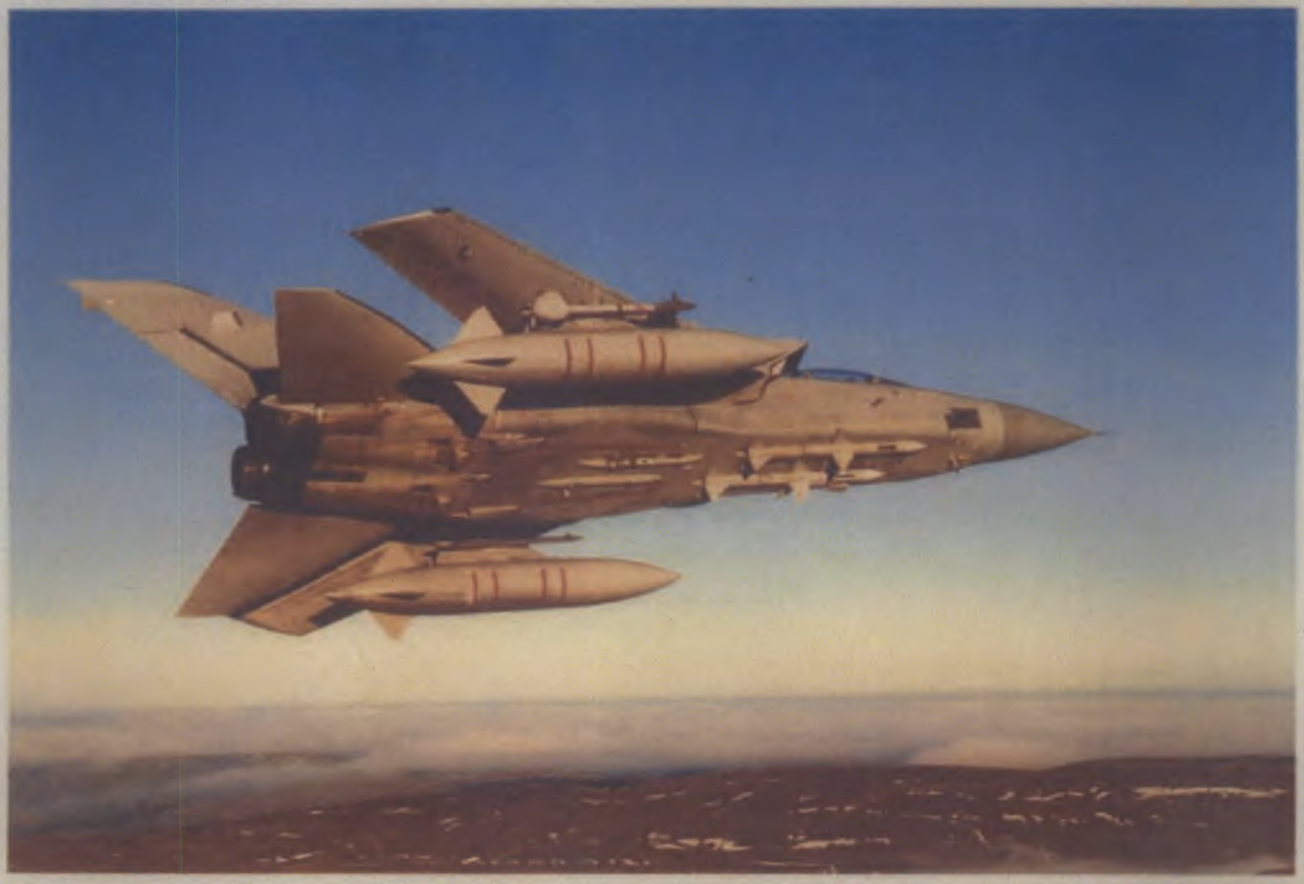
[original signed]

Air Command Secretariat

~~RESTRICTED~~

Royal Air Force

14 October 2005



Tornado F3 ZE962

AIRCRAFT ACCIDENT REPORT

~~RESTRICTED~~

DAS/BOIA/140/39/03/2

ROYAL AIR FORCE

AIRCRAFT ACCIDENT REPORT

Date:	**14 Oct 05**
Aircraft:	**Tornado F3 ZE962**
Crew:	**Pilot and Passenger**
Sortie:	**Transit**
Casualties:	**2 Major**
Aircraft Damage:	**Cat 5**

INTRODUCTION

1. On 14 October 05, the pilot of Tornado F3 ZE962 was tasked to transit the aircraft from RAF Leuchars to RAF Leeming. A ground crew passenger occupied the rear seat of the ac. The crew-in, start up, taxy and take-off were reported as uneventful and the pilot initially maintained a shallow climb in order to build airspeed. At 570kts the pilot commenced a performance climb to his cleared level (9000ft) and deselected reheat at 578kts. On rolling left to overbank and arrest the rate of climb, at a speed of approximately 450kts, the pilot felt the ac roll rapidly to the left in excess of the rate of roll expected. Subsequent actions by the pilot to regain control of the aircraft were unsuccessful, resulting in the pilot initiating command eject as the aircraft passed through approximately 7000ft in a descent. The ejection sequence was successful and the pilot and passenger landed in the sea 9nm East of RAF Leuchars.

CIRCUMSTANCES

2. Background. The flying control system of the Tornado F3 comprises mechanical, hydraulic, electrical and avionic systems which operate control surfaces to control and stabilise the aircraft in flight. In normal operation an avionic command and stability augmentation system (CSAS) provides fly-by-wire control. Part of the CSAS is an asymmetry detection system which uses 2 Asymmetry Position Transducers (APTs). The right flap APT also incorporates a microswitch which increases rudder effectiveness tenfold when the flaps are extended beyond 15deg.

3. Accident Events. On 14 October RAF Leuchars was due to launch 12 ac to RAF Leeming from where they would fly on the following Monday to RAF St Mawgan for an OPEVAL. After a number of unserviceabilities across the wing, the duty SENGO decided to delay the launch of any remaining aircraft until 1400 the following day. However, the Duty Authoriser needed to position a pilot at RAF Leeming to takeover QRA at 1200 the following day and the decision was taken to launch ZE 962 when it became serviceable. Due to a lack of rear seat crew, it was also decided that a passenger would fill the rear seat for the transit. ZE962 had a recent history of CSAS related maintenance and had already been placed unserviceable earlier in the day due to a CSAS related failure. A fault analysis suggested that the right flap APT might be at fault and a job card was raised for its replacement. This task was completed and the ac placed serviceable. The crew walked for the ac at about 1700hrs and the pilot, being aware of the previous unserviceability, asked the crew chief if a CSAS test was required and was informed that it was not. The start-up was relatively uneventful, although the pilot stated that he carried out the control checks very pedantically. The taxy and take-off was normal, though in the climb the CSAS Central Warning Panel caption illuminated as the wings were being swept and was cancelled by the pilot. Between 450kts and 500kts the pilot selected maximum reheat and started to pull up at about 570kts. At

578 kts, the pilot deselected reheat in order to control the speed. At about 6000ft, the pilot started to roll the ac gently with the intention of rolling inverted to level off at 9000ft. At this point, the ac rolled rapidly left which the pilot tried to correct by applying right roll control. This input was ineffectual. The pilot then centralised the controls and noted that he had an upward vector. The pilot then set the throttles to flight idle and at 450kts, set the wings from 67deg to 45deg. The pilot stated that the ac felt quite pitchy and was similar to a Hawk spin. As the ac had still not recovered, he put the wings to 25deg. At 7000ft with the ac still out of control, the pilot made the call to eject and pulled the ejection seat handle.

SURVIVAL ASPECTS

4. Post Ejection Events. The pilot initiated the ejection using a 2 handed pull, after giving a brief but unacknowledged order to the passenger. Both occupants recalled the acceleration from the ac and man-seat separation. Neither recalled any excessive tumbling or spinning. Canopy inflation appeared normal; however, neither was able to visually inspect the canopy due to the inflated LSJ stoles. The pilot was able to attract the attention of the passenger to confirm [redacted] During the descent the pilot [redacted] He entered the water a few seconds after seeing the passenger do so.

a. Pilot. The pilot boarded his dinghy immediately and rested [redacted] on the gunwale. Once settled into the dinghy, the pilot attempted unsuccessfully to locate the day/night flare; he recalled almost cutting himself on the axe at the time. As the pilot was due to perform QRA duties at RAF Leeming he had elected to wear his immersion suit. Although the pilot had elected not to raise his dinghy canopy he [redacted] Once in the dinghy, the pilot remembered that he had his mobile phone with him and called [redacted] the duty authoriser, [redacted] and his sqn OC. He then prepared his miniflares, some of which he fired at a Cessna circling overhead which had been vectored into position by RAF Leuchars ATC. The recovery by the rescue helicopter was uneventful.

b. Passenger. The passenger attempted to release his parachute harness before hitting the water. This was in accordance with the passenger video though in contravention of current practise. The passenger took three attempts to board his dinghy; his first attempt was hindered by the PSP lanyard and the second attempt by a large wave. The passenger had [redacted] and no suitably sized cold weather jacket had been available. Furthermore, he did not raise the dinghy canopy as he assessed the weather to be favourable. [redacted]

5. Aircrew Equipment Assembly.

a. Pilot. The pilot [redacted] The dynamic nature of the ejection coupled with the excessive roll rate and wind blast probably caused sufficient flailing to induce [redacted] Alternatively, [redacted] during the initial ejection sequence, particularly as the pilot had failed to take in the slack on his leg restraints. The pilot's lower leg pocket only remained attached by its lower stitching. The lower leg garter was not recovered; however it was not clear whether this was lost in the ejection, rescue or at the hospital. During the ejection sequence, the pilot's right arm restraint line failed to operate correctly. The pin and connector at the top of the sleeve were not drawn down the sleeve. The snubber unit, through which the line travels was found to be functioning correctly. It was therefore assumed that the arm restraint line became snagged during the ejection, although no witness marks were discovered to confirm this.

b. Passenger. The passenger's parachute harness suffered marked failures. There was no evidence to indicate how the damage may have occurred, though it is possible that it may have happened during man-seat separation as a result of the parachute lifting web deploying over and around the side of the headbox. [redacted]

DETERMINATION OF THE CAUSE

6. The Board's investigations were hampered by the lengthy salvage operation that recovered 50% of the ac wreckage. Furthermore, the recovered wreckage had suffered massive impact damage and some had been further damaged by its subsequent exposure to seawater. Additionally, the investigation was hindered by the lack of an ADR or any other on board recorded data (the RAIDs pod card was in the pilot's pocket and the Displayed Data Video Recorder tape was in a map stowage box). The F700 was also destroyed in the ac crash. Statements from the crew and detailed analysis by the Air Accidents Investigation Branch (AAIB) and BAe systems allowed the Board to rule out FOD, ac centre of gravity, weather, birdstrike, disorientation and pilot mishandling as factors in the accident. It was decided that the CSAS CWP warning during wing sweep was a transient and unrelated event. The evidence indicated a rapid and undemanded departure of the ac from controllable flight at relatively high speed. Therefore, the Board concentrated its investigations on the ac flying controls and CSAS.

7. Maintenance. When replacing the right hand APT, the schedule requires that the unit is removed with the flaps in the UP position and replaced with the flaps in the DOWN position. The replacement RH flap APT fitted to ZE962 prior to its final flight was fitted with the flaps in the UP position; essentially 180deg out of phase. With the flap APT rigged in this manner the ac would have been flying with CSAS gains opposite to those expected during the associated extension of flap. The rudder would have been 10 times more effective with the flap up. After replacement of the RH flap APT, the schedule calls for several independent and functional tests to be carried out. One of these functional tests is the flap/asymmetry test which would have highlighted the incorrectly fitted APT. This test was not completed correctly.

8. Human Factors.

a. Pressure to achieve the task. RAF Leuchars had runway maintenance scheduled for one week's duration, due to commence the following day. The majority of the station's ac were either boltholing to RAF Leeming or deploying to RAF St Mawgan for OPEVAL. The sqn was not operating at full complement on the day in question due to its dispersal over 3 locations. Despite the runway maintenance, the station management had decided that station flying would cease at 1400 and that there would be a window of opportunity to launch any remaining ac on the following day. The sqn were made aware of this decision but continued with its goal of deploying all its ac by the end of the day; a driver in this decision was the requirement to get the pilot to RAF Leeming for his QRA duty. RAF Leeming required that the ac should land by 1845 and it was established that ZE962 should leave RAF Leuchars NLT 1800. A further factor identified for causing extra pressure was the sqn's commitment to OPEVAL at RAF St Mawgan. There was a general feeling amongst the engineers that all the sqn ac should have deployed before the end of the day, so as not to 'fail the OPEVAL before it starts.' Several of ZE962's groundcrew reported that they felt pressurised to rectify the ac in time for the planned departure as they knew that failure to do so would mean a rectification team would be required to work on Saturday morning. Indeed, a SNCO had to order some of his team to slow down as he felt that they were rushing.

b. Advice to deviate from MP 19-23. The replacement of the RH flap APT is a rare event; of the personnel

carrying out the rectification on ZE962, only one person had completed the job before. In light of his past experience 4 years earlier he advised the rest of his team that they would have to deviate from the MP as it was incorrect. In his previous experience he found that he was unable to motor the flaps and slats due to the fact that the missing APT meant that the asymmetry detection system prevented them from moving. He believed that the solution was to leave the flaps in the UP position when replacing the APT. Unfortunately his understanding of the system was flawed. The MP directs that prior to motoring the flaps to the DOWN position, the 2 circuit breakers associated with the asymmetry system should be pulled thus disabling the flap/slat asymmetry detection system.

c. Inaccurate corporate knowledge of asymmetry system and CSAS. The Tornado IPT demands that a full CSAS BITE (Built In Test Equipment) be carried out every time an ac has had its flying control system broken into for maintenance, as a CSAS BITE is the most diagnostic method of ensuring the integrity of the CSAS and the ac flying controls prior to flight. The IPT were of the opinion that the RH flap APT did not constitute part of the CSAS and a CSAS BITE had not been required post any APT change. The RH flap APT contains the three 15deg microswitches that signal the position of the flaps to the CSAS that in turn controls the gains to the flying controls.

d. Stn and Sqn management. The Board observed that all major posts on station had a deputy in place at the time of the accident, the only post occupied by an individual current in the flying branch was the Sqn Authoriser. There had been a loss of engineering experience on the sqn in the recent 6 months and both the JEngO and SEngO were new in post. In addition, the SengO was supervising on both sqns. A comment was also made to the Board about the lack of supervisors at Cpl level which may account for the lack of supervising Cpls at AF and BF servicing as mandated in engineering orders.

e. Rejection of F765 dated 16 Feb 04. During the Board's investigations, an incident signal came to light concerning a RH flap APT which had been incorrectly fitted to an ac at RAFU Goose Bay in Nov 03. In this instance, the ac was in a benign flight regime and did not crash. The lessons and recommendations highlighted in the aftermath of the Goose Bay incident resulted in a F765, dated 16 Feb 04 being submitted to the IPT. In particular, the unit which had submitted the F765 requested that a CSAS BITE be included in the functional test portion of the MP. This F765 was rejected and the issue closed on 2 Aug 04. If the recommendations of the F765 had been implemented, the events leading up to the crash of ZE962 would not have occurred.

9. Loss of control. Just prior to departure from controlled flight the ac was flying at approximately 450 kts, with an approximate angle of climb of 35deg. In order to level off, the pilot rolled the ac to the left. During this first significant application of roll during the sortie, the CSAS attempted to balance the ac turn with 10 times more rudder than expected. This in turn led to an unpredictable and violent departure from controlled flight. This is not the first time that a Tornado has flown with an incorrectly rigged APT. On a previous occasion, the error was evident through the excessive yawing experienced during turns; however, importantly, it did not end in the loss of the ac. Flight model analysis suggests that flight at slower speeds would keep an ac with an incorrectly rigged RH flap APT controllable. In addition, the modelling showed that ZE 962 would have been recoverable up to 70deg AoB. The Board concluded that a more benign flight profile could have prevented the loss of the ac.

SUMMARY OF CAUSES AND FACTORS

10. **Cause.** The Board concluded that ZE962's crash was caused by an irrecoverable loss of control due to the excessive rudder deflection demanded by the ac CSAS.

11. **Contributory Factors.** The Board considered that the following were contributory factors in the loss of ZE962:

a. The failure to action the recommendations on the F765 dated 16 Feb 04.

b. The advice to deviate from MP 19-23.

c. The incorrect rigging of the RH Flap APT.

d. The execution of MP 19-23/2 Block 9.

e. The flight profile just prior to the accident.

12. **Aggravating Factors.** The Board considered that the [redacted] were aggravating factors in this accident.

13. **Other Factors.** Although not related to the loss of ZE962, the Board considered the following were other factors:

a. Inaccurate corporate knowledge of the flap/slat asymmetry system and CSAS.

b. Stn and Sqn management.

c. The pressure to achieve the task.

OBSERVATIONS

14. The Board made the following observations:

a. The passenger attempted to carry out post ejection drills that were in contravention of the current SCSR advice. This was due to one of the numerous incorrect techniques described in the Tornado passenger video.

b. The pilot elected to continue his performance climb despite him feeling somewhat unfamiliar with the ac handling.

c. A large proportion of sqn personnel had recently signed as having read JSP318 on their cardex system: this document had been superseded by the JSP550 series over 2 years previously. Moreover, after inspecting the sqn authorisation matrix it was apparent that a junior flt lt pilot had been awarded and exercised powers of self-authorisation for a passenger flight. This was in contravention of 1 Gp ASO 340.110 which details that only a CO, OC or fltcdr/senior pilot may authorise passenger sorties in Tornado ac.

d. The pilot had been scheduled to be on duty in excess of the 6 days mandated by 1 Gp ASO 345.100.3

e. The ADR did not survive the impact of the crash; furthermore, its poor reflectivity made it difficult to locate and recover.

f. The decision not to load or run the DDVR tape or to place the RAIDS card in the RAIDS pod contributed to the lack of evidence available to the Board in this Inquiry.

g. The Board considered the use of passengers in lieu of qualified aircrew to crew ZE962 for this sortie was inappropriate. The use of non aircrew in this manner contravenes JSP 550. The decision was driven by the lack of available navigators on the Stn.

h. The Tornado F3 force do not include spin/loss of control drills in its emergency FRCs or provide flight simulator training, despite them being a mandatory briefing item prior to air combat sorties.

i. MP 19-23/2 Block 9 is a comprehensive process that demands specific observations on different control surfaces at the same time from the same person. The stipulation of an almost impossible requirement undermines the authority of the MP and is likely to encourage deviation from normal practises.

j. Once the ac had departed controlled flight, the pilot's attempt to regain control was correct. The selection of 45deg wing sweep was reasonable. It is arguable that the pilot's attempt to regain control went beyond what would normally be expected of a crew in that usually, total loss of control below 10000ft would require an immediate ejection. The decision to eject at 7000ft was timely.

k. Although technically qualified to perform passenger familiarisation sorties, the Board observed that the pilot was relatively inexperienced with little exposure to the intricacies of the rear cockpit.

RECOMMENDATIONS

15. The Board recommended that:

a. The Tornado IPT ensure that a CSAS 1st Line BITE be added to DAP 101B-4102/3-EE3C post the RH Flap APT change.

b. The Tornado IPT re-educates and reinforces the importance of the RH Flap APT, specifically its 3 microswitches and their function with respect to the CSAS..

c. The Tornado IPT reviews the current wording of MP 19-23/2 Block 9. Specifically the importance of the reduction in taileron differential as the flaps travel down through 15 deg should be highlighted. Additionally, it should advise that the optimal place to view this change is from the rear of the ac.

d. The current Tornado passenger video should be withdrawn from circulation and a replacement or alternative means of passenger briefing sought.

e. JSP 550 Annex C to D340 be amended such that the captain certifies that the passenger is dressed and briefed iaw JSP 550 R340.130.3.

f. The Tornado IPT initiates the practice of placing reflective tape on Tornado ac ADRs to assist in their rapid and effective recovery.

g. Operators of ac equipped with data recording facilities should ensure that the equipment is utilised to its fullest capability so as to ensure comprehensive post-crash evidence.

h. The Tornado F3 force includes spin/loss of control drills in its FRCs and introduces basic spin recovery training in its simulators.

i. 1 Gp reassess the qualifications required to attain the status of passenger pilot of a 2 crew ac. The Board recommended that the current requirement to hold rear seat captaincy in order to fly passengers in a Tornado trainer be extended to include all Tornado ac.

COMMENTS BY HIGHER AUTHORITY

16. The Stn Cdr thanked the Board for the thoroughness of its inquiry and the enquiring and stimulating questions which were posed. He commented that a major point coming through the sub-text of the findings was one of supervision and dilution, and its relationship to high tempo fighter operations and tasking. The Stn Cdr noted that whereas a decade earlier, engineering personnel would have had a deeper than black box level of system understanding, dilution and the pressure to achieve more from less had increased risk, particularly as supervisors were neither omniscient nor omnipresent. Similarly, aircrew had greater tactical flying experience, though not necessarily the time in the logbook, airmanship and gut feel to match. He felt that the Board's findings gave a snapshot of the Leuchars wing working at high tempo and re-emphasised the need to launch ZE962 on 14 Oct 05 or delay commencement of runway repair. The Stn Cdr felt that supervision on Stn and Sqn were adequate, given that ZE962 was the last ac to depart RAF Leuchars and was on a simple transit mission. It would have been pointless to maintain a complete level of supervision for a single movement when the Stn's flying was taking place elsewhere. He agreed that in hindsight, it would have been better for the sqn to fill the rear seat with aircrew, though in all probability the accident would still have occurred. The Stn Cdr agreed with the Board's recommendations on IPT changes to the MP and the re-education on the importance of the RH Flap APT; ADR conspicuity and use of other ac data recording facilities; the requirement for a replacement F3 passenger briefing video or alternative; and that the captain certifies that the passenger is appropriately dressed. He doubted the need for spin/loss of control drills to be in the FRCs and believed that the current regulations for flying passengers were adequate. He felt that the Board had presented a fair idea of why an ac had been lost and some sound advice for preventing a recurrence.

17. The AOC felt that the Board had reached a clear and unambiguous determination of the cause of the accident. He felt that the conduct of a phased deployment was well within the capabilities of the supervisory staff remaining at RAF Leuchars and that this was not a factor in the accident, though the undeniable time pressure to deploy the ac may have impacted on their decision-making process. The AOC felt that the F3 force had a demanding schedule against which to pace output. However, it was incumbent on all levels of the supervisory chain to follow standard practices whatever the circumstances. If this meant failing to achieve the deadline then so be it, as long as the chain of command was informed so that the ramifications could be fully considered. He commented that it was disappointing that the recommendations of the earlier F765 had not been followed as this would have prevented the accident. It was also manifestly wrong that a SNCO should override the MP, though it was noted that this 'Group Think' was widely held across the engineers in the F3 force. The AOC also felt that components of a safety critical nature should be highlighted in the MPs. The AOC generally agreed with the Board's recommendations and concurred that the FRCs should contain spin recovery drills. The F3 simulator was unable to replicate the spin adequately and spin recovery drills would not be mandated. The AOC believed that more stringent limitations on passenger qualified pilots would reduce flexibility. He

believed that the avoidable accident had been caused by systemic failures when the decision making process had been clouded by the operational tempo. The F3 force was not 'at war' and even had it been so, there were procedures in place to ensure that ac were launched in a safe condition.

18. The CinC STC agreed with the Board's findings and accepted and endorsed the recommendations of the Board and the convening authority. He felt that the Board's findings highlighted the twin themes of supervision and pressure. In particular, the CinC felt the accident highlighted the maxim of 'know when to say no' throughout the supervisory chain in light of the high-tempo of current RAF activities. He agreed that the rectification team had intended to undertake a professional and successful job, but were working in contravention to the MP and under mistaken assumptions. He felt that the decision not to include a full CSAS BITE based on the earlier F765 had been reasonable at the time when considering the stresses that such a BITE placed on the flying controls. Overall, he felt that this accident highlighted the need for every individual to play their part in identifying hazards to flight safety and mitigating against them or raising their concerns to an appropriate level.

FLIGHT SAFETY COMMENT

19. The flight safety message is simple. Follow the MPs. If the MPs are wrong – get them changed.

[redacted]

I L DUGMORE
Air Commodore
DMARSG

Sep 07