RAF FORM 412 (ADP)
(Revised Jan 92)

ROYAL AIR FORCE
PROCEEDINGS OF A BOARD OF INQUIRY
INTO AN AIRCRAFT ACCIDENT

PART 1

DETAILS OF THE BOARD

Reconvened on 26 FEB 96 at RAF KINLOSS.

By order of the AIR OFFICER COMMANDING NO. 18 GROUP.

To inquire into an accident involving NIMROD MR2 XV239

on 2 SEP 95.

1. **Composition of the Board.**

Duty	Rank, Name, Service No & Decorations	Branch	Unit
President	Redacted S.40 - Wg Cdr A	GD/P	HQSTC
Members	Redacted S.40 - Sqn Ldr B	GD/P	RAF KINLOSS
	Redacted S.40 - Sqn Ldr D	ENG	RAF KINLOSS
	Redacted S.40 - Flt Lt E	GD(ENG)	RAF KINLOSS

2. **Terms of Reference.**

a. Further investigate the circumstances of the accident to Nimrod MR2 XV239 at Toronto Canada on 2 Sep 95.

b. Determine the cause or causes of the accident and examine related factors, paying particular attention to the areas of;

(1) **Adequacy of crew experience.**

(2) **Adequacy of crew selection procedure.**

(3) **Minimum required crew for display flying.**

(4) **Adequacy of training, including air and simulator training and techniques taught.**

(5) **Adequacy of supervision.**

(6) **Whether supervising chain was aware of Flt Lt Gilbert's difficulties with the dumb-bell manoeuvre.**

(7) **Further consideration of crew competence.**

(8) **Implications of on-crowd wind as a factor in the**

accident.

(9) Implication of trimming into manoeuvre at low speed.

(10) Whether post-stall recovery action was optimised.

(11) The adequacy of orders and instructions relating to display flying.

(12) The aircraft configuration for the display, including the fuel load and weight of the flyaway pack and their effects on the centre of gravity and handling characteristics, particularly stalling speed.

c. Ascertain if all relevant orders and instructions were complied with.

d. Assess any human failings.

e. Make appropriate recommendations.

PART 2: CONCLUSIONS OF THE BOARD

DIAGNOSIS OF CAUSES

All times Local.

INTRODUCTION

1. The Board was reconvened on 26 Feb 96 under the Terms of Reference detailed in Part 1 of this report, and considered the following factors:

a. Adequacy of crew experience.

b. Adequacy of crew selection procedure.

c. Minimum required crew for display flying.

d. Adequacy of training, including air and simulator training and techniques taught.

e. Adequacy of supervision.

f. Whether supervisory chain was aware of Flt Lt Gilbert's difficulties with the dumb-bell manoeuvre.

g. Further consideration of crew competence.

h. Implications of on-crowd wind as a factor in the accident.

i. Implication of trimming into manoeuvre at low speed.

j. Whether post-stall recovery action was optimised.

k. The adequacy of orders and instructions relating to display flying.

l. The aircraft configuration for the display, including the fuel load and weight of the flyaway pack and their effects on the centre of gravity and handling characteristics, particularly stalling speed.

2. Adequacy of Crew Experience. The Board re-considered what effect the experience of the flight deck crew may have had on the circumstances

of the accident.

a. Flt Lt GILBERT. Flt Lt GILBERT, had a total of 2960 hours flying experience, 2635 hours of which were on the Nimrod, and 946 were as captain. During his 2 sqn tours, and a tour in Ops Wg at RAF Kinloss, Flt Lt GILBERT experienced the full gamut of maritime flying, including several maritime training exercises, both national and overseas based. He was trained in fighter evasion techniques and undertook the duties of an Authorized Checking Officer. Exhibit 2,3 & Witness 11 Annex BB

b. Flt Lt HOOPER. Flt Lt HOOPER had completed 22 months of his first sqn tour and had a total of 1095 flying hours, of which 800 hours were on the Nimrod. During his time on the sqn, Flt Lt HOOPER had taken part in several major maritime exercises, both national and overseas based. Additionally, during the 1994 display season, he was trained in rear crew emergency procedures which enabled him to fly as an authorised rear crew member on 11 display sorties with the 120 Sqn display crew. As such, the Board consider that he would have gained a valuable insight into the routine aircraft operations and procedures employed during air displays. Furthermore, during this period, he was responsible for the majority of the routine flight planning for the displays, and the Board further considered that he would have gained valuable experience of the duties and responsibilities of a display co-pilot. Exhibit 4,5 & Witness 11 Annex BC

c. Sgt MOXHAM. Approaching the end of his first tour on Nimrods, Sgt MOXHAM had a total of 1304 flying hours, 1269 of which had been flown on the Nimrod. This was his first Nimrod display season; however, he was an experienced glider pilot and was the Chief Flying Instructor and Display Pilot for the Stn Gliding Club. Exhibit 6,7 & Witness 11

The Board noted that 18 Gp ASOs do not stipulate minimum levels of experience or flying hours when considering the selection of Nimrod Display crews. In order to establish a yardstick by which to measure and compare the experience of the flight deck crew of XV239, the Board reviewed the appropriate ASOs for the selection of Tornado F3, Annex BD

Hercules and Support Helicopter display crews together with details of the experience levels of the Nimrod Display crews for the previous 4 seasons. It was apparent that 18 Gp ASOs covering the selection of display crews do not differ significantly from those of the other Gps, in that they too do not stipulate minimum experience levels. Whilst the Board noted that both Flt Lt HOOPER and Sgt MOXHAM were relatively inexperienced when compared with their counterparts over the previous 4 display seasons, they were by no means the least experienced aircrew to be selected for flying display duties. The Board believe that the inclusion of minimum experience criteria for display crews in ASOs would be overly restrictive, and would remove any flexibility for sqn and stn cdrs to select display crews on their proven ability as aircrew. The Board considered that individual and collective experience did not affect the outcome of this accident and was therefore not a factor.

Annex BD
Annex BE
Annex AH

3. Adequacy of Crew Selection Procedure. The Board had been satisfied that the crew selection procedure was sound, providing sufficient checks and balances up to the highest level in the command chain. Despite the lack of any laid down experience criteria, the Board support the views of OC 120 Sqn and the Stn Cdr who consider that the selection process is based upon the ability of the individuals, their approach and attitude to their work and upon their ability to work together as a team. At no time during the display season did Flt Lt GILBERT's crew give any cause to doubt their ability to safely carry out the duties of a display crew. The thoroughness with which the selection process is staffed at HQ 18 Gp, with the AOC reviewing and signing every entry on an individual's F5000 series, further led the Board to maintain that the crew selection procedure was not a factor in this accident.

Witness 11 & 15

4. Minimum Required Crew for Display Flying. The Board had previously considered the minimum crew requirements for display flying, and had consulted with the Nimrod Standardization Unit (NSU) who had been tasked by HQ 18 Gp, post the accident, to review minimum crew requirements. The NSU concluded that the minimum crew requirement for non-operational sorties was 7 (2 pilots, 1 air engineer, 1 navigator, 1 AEO and 2 AEOps). Whilst the Board concedes that during the

Annex BF

air display sequence only the flight deck crew and the navigator are actively involved with the operation of the aircraft, it agrees with the NSU view that the remaining 3 crew members have an essential safety role in handling cabin and underfloor emergency drills. Therefore, the Board recommends no changes to the current minimum crew requirements and considers that it was not a factor in this accident.

5. Adequacy of Training, Including Air and Simulator Training and Techniques Taught. Whilst the Board had previously investigated the training undertaken by Flt Lt GILBERT's crew and had considered it to be a contributory factor in the accident, the Board further considered the adequacy of the training.

a. Air Training. The Board had previously concluded that the training of display flight deck crews was a contributory factor in this accident. The lack of a formal training syllabus, which should have included detailed theory of important aerodynamic factors, display planning, weather minima, and the effect of wind and visibility during the display, meant that Flt Lt GILBERT could have commenced his display flying without a thorough appreciation of these factors. Furthermore, the Board noted that there is no formal requirement for Nimrod display pilots to practise stalling in the turn (recovering at the onset of stall warning) as part of their work-up training. As a result, Flt Lt GILBERT had little recent practical experience of stalling in the turn.

b. Simulator Training. Flt Lt GILBERT carried out 2 practice display sequences in the Nimrod Dynamic Simulator (NDS), in accordance with the directions given in the HQ 18 Gp NDS Handbook. Although the NDS does not fully emulate the aerodynamic performance of the Nimrod, it is useful for practising display techniques, handling aircraft emergencies and exercising crew cooperation. During the 2 NDS display exercises, Flt Lt GILBERT asked the pilot NDS Controller to introduce a major malfunction at a critical stage of each display sequence. The pilot NDS Controller for both NDS display practises, who was a very experienced ex-

Annex AI

Witness 12

Nimrod captain and Test Pilot, considered that Flt Lt GILBERT and his crew handled both incidents, which were introduced during the second dumb-bell manoeuvre, in an outstanding and professional manner. Likewise, at no time did Flt Lt GILBERT display any dangerous tendencies or excursions from the laid down sequence. The Board considers that NDS training should be included as an integral part of the training syllabus for Nimrod display crews. Witness 12

c. Techniques Taught. During his display work-up training, Flt Lt GILBERT was demonstrated the second dumb-bell turn with a target speed of 150kts, with the power left on and the aircraft aerodynamically unloaded until the aircraft's nose had dropped below the horizon. In the absence of a formal training syllabus and instructions in 18 Gp ASOs relating to a minimum speed in the second dumb-bell manoeuvre, the Board considered that S.40 - Sqn Ldr AL instruction on display technique was adequate. Furthermore, the Board considered that the manoeuvre, as demonstrated by S.40 - Sqn Ldr AL was inherently safe. For example, at the maximum display weight of 130,000lbs, with the aircraft flying at 150kts, the aircraft could be subjected to a loading of 1.92G before stalling occurs, which the Board considered to be an adequate margin of safety. Witness 14 Annex W

Having reconsidered all aspects of Flt Lt GILBERT's display training, the Board concluded that it was probable that the lack of training based on a formal syllabus, which should have included theory, simulator, and airborne instruction, left Flt Lt GILBERT without a solid base on which to safely develop his technique during his work-up training. The Board further considered that the inadequacy of his training led Flt Lt GILBERT to develop a technique for the second dumb-bell turn which was inherently unsafe as it provided insufficient margins to the stall. The Board, therefore considered that the lack of appropriate training based on a formal syllabus was a contributory factor.

6. Adequacy of Supervision. The Board had previously considered that the supervision of

Nimrod display flying was a contributory factor in the accident; it further considered the adequacy of the supervisory regime. The Board determined that both the display supervisors were experienced Nimrod pilots who had previous experience of display supervision. OC Ops Wg, as the designated primary supervisor for all Nimrod display pilots at Kinloss, supervised all but 3 of Flt Lt GILBERT's 24 practise display sequences. OC 206 Sqn supervised the remainder of Flt Lt GILBERT's display practises when OC Ops Wg was not available. Following each display sequence, a hot debrief was carried out over the radio, followed by a face-to-face debrief on completion of the sortie. The Stn Cdr also took an active interest in the supervision and debriefing of the display crews, particularly during the work-up training. He was aware that, as a navigator, he had to ensure that he used the best advice available. He considered himself fortunate to have 2 wg cdr pilots under his command, who were QFIs with previous display experience, to advise him and to whom he delegated supervisory responsibilities. The Stn Cdr observed all 3 display crews at various stages during their work-up schedule, and would listen to hot debriefs of the crews over the radio. Furthermore, he met with crews and supervisors after landing if time allowed. Flt Lt GILBERT regularly discussed his performance with the Stn Cdr, OC 120 Sqn and OC Ops Wg following his displays, and at no time did he express concern over any element of the display sequence. In further considering the adequacy of the supervision, the Board reviewed the appropriate ASOs for the supervision of Hercules and Support Helicopter display crews. The 18 Gp ASO covering the supervision of Nimrod display flying was found to be consistent with the HQs 1 and 38 Gp ASOs and the HQ STC ASIs covering displays and demonstrations. The Board had previously recommended that the supervision of Nimrod display crews is reviewed to contain an element of airborne supervision both before and after ratification, and further recommend that this on-board supervision is carried out by a previous display pilot, who would act as a mentor for the whole of the display season. In addition, the display practices should continue to be supervised from the ground by the Stn Cdr, or by a nominated deputy. Given that on-board supervision could have prevented the development of the technique adopted by Flt Lt GILBERT for flying the second

Witness 4,5 & 15
Exhibit 14
Witness 15
Witness 5,11 & 15
Annex BD
Annex AH
Annex BD

dumb-bell manoeuvre, the Board considered that the 18Gp ASO covering the supervision of flying displays was inadequate. Accordingly, the Board again conclude that supervision was a contributory factor in the accident.

7. Whether the Supervising Chain was Aware of Flt Lt GILBERT's Difficulties with the Dumb-Bell Manoeuvre. The Board re-interviewed all those involved in the Nimrod flying display supervisory chain. Despite the inadequacy of the 18 Gp ASO covering the supervision of display flying, the Board considered that all those involved carried out their duties in a punctilious manner. There was no evidence to suggest that Flt Lt GILBERT would have been reluctant to approach any of the supervisors to discuss any problem concerning his display flying. Indeed, Flt Lt GILBERT was known to be forthcoming and open in his display practice debriefs. He enjoyed good working relationships with the Stn Cdr and OC Ops Wg. Accordingly, the Board determined that none of Flt Lt GILBERT's supervisors were aware of any difficulties he may have been experiencing with the dumb-bell manoeuvre, or indeed with any part of his display sequence and, therefore, that this was not a factor.

Witness 4,5 & 15

Witness 4,5 & 15

8. Further Consideration of Crew Competence. When considering the competence of Flt Lt GILBERT's crew the Board assessed whether they possessed the ability to cope with the demands of display flying. Witness statements, personal reports and training records confirm that all three flight deck crew members worked well together under pressure and displayed a good level of crew cooperation. Flt Lt GILBERT was considered to be an extremely dependable captain and an above average pilot. Furthermore, Flt Lt HOOPER was assessed to be a reliable co-pilot who demonstrated a high degree of airmanship and handling ability. In addition, he had gained a valuable insight into the demands and requirements of display flying during the previous season. At no stage during the selection process or subsequent display flying were any concerns expressed by those involved with supervision, or training, as to the competence of Flt Lt GILBERT's crew. Neither had Flt Lt GILBERT given any indication that he was not happy with any element of his sequence. Furthermore, the Stn Cdr considered that Flt Lt GILBERT was possibly the

Witness 11,12 & 15
Annex AI

Witness 11

Witness 15

most promising of his junior officer pilots. Likewise, he also considered that Flt Lt HOOPER was a very capable officer and that, as a co-pilot, he provided more than enough support to his captain. Moreover, despite his relative inexperience, Sgt MOXHAM was considered to be a capable aviator and a good air engineer. In addition, in confirming Flt Lt GILBERT's selection as a display pilot, AOC 18 Gp had no doubts about his competence as a pilot. Accordingly, the Board maintains that the crew were competent to carry out the duties of a display crew, and that crew competence was not a factor in the accident.

Witness 15

Annex F

9. Implications of an On-Crowd Wind as a Factor in the Accident. Flt Lt GILBERT's display work-up training sorties were carried out in varied wind conditions, with wind speeds of up to 28kts, and a worse-case on-crowd component of 20kts. During this training, there was much discussion with the supervisor concerning correcting the display sequence for various wind conditions. In particular, on Flt Lt GILBERT's final supervised display practice prior to his detachment to Canada, the display supervisor recorded that conditions were turbulent with a 25 kt wind. He commented that Flt Lt GILBERT flew a good sequence throughout, making good allowance for wind in difficult conditions. The forecast wind at the Airshow briefing was given as light, about 10kts. The wind over the lake at the time of the accident was 170 degrees at 11 kts which resulted in an on-crowd component of approximately 10 kts. Notwithstanding the briefed wind, the Board considered that Flt Lt GILBERT would not have decided on his final wind corrections for the display sequence until he was running in to the display datum, at which time the actual wind would be computed by the aircraft's navigation system. The Board considered that the wind conditions at the time of the accident were well within those previously experienced by Flt Lt GILBERT during his display work-up training and subsequent display practises. The ground radar plot of the aircraft track and the reconstructed flight path derived from DARU data, both indicate that Flt Lt GILBERT had made due allowance for wind. Accordingly, the Board maintain that a 10 kt on-crowd wind did not present Flt Lt GILBERT with a problem and, therefore, concluded that the on-crowd wind was not a factor in the accident.

Exhibit 14

Witness 5

Exhibit 14

Witness 1

Annex O

Annex M & S

10. Implication of Trimming into Manoeuvre at Low Speed. At the top of the second dumb-bell manoeuvre, at a speed of 122kts, the Data Acquisition and Recording Unit (DARU) information indicates that the elevator was 10 degrees up. At the point of impact, the elevator trim wheel was set at 5 divisions nose up which equates to 10 degrees of up elevator. The Board considered it was unlikely that Flt Lt GILBERT would have changed the elevator trim setting after the point at which the aircraft stalled. It further considered that, at the point of stall, when the elevator was at 13 degrees up, the elevator position probably comprised 10 degrees of up elevator provided by elevator trim and 3 degrees of pilot applied elevator. As the airspeed increased, the elevators became more effective causing the G to increase. From the top of the second dumb-bell manoeuvre, the G steadily increased, from 1G to 1.6G in 6 seconds as a result of the speed increase from 122 to 136kts. The implication of Flt Lt GILBERT trimming the aircraft to 5 divisions nose up was to leave little margin for pilot input to the elevator before the G increased to the point where manoeuvre stall occurred. The Board consider that, during routine flying, it is not inherently dangerous to trim to such a degree. However, although trimming during a manoeuvre is correct and is an instinctive action for an experienced Nimrod pilot, the Board considered this to be unwise given the nature of air display flying where increased G loading is likely. Consequently, the Board considered that trimming to 5 divisions nose up was an additional contributory factor in the accident.

Annex R

Annex V

Annex R

11. Whether Post-Stall Recovery action was Optimised. The Board had previously concluded that, following the aerodynamic stall, the absence of a positive G-break (the discontinuity of the normal acceleration trace resulting from the sudden loss of wing lift) meant that the aircraft unstalled almost immediately. Analysis of DARU and video evidence indicates that, at the point of stall, the port wing dropped and the nose pitched down significantly. Further analysis of DARU data also indicates that recovery action was taken in arresting the wing drop by applying full opposite aileron and by unloading the elevators, albeit only by a reduction in up elevator of 3 degrees. Full power was also applied. These actions are

Annex T

Annex P & R

entirely consistent with the recommended recovery technique for a stall in the turn contained in the Aircrew Manual, Book 3. The Board maintain that, after the stall, the aircraft unstalled almost immediately following the actions which Flt Lt GILBERT had taken. However, the Board concluded that it was the aircraft attitude and lack of height following the stall that resulted in the aircraft crashing. The results of a series of exercises conducted by the Board in the NDS confirmed this. Annex AV Annex AG

12. The Adequacy of Related Orders and Instructions Relating to Display Flying. The Board further reviewed the orders and instructions relating to Nimrod display flying, outlined in Annex C to Order 2103 of Part 1 to 18 Gp ASOs. The Board noted that, whilst the ASO stipulates a maximum height of 1000ft during the second dumb-bell manoeuvre, it does not specify a target speed for the manoeuvre. The Board noted that Flt Lt GILBERT flew the second dumb-bell manoeuvre to a height of 1400ft. However, the 1000ft limitation was included to allow separation from the 1500ft cloud-base limit stipulated in the ASO. Given the excellent weather conditions, the Board considered that Flt Lt GILBERT's excursion from the ASO was not significant. The Board determined that in 1984 the ASO had specified a target speed of 180kts during this manoeuvre. However, the Board further determined that, in a subsequent amendment to the ASO in 1991, this minimum speed was removed as it was considered that the second dumb-bell was an accelerating manoeuvre where too much, rather than too little speed would be a problem. During his display training, Flt Lt GILBERT was demonstrated this manoeuvre using a target speed of 150kts, with power maintained until the aircraft's nose dropped below the horizon. The Board considered this to be an inherently safe manoeuvre. However, the lack of a target speed for this manoeuvre in the ASO may have seduced Flt Lt GILBERT into reducing speed during the dumb-bell, thus eroding his safety margins to an unsafe value. The Board considered that the inclusion of a target speed for the second dumb-bell manoeuvre would be prudent, and that the absence of a target speed in the most recent amendment to the ASO was a contributory factor in this accident. Annex AH Annex AL Witness 18 Witness 14

13. Aircraft Configuration for the Display, Including the Fuel load and weight of the Flyaway Pack (FAP)and their effects on the Centre of Gravity (C of G) and Handling Characteristics, Particularly Stalling Speed. At the time of the accident, the combination of the basic weight of the aircraft, together with its fuel and internal loads, resulted in an All Up Weight (AUW) of approximately 120,000lbs, and a C of G position 0.36ft forward of the datum. This put the C of G close to the centre of the flight range. The fuel load was approximately 21,800lbs, and was correctly distributed. The FAP weighed approximately one tonne, and had this not been fitted, the reduction in AUW would have resulted in the stalling speed reducing by approximately 1kt, and a change in the C of G position to 0.66ft forward of the datum, which is also close to the centre of the flight range. The Board considered that the change in AUW and C of G that resulted from flying with the FAP fitted had an insignificant effect on the stalling speed. The Board also determined that the FAP was properly secured for the flight and there is no evidence to suggest that it moved during the display sequence or that it had an adverse effect on the handling characteristics of the aircraft. Accordingly, the Board did not consider that flying with the FAP fitted was a factor in the accident. However, the Board recommend that all extraneous equipment should be removed from the aircraft before display flying.

Exhibit 12, Annex V & BG

Witness 2

Annex W & BG

Witness 2

SUMMARY OF CAUSES AND FACTORS

14. Cause. Having reviewed a number of additional factors which may have been the potential cause of the accident, the Board maintain that the cause of the accident was that the aircraft stalled at a height from which recovery was impossible.

15. Additional Contributory Factor. The Board found that trimming into manoeuvres at low speed was an additional contributory factor in the accident.

RELEVANT ORDERS AND INSTRUCTIONS

16. The Board determined that all relevant orders and instructions were complied with, with the

Annex AH

exception of Order 2103 to Part 1 of HQ 18 Gp ASOs, in that:

a. By exceeding the 1000ft height limit for the second dumb-bell manoeuvre, Flt Lt GILBERT did not fly the standard Nimrod display sequence.

b. Although not specifically prohibited, a Verey flare was fired during the second dumb-bell manoeuvre. The order permits the firing of a Verey flare prior to the final wingover.

CONSIDERATION OF HUMAN FAILINGS

17. **In previously considering human failings the Board concentrated on the performance of the flight deck crew and concluded that, in flying the dumb-bell manoeuvre at such a slow speed, Flt Lt GILBERT had developed an inappropriate modification to his display sequence which left little room for error. However, without the irrefutable evidence of a CVR or modern ADR, the Board could not positively determine the sequence of events leading to the accident, and could not discount the possibility that Flt Lt GILBERT was distracted by a transient aircraft systems or instrument failure, or that the aircraft had suffered a transient control restriction at a critical point during the final manoeuvre. Furthermore, no evidence was discovered which even hinted at undisciplined or reckless flying. The Board considered that Flt Lt GILBERT had made an honest mistake and concluded that he had made an Error of Judgement and recommended that he be absolved from blame in accordance with QR1270(2). The Board had also previously concluded that there were no human failings attributable to Flt Lt HOOPER or Sgt MOXHAM.** In considering further factors the Board were unable to discover any new evidence which would support a change to the original consideration of human failings in respect of the flight deck crew. However, whilst the Board had previously considered that no blame should be attached to those individuals involved in the supervision and training of Nimrod display crews, the Board examined the corporate responsibilities of the Station and HQ 18 Gp staffs. In particular, the Board considered the duty of care which they exercised in the selection, training and supervision of Nimrod display flying and in issuing the appropriate HQ

18 Gp ASOs.

a. Selection of Nimrod Display Crews. In the absence of any guidance on minimum experience levels for Nimrod display crews, Flt Lt GILBERT and his flight deck crew were selected on the basis of their proven ability as aircrew. The Board considered that it was not necessary to include direction on minimum experience levels in HQ 18 Gp ASOs and that the thoroughness of the staffing process provided checks and balances to the highest levels in the command chain. The Board could find no evidence to suggest that anyone involved in the selection process had failed in their duties in ensuring that Flt Lt GILBERT and his crew where qualified to proceed to the next phase of training as a display crew.

Exhibits 2,3, 4,5,6 & 7 Annex BB & BC Witness 5,11, 12 & 15

b. Training of Nimrod Display Crews. The Board had previously considered that the training of Nimrod display flight deck crews was a contributory factor in the accident. Despite the fact that the same training regime had been in place for a number of years, the Board considered it is axiomatic that, given the extra demands placed upon display crews, a formal training syllabus should have been in place which would have better prepared Flt Lt GILBERT for the display season. With the benefit of hindsight, the Board considered that the HQ 18 Gp staffs responsible for the orders and instructions covering the training of Nimrod display crews failed in their responsibilities in 2 areas: Firstly, under the current HQ 18 Gp ASO, in providing insufficient guidance to the display instructor on the conduct of display training; and, secondly, in not providing a formal training syllabus similar to those for fighter affiliation and AAR training. Accordingly, the Board concluded that the HQ 18 Gp staffs had made a corporate error of judgement in not providing a formal training syllabus for Nimrod display crews. However, the Board do not consider that any blame is attributable to any individual member of the HQ 18 Gp staffs responsible for the orders and instructions covering the training of Nimrod display crews. Furthermore, the Board

Annex AH

considered that S.40 - Sqn Ldr AL instruction on display technique was adequate and that the technique demonstrated for the second dumb-bell was inherently safe. Accordingly the Board considered that no human failings are attributable to S.40 - Sqn Ldr AL for the manner in which he conducted display training.

c. Supervision of Nimrod Display Flying. Whilst the Board, again with the benefit of hindsight, considered that the supervision of Nimrod display flying could have been improved by including an element of on-board supervision, it did not consider that the HQ 18 Gp staffs had failed in their duties. The Board determined that the supervision of Nimrod display flying during the 1995 season was carried out in a punctilious manner by all those in the supervisory chain. Furthermore, the Board considered that Flt Lt GILBERT's willingness to discuss his display technique during debriefs, and the lack of any indication that he was having any problems with the display sequence, would not have led his supervisors into considering an alternative regime. Accordingly, the Board concluded that there were no human failings attributable to the display supervisors, or the HQ 18 Gp staffs responsible for the ASOs covering the supervision of Nimrod display flying.

Exhibit 14
Witness 1,4, 5,11 & 15

d. HQ 18 Gp ASOs. Whilst the Board concurred that the second dumb-bell is an accelerating manoeuvre, where too much speed rather than too little could present the pilot with a problem, it considers that the inclusion of a target speed for the second dumb-bell turn within the ASOs would have been prudent. The Board determined that Flt Lt GILBERT had experienced problems controlling speed during the dumb-bell turn, and considered that, had a target speed been included in the ASOs, he may not have been seduced into flying the manoeuvre at such a slow speed. Accordingly, the Board concluded that the HQ 18 Gp staffs had made a corporate error of judgement in not issuing guidance on a target speed for the second dumb-bell manoeuvre. However, the Board do not consider that any blame is attributable to

Annex AZ
Witness 9

any individual involved in the framing, issuing and any subsequent amendment to the ASO outlining the standard display sequence.

RECOMMENDATIONS

18. The Board further recommends that:

a. Nimrod display pilots are warned of the inherent dangers of trimming to low speeds during a display sequence.

b. All extraneous equipment is removed from the Nimrod prior to air displays.

c. No change is made to the current minimum crew requirement for display flying.

d. On-board supervision of Nimrod display practises is conducted by a pilot with previous Nimrod display experience, who would also act as a mentor to the flight deck crew for the entire season.

Preside	Redacted S.40 - Wg Cdr A	Wg Cdr
Members	Redacted S.40 - Sqn Ldr C	Sqn Ldr
	Redacted S.40 - Sqn Ldr D	Sqn Ldr
	Redacted S.40 - Sqn Ldr E	Sqn Ldr

PART 3

REMARKS BY STATION COMMANDER

INTRODUCTION

1. The Board has carried out a detailed and thorough investigation into the circumstances surrounding the accident involving Nimrod MR2P, XV239. Despite the lack of comprehensive evidence, in particular the absence of voice recordings from a cockpit voice recorder or modern ADR, the Board has met its terms of reference and established the most likely cause of the accident. Furthermore, the Board has provided logical and well considered advice and recommendations for the future.

2. **Nimrod Display History**. Before reviewing the Board's findings, it is appropriate to consider briefly the Nimrod's display history. The Nimrod has been involved in the display circuit for more than 20 years and, throughout this period, the display sequence has remained largely unchanged. There is little doubt that the Nimrod is a popular combat aircraft at displays, particularly overseas, and in recent times has replaced the Vulcan as the agile "heavy". The number of display pilots selected for each season has varied, but has generally been 3 or 4, with each pilot conducting around 15 displays per season. In addition, each pilot has flown approximately 20 work-up and in-season practices during a display season. Therefore, well over 2000 Nimrod flying displays have been successfully conducted. While the specific display sequence was removed from 18 Gp ASOs over the period from 1984 to 1991, the restrictions imposed on the aircraft by its size and flight envelope have always resulted in a sequence which closely mirrors that detailed in the current ASO. Accordingly, it is reasonable to conclude that the display sequence is well proven and safe when flown correctly.

SELECTION OF NIMROD DISPLAY FLIGHT DECK CREWS

3. **Adequacy of Selection Procedure**. I support the Board's conclusion that the selection of the display flight deck crews for the 1995 season was carried out in accordance with current 18 Gp ASOs. However, the selection process is rarely easy, particularly given the current decline in crew experience levels, the effect of postings and squadron workload. These factors led to changes to the initial 206 Sqn flight deck crew combination, with the inclusion of S.40 - Sqn Ldr AM as display pilot. In addition, the NOCU crew nomination, with S.40 - Sqn Ldr AL as display pilot, was withdrawn. This latter decision was taken because S.40 - Sqn Ldr AL had a particularly heavy workload, but more importantly, it was felt that a third consecutive season as display pilot might have led S.40 - Sqn Ldr AL to become

overconfident. These changes typify the rigorous scrutiny that is undertaken and serve to illustrate that crew compositions are considered carefully at every level of the command chain. I agree with the Board's finding that the crew selection procedure was not a factor in this accident.

4. **Adequacy of Crew Experience**. Like many previous Nimrod display pilots, Flt Lt GILBERT held an 18 Gp B category (an above average standard) and was also an authorised checking officer (ACO), an appointment similar to a sqn QFI. Moreover, he was a qualified fighter affiliation pilot and, in this role, would have flown the aircraft using evasion manoeuvres in a flight regime just as demanding as the flight profile in the standard Nimrod display. However, whilst Flt Lt GILBERT's ability as a Nimrod pilot was not in doubt, he had no previous experience of display flying and, more importantly, had little experience of stalling the aircraft outside the simulator. What stalling experience he did have would certainly not have included stalling the aircraft in the turn or in the 20 flap configuration. Notwithstanding his limited stalling experience, I consider that Flt Lt GILBERT was adequately experienced to enter training as a display pilot. Whilst Flt Lt HOOPER and Sgt MOXHAM were relatively inexperienced when compared with their counterparts over the last 4 display seasons, the Board highlighted that they were by no means the least experienced aircrew to have been selected. Indeed, Sgt MOXHAM was an experienced and highly capable glider pilot and CFI, whilst Flt Lt HOOPER was an above average co-pilot who had also flown as an authorised rear-crew member on the 120 Sqn display crew for the 1994 season. Another major consideration was that the flight deck crew were known to work well together as a team. The combination of all these factors led me to conclude that the 120 Sqn flight deck crew had sufficient overall experience to be nominated for display duties.

5. **Minimum Experience Levels Required for Display Flying**. The Board discussed whether minimum levels of experience should be considered in the selection process. I support the view that stipulation of minimum experience levels (flying hours) would be overly restrictive and could remove any flexibility for stn and sqn cdrs to select display crews from already established teams on the basis of their proven ability as aircrew and their ability to work together. Although not discussed by the Board, I also consider that it is unnecessary to stipulate that both pilots should be filling designated first pilot appointments. All Nimrod pilots are trained to first pilot standard on the NOCU course and, once again, this stipulation would mean that an already constituted flight deck crew, with proven ability to work together, could not be nominated for display duties. In sum, it is ability as much as experience that counts and I support the Board's finding that the individual and collective experience of

the 120 Sqn flight deck crew was not a factor in this accident.

6. **Minimum Required Crew for Display Flying.** The Nimrod minimum crew has been questioned on a number of occasions and it has always been concluded that 7 is a sensible and practical minimum. Even assuming the aircraft can return to base and land quickly, a cabin fire or underfloor emergency, if allowed to go unchecked, could result in a rapid build-up of smoke or fumes in the fuselage. Moreover, with the limited visibility offered by the Nimrod, the extra lookout and positional information afforded by 2 beam lookouts can be invaluable during displays. Taking these factors together, I agree that there should be no change to the minimum crew requirement.

TRAINING OF NIMROD DISPLAY FLIGHT DECK CREWS

7. **Absence of Syllabus of Training.** The Board highlighted that no syllabus of training for display flying exists and, with hindsight, I agree that this was a factor in the accident. Such a syllabus should be implemented and should be wide-ranging, covering topics such as stalling and aerodynamic theory.

8. **Airborne Training.** Flt Lt GILBERT was flying his 40th airborne display routine of the 1995 season (26 practices and 14 displays) and was, thus, well familiar with the display sequence. However, despite the existence of a well practised training regime which included discussion on display flying theory and technique, and the opportunity to carry out a supervised stall in the clean configuration, the Board correctly identified that the dangers associated with manoeuvre stall may not have been adequately understood by Flt Lt GILBERT and his crew.

9. **Simulator Training.** Under existing arrangements, display crews rehearse in the Nimrod Dynamic Simulator (NDS) and additional serials are made available if required. Flt Lt GILBERT had flown 2 NDS serials prior to deploying to Toronto, both of which included a serious simulated emergency during the second dumb-bell manoeuvre; these emergencies were handled well by the crew. Since the principles and recognition of manoeuvre stall could easily be taught and demonstrated in the NDS, I consider that additional NDS sorties should be flown as part of an enhanced training package.

10. **Techniques Taught.** S.40 - Sqn Ldr AL was an experienced display pilot and the technique he taught for flying the second dumb-bell manoeuvre with a target speed of 150 kts was inherently safe, allowing sufficient safety margin between target airspeed and the manoeuvre stall speed. However, while Flt Lt GILBERT had clearly used a similar technique during his early displays, he may have been seduced into reducing the target speed to negate a perceived

excess of energy at the top of the dumb-bell climb. In doing so, he would have reduced the safety margin to a critical level. Alternatively, Flt Lt GILBERT could have been aiming for a target speed of 150 kts and had, perhaps, not retained sufficient flying accuracy on the day. In any event, had the target speed for the dumb-bell been 180 kts, as stipulated in the 18 Gp ASO which was removed in 1984, it is almost certain that the aircraft would not have stalled.

11. **Overall Adequacy of the Training System**. As had become standard practice, all the 1995 season display pilots were trained and supervised during their initial displays by an experienced display pilot. Historically, this positive handover of skills, combined with the experience levels of the nominated pilots and the strict and regular regime of practice and currency displays, led to a formal training syllabus being considered as unnecessary. With hindsight, it is now clear that display flying techniques can evolve over the season and specific checks are not in place to eradicate dangerous deviations from the initial methods taught. Moreover, while it is impossible to cover all eventualities, Nimrod pilots are currently not required to cover theory relating to problem areas, such as stalling, which may be experienced during display flying. Stalling was clearly the cause of this accident, but a relatively routine aircraft emergency, or perhaps a control restriction during a critical moment of a manoeuvre, could be just as serious. Thus, while I agree that stalling should be comprehensively covered during display work-up, it should be covered as part of a comprehensive aircraft handling package. The NDS is an excellent training facility and I consider that mandatory simulator exercises should be included as part of the work-up and continuation training schedule. These sessions should be overseen by a display supervisor who would act as "mentor" during the season, and should include all of the major aircraft handling emergencies (stalling, flying control failures, engine failures etc). In addition, a review of the aerodynamic theory involved with display flying should be covered before training commences. All of the above should be covered by a formal training syllabus. In sum, I agree that overall training was inadequate and was a factor in the accident.

SUPERVISION OF DISPLAY FLYING

12. **Adequacy of Supervision**. Within the current regulations, I am satisfied that Flt Lt GILBERT'S display flying was overseen by appropriately qualified and experienced supervisors who had been correctly briefed. However, while I agree that increased supervisory checks are necessary as a result of the accident, I have some concerns about the Board's recommendation that airborne supervision should be introduced. Airborne supervision might

place an extra burden on a display pilot and, more importantly, this supervision could not be conducted satisfactorily from the co-pilots seat, since any display co-pilot is always fully occupied in a supporting role. Moreover, use of the 3rd pilot's jump-seat inhibits the flight engineer's movement and, arguably, would be an unwise practice during display manoeuvres. Thus, while airborne supervision may have identified the development of an unsafe flying technique, this could equally have been identified by supervised practices in the NDS and the use of Central Tactical System (CTS) tape strips to examine parametric data. I consider that the use of the NDS and CTS tape strips should become a routine part of the monitoring and debrief system during a display pilot's work-up and in-season training.

13. **Awareness of Supervisory Team**. All members of the supervisory team had a good rapport with the 1995 display pilots and I am confident that Flt Lt GILBERT, in particular, would have felt able to approach the supervisory team. The Board highlighted that Flt Lt GILBERT had expressed no concerns to his supervisors and it was not until early August, following a display practice at Kinloss and a subsequent display at Sunderland, where he flew slightly through the display line, that he developed his slow speed technique for the second dumb-bell manoeuvre first used at CFB Shearwater later in the month. Flt Lt GILBERT was already in Canada by this stage and, accordingly, as the supervisors were not aware of any problems experienced by Flt Lt GILBERT, I agree that the supervisory team were not at fault.

14. **Use of Non-pilots in the Supervisory Chain**. The Board did not specifically address whether it was appropriate to use navigators in the display flying supervisory chain. I do not consider this to be a factor, since the normal supervisory chain includes navigator or, indeed, AEO flt cdrs, sqn cdrs and stn cdrs as full authorising officers and supervisors. For obvious reasons, the supervision of display work-up and continuation training is always undertaken by a suitably qualified senior pilot. It would, of course, be possible to delegate all display supervision and authorisation to a senior pilot, but, eventually, this would cut-across the Stn Cdr's absolute responsibility for all aspects of flying supervision and authorisation. S.40 - Sqn Ldr L was a flt cdr with full authorising powers and was also the normal first navigator on Flt Lt GILBERT's crew; thus, he knew the crew extremely well and was a suitable choice to command the detachment. The Board did not mention that S.40 - Sqn Ldr L had also flown as a display crew navigator during a previous tour on 206 Sqn and had also flown 3 displays as navigator with Flt Lt GILBERT; thus, he was well familiar with the display routine. Moreover, during Flt Lt GILBERT's last practice at Kinloss, S.40 - Sqn Ldr L viewed the display with OC 206 Sqn and was briefed on

the specific areas of the display to monitor closely. Therefore, although he was a navigator, S.40 - Sqn Ldr L was familiar with the display sequence and was aware of the possible pitfalls in flying the display. The current 18 Gp ASO allows a Nimrod display pilot to self-authorise when flying an overseas display, but this is rarely done. The practice of always including a flt cdr as an authoriser on overseas displays was implemented at Kinloss to ensure that another safety check was in place and, more importantly, to ensure that the display pilot was not pressurised by display organisers; in this way the display pilot is left free to concentrate on the flying aspects. I recommend that the 18 Gp ASO is regularised to reflect the requirement for a flt cdr or sqn cdr to supervise and authorise overseas displays.

THE NIMROD DISPLAY SEQUENCE

15. **Aircraft Configuration**. The Board established that the aircraft's C of G was well within limits for the display and that removal of the FAP would have had a negligible effect on the stalling speed. I support the view that all extraneous equipment should be removed from the aircraft before display flying.

16. **Adequacy of 18 Gp ASO and Other Documents**. While 18 Gp ASOs stipulate that 1000 ft is the maximum height for the dumb-bell turns, I agree that Flt Lt GILBERT's climb to 1400 ft was insignificant on this occasion. However, it is arguable that, had he levelled at 1000 ft, the aircraft's speed would have been higher. While this may be true, it is likely that Flt Lt GILBERT had planned to fly the turn at slow speed and would probably have throttled back earlier in an attempt to achieve his target speed. Therefore, I am content that the height reached was not a factor. Conversely, had 180 kts been stipulated as a target speed, I believe that Flt Lt GILBERT would have flown to this speed and it is most unlikely that the aircraft would have stalled. Therefore, the absence of a target speed in 18 Gp ASO's must be seen as a factor in the accident. With hindsight, this was an omission, but I do not support the Board's view that blame should rest solely with the 18 Gp Air Staff. This was undoubtedly an organizational fault and the responsibility should be shared at all levels from HQ 18 Gp down to the individual display pilots involved over many years. Finally, I support the view that the Aircrew Manual Book 3 guidance on stall warning speeds is confusing and misleading and should be improved.

FLIGHT DECK CREW COMPETENCY

17. **Crew Competency**. Flt Lt GILBERT's record speaks for itself; as a B category, ACO and fighter affiliation qualified pilot, there could have been few sqn line pilots at Kinloss better qualified to enter training as a display pilot. His co-

pilot, while relatively inexperienced on the Nimrod, had a high degree of airmanship, crew co-operation and handling ability and was recognised as one of the best co-pilots on 120 Sqn; moreover, he and Flt Lt GILBERT worked well as a team. Similarly, Sgt MOXHAM was a good air engineer who also worked well with his pilot team; he was also an experienced and highly capable glider pilot and chief instructor. While the co-pilot and air engineer were relatively inexperienced on the Nimrod, they were nearing the end of a full display season and had considerable display experience to draw upon. In sum, the handling pilot was well above the average and, with a fighter affiliation and ACO qualification, he was knowledgeable and well qualified in those areas requiring pure piloting and airmanship skills. I am satisfied that all 3 members of the flight deck crew were competent to undertake display duties.

18. **Planning and Briefing**. Flt Lt GILBERT and his authorising officer attended the CIAS main brief and were satisfied that the airshow organisation was sound. Flt Lt GILBERT then briefed his authorising officer on the actual display procedure and satisfied the latter that his intentions and planning for the display on the day in question were sound. In addition, Flt Lt GILBERT briefed his crew on his intentions for that particular display, including visual references and crew duties. Moreover, the subsequent ground radar track indicated that Flt Lt GILBERT had made due allowance for the slight component of on-crowd wind and it is, therefore, likely that wind corrections had also been carefully briefed. In locations with limited crew briefing facilities, it is not unusual for crew briefings to be carried out in the aircraft galley area before flight. The galley area is the only area in the aircraft where the crew can gather around a table with sufficient room to display maps and other briefing material. Briefings conducted in this manner are no less professional than those conducted in normal briefing facilities. Moreover, the flight engineer is invariably preparing the aircraft for flight during the main briefings and an on-aircraft brief is the only sure method of bringing the complete crew together in relative quiet, and with all the necessary briefing details, before commencing a display. I am content that the sortie was well briefed and correctly authorised, and that each crew member was fully aware of his responsibilities.

STRUCTURAL/TECHNICAL FAILURE AND DISTRACTION

19. **Structural/Technical Failure**. While there is no evidence to suggest that a structural or technical failure contributed to the accident, such a failure, or indeed a transient technical failure, cannot be positively ruled out. Similarly, the aircraft may have suffered a birdstrike at a critical stage which was undetected by the photographic or technical evidence.

20. **Distraction.** Flt Lt GILBERT was nearing the end of a full display season and it is unlikely that a minor distraction would have led to the low speed at the top of the dumb-bell; however, in the absence of any cockpit voice recordings, I agree that the possibility of distraction by a system or instrument malfunction cannot be completely ruled out.

AIRCRAFT HANDLING AND TECHNIQUE

21. **Relevance of On-Crowd Wind Vector.** Flt Lt GILBERT had dealt satisfactorily with on-crowd wind components of up to 20 kts during his display work-up training. The ground radar plot at Toronto indicated that he had made due allowance for the small on-crowd wind at Toronto (approx 10 kts) and I agree that the wind was not a factor in this accident.

22. **Use of Signal Pistol.** I support the Board's view that the signal pistol was probably operated by the flight engineer in the normal manner. However, while 18 Gp ASOs do not prohibit the use of the signal pistol during the dumb-bell manoeuvres, such use is not part of the recognised display sequence. Moreover, repeated use of the pistol requires the air engineer to unstrap temporarily from his seat to carry out a reload. While this in itself is not a problem, it would distract the engineer from his primary duty of monitoring system indications and acting as an extra pair of eyes. Moreover, had the engineer dropped a live cartridge during the reload process, it could have caused a distraction at a critical stage. There is no evidence to suggest that this occurred; hence, I agree that the operation of the signal pistol was probably not, in itself, a factor.

23. **Handling and Technique.** Having allowed the aircraft speed to fall to 122 kts during the dumb-bell turn, it is not surprising that Flt Lt GILBERT instinctively trimmed the aircraft to relieve the control loads. Indeed, trimming into all turns is standard practice on the Nimrod. Given the exaggerated nose up trim setting, the onset of G as the speed increased would have been more rapid than he was used to and possibly would have led him to believe initially that the stick shakers were operating as a result of the G switch and not manoeuvre stall. Moreover, the trim setting would have reduced the pull required to achieve the desired turn rate and, given a normal pull force on the control column, may have further exacerbated the rate at which the G increased. Therefore, a combination of the high nose up trim, and even a small nose up control movement, would have induced a stall. While there is little that can be done to prevent such trimming, and a higher target speed would have negated the effect, I agree that the trim position was an additional contributory factor.

24. **Post-Stall Recovery Action**. The standard stall recovery on the Nimrod requires the aircraft nose to be lowered sufficiently to ensure that the wings are unstalled and to stop the stall warning, and a simultaneous application of full power. I agree that the evidence shows that the correct recovery action was taken almost instantly; however, insufficient height remained to recover from the nose and wing drop and an impact with the surface was inevitable.

CONSIDERATION OF HUMAN FAILINGS

25. **Supervisory Chain**. The display crews for the 1995 season were selected, supervised, trained, authorised and briefed in accordance with current 18 Gp ASOs. The primary pilot display supervisor and his nominated deputy had both previously flown and supervised display work-ups. Although with hindsight, both might have considered viewing display practices in the NDS, neither considered airborne supervision as an option as this was not recognised practice. The supervisors had been fully briefed on their responsibilities and had carried out their duties methodically and conscientiously. Similarly, S.40 - Sqn Ldr L was fully briefed on the display sequence and carried out his supervisory duties in strict accordance with regulations and my own directive. The personal briefing given to the selected display crews by the AOC 18 Gp was a mark of the importance in which the whole supervisory chain regarded display flying and I support the Board's finding that no blame should be attached to the supervisory chain.

26. **HQ 18 Gp Staff**. The Board found that HQ 18 Gp staff over many years had failed in their responsibilities. Firstly, they failed to provide sufficient guidance on the training required for display flying and, secondly, they failed to provide an adequate training syllabus. Finally, the Board found that the 18 Gp staff had failed to amend 18 Gp ASOs to include a target speed for the second dumb-bell manoeuvre. While all these failings have been rightly identified, I do not agree that the responsibility was HQ 18 Gp's alone. These failures result from an organizational fault and must be shouldered by everyone involved in the process over many years of Nimrod display flying.

27. **Flt Lt GILBERT**. As he commenced the Toronto display, Flt Lt GILBERT was in current display practice and had the benefit of almost a full season of display flying behind him. While the DARU data taken from the 2 displays flown at CFB Shearwater shows that he had previously flown the second dumb-bell manoeuvre at slow speed, he would have had no specific warning that he was placing the aircraft close to the edge of its manoeuvre envelope. Therefore, the possibility of a sudden departure from controlled flight, which he ultimately experienced, would have been far from

his mind. Nevertheless, Flt Lt GILBERT took every precaution to ensure he produced a safe and competent display. He was well rested, had briefed his crew carefully and comprehensively on their duties, and had satisfied his authoriser that he was competent and capable of conducting the display. However, in flying the aircraft slowly during the second dumb-bell manoeuvre without applied power he had, unknowingly, degraded his safety margins to a dangerous, and in this case, fatal degree. Given his thoroughly professional overall approach, it is likely that Flt Lt GILBERT had considered the implications of the speed change and had judged that, with 20 flap selected, his safety margins were adequate. Therefore, I support the Board's view that Flt Lt GILBERT was not negligent, but made an error of judgement.

28. **Remaining Flight Deck Crew Members**. The co-pilot was in a good position to monitor aircraft handling during the display and may have become familiar with seeing a low speed during the second dumb-bell turn. Therefore, assuming he had noticed the airspeed decay to 122 kts, it could have been some time before he thought to make a verbal warning. Given the rapidity with which the incident developed, it is highly unlikely that any such warning would have been effective. The engineer or navigator could also have warned the pilot of his excessively low airspeed and, indeed, may well have done so; however, given the engineer's involvement with the signal pistol and the navigator's limited attitude reference, such a warning would have been unlikely. Overall, therefore, I support the view that there are no human failings attributable to the remaining crew members.

SCHOOL OF AVIATION MEDICINE (SAM) REPORT

29. The School of Aviation Medicine (SAM) Aircraft Accident Investigation Report 14/95 (Annex Y to the BOI Report) arrived too late to be included with the main body of the Part 2. In the SAM Report I note that the quick release fastener (QRF), as fitted to the first pilot's restraint harness, did not comply with the specification for restraint harnesses and QRFs laid down in Def Stan 00-970. The harness and QRF as fitted to the new IPECO pilot's seat on the Nimrod are being replaced under the direction of SM60(RAF). Accordingly, SM60(RAF) should be tasked to investigate the provision of restraint harnesses and QRFs which conform to the requirements of Def Stan 00-970.

RECOMMENDATIONS

30. I have the following comments regarding the Board's recommendations:

a. **Accident Recorder**. The Nimrod is likely to remain in

service until 2006; hence, I support the recommendation to provide a modern accident recorder for the aircraft.

b. **Display Sequence**. The display sequence has been reviewed at Station level and recommendations, including a minimum airspeed of 180 kts for the second dumb-bell manoeuvre, have been sent to HQ 18 Gp.

c. **Stall Warning System**. While an improved stall warning system, incorporating rate of approach to the stall, would be beneficial during displays, its use during routine flying operations would be limited. Moreover, given the suggested amendments to the display sequence, it is extremely unlikely that a stall could cause a future display accident. I support a relatively inexpensive modification to de-couple the 2.05 G switch from the normal stall warning (and replace it with an audio warning), but an extensive modification to the stall warning system is probably inappropriate and unnecessary.

d. **Aircrew Manual Book 3**. I support the recommendation that a thorough review of the stalling advice offered in the Aircrew Manual Book 3 should be undertaken.

e. **Training**. I support the recommendation that a formal training syllabus for display flying should be implemented and that the training package should include theoretical and practical instruction on stalling techniques. However, the training package should also include advice on dealing with all major emergencies and failures that could occur during the display sequence and these should be practised in the NDS.

f. **On-Board Supervision**. I do not wholly support the recommendation calling for the inclusion of an element of on-board supervision. Increased use of the NDS to check display technique, and use of the CTS strip as a diagnostic tool, would, in my opinion, be a safer and less problematic method of ensuring consistency of technique during the season.

g. **Review of Stalling Training**. While I support the need for a review of stalling training, particularly with regard to display flying, it should be noted that current NOCU training undertaken by pilots is based on scenarios which might be encountered during routine flying operations. This requirement remains valid and, given the high fatigue penalty involved in stalling practice, a review is unlikely to justify the need for major change. However, stalling in the simulator, while not entirely realistic, could

certainly be made more rigorous.

h. **Trimming During Displays**. I support the recommendation that Nimrod display pilots are warned of the dangers of trimming to low speeds during the display. However, a practical method of applying a restriction would be difficult. Moreover, providing the target speed during the second dumb-bell is 180 kts, any instinctive trimming carried out would not be a problem.

j. **Extraneous Equipment**. I support the recommendation that all extraneous equipment should be removed from the aircraft prior to display flying.

k. **Minimum Crew**. I support the recommendation that there should be no change to the minimum crew requirement.

l. **Use of Signal Pistol**. Provided the signal pistol is loaded before commencing the display sequence and only fired once during the final pull up manoeuvre, its operation is a safe and sensible part of the overall display sequence. 18 Gp ASOs should be amended to prohibit firing of the signal pistol at any other stage of the display.

ADDITIONAL RECOMMENDATIONS

31. I offer the following additional recommendations for consideration:

a. **Supervision of Overseas Displays**. The current 18 Gp ASO dealing with authorization (Annex A to Chapter 4 Order 0401) should be amended to prevent captains self-authorising overseas displays.

b. **Quick Release Fastener (QRF) Modification**. Restraint harnesses and QRFs fitted to the cockpit crew seats should conform to Def Stan 00-970.

CONCLUSION

32. This has been a difficult Inquiry, but I consider that the Board has completed a thorough and painstaking investigation into the fatal accident involving Nimrod XV239 at the Toronto International Airshow on 2 Sep 95.

33. Although the training methods and supervision practices for display flying have been used successfully over many years, the Board has identified weaknesses in these areas along with

shortfalls in the aircraft stall warning system and confusing Aircrew Manual advice on stalling. Moreover, the absence of a cockpit voice recorder or modern ADR on the Nimrod means that the full circumstances behind the tragedy will never be known. Therefore, I support the finding that Flt Lt GILBERT made an error of judgement in allowing the airspeed to decay to 122 kts during the second dumb-bell manoeuvre. It is clear from the evidence gathered that the crew performed in a professional manner throughout, but failed to appreciate the late development of a major flaw in their display technique. The Board has made recommendations which, if implemented, would allow the Nimrod to be returned safely to the display circuit.

Redacted S.40 - Gp Capt AN

28 Mar 96

Part 4

REMARKS OF AIR OFFICER COMMANDING

1. Given the available weight of evidence, I agree that the aircraft was serviceable to undertake the flight and believe that we are able to reconstruct the events that led up to this tragic accident; however, without the irrefutable evidence of a modern ADR or CVR, any absolute conclusions drawn from the last few seconds of XV239 would be unsafe. I am therefore forced to agree with the Board's findings that Flt Lt GILBERT made an Error of Judgement in developing an inappropriate modification to his display sequence. It was this Error of Judgement which ultimately led to him flying the dumb-bell manoeuvre at a very low speed that left no margin for error and subsequently led to the stall and departure from controlled flight. Accordingly, I also agree with the Board that the cause of the accident was as the result of the aircraft stalling at a height from which, as flown, it was impossible to recover; although it is possible that, had Flt Lt GILBERT taken timely and appropriate stall recovery action at the first signs of stall warning, the accident may never have happened. I will return to this later.

2. I am conscious that, in reviewing this Board of Inquiry there have been over 2000 successful Nimrod flying displays during the past 20 years and thus it is entirely reasonable to conclude that the practices that have evolved have been seen as acceptable and logical at all levels; indeed, it was the benign nature of the display that was so dangerously seductive. Therefore, while I agree with many of the conclusions made by the Board, I disagree with their findings with regard to the adequacy of the selection process and, closely allied to this, the experience levels of those aircrew employed on displays. Further, I consider that the stall recovery action was a significant contributory factor in the accident.

HANDLING AND TECHNIQUE

3. Before discussing the handling aspects of the accident and examining the technique used, it is important that we review the evidence available on the final fateful seconds of the flight and establish an accurate sequence of events.

4. **Sequence of Events**. The aircraft had flown an unremarkable, initial portion of the display sequence. At the point of entry into the second dumb-bell manoeuvre the aircraft was turned onto a heading some 75 deg off the display line and pitched up in 2 stages to a maximum of 24 deg, as the aircraft passed 950ft the power was reduced to a setting just above flight idle on all 4 engines. At this point the IAS began to decay very rapidly below the assumed (and taught) target speed of 150 kts. At 1000ft the aircraft rolled into a port

turn with the IAS continuing to decrease to 122 kts (at which speed it stabilised for 5 secs) while the ac elevator was trimmed to the 10 deg nose up position (a trim position that equates approximately to 122 kts). As the nose of the aircraft dropped through the horizon and the speed began to increase, a further 3 deg nose up pitch was applied to the elevator just before the predicted stall warning point. With the application of elevator, and despite the moderate increase in IAS, the subsequent increase in G loading led to the predicted and actual stall point some 2.5 secs after the stall warning should have occurred. The aircraft then departed controlled flight and the aircraft nose and port wing dropped rapidly. At the point of stall it is apparent that full opposite aileron and full power were applied, although there is **no** forward movement of the elevator for a further 2 secs, and even then the movement appears to be consistent with relaxation to the trimmed position rather than a positive unloading. At this point the aircraft has radically departed from controlled flight and it is reasonable to assume that the subsequent application of maximum up elevator is an instinctive reaction to the proximity of the water. The evidence from both the DARU trace and video shows a progressive increase in both nose down pitch and roll angle until, it is assumed, with increasing airspeed the wing unstalled and an element of control was regained. At this point the DARU predicted stall speed and actual IAS can be seen to be convincingly divergent and the aircraft pitch and roll attitude is starting to improve; moreover, the video evidence supports the DARU indications. Therefore, I am convinced that the aircraft remained stalled until some 3-4 secs before impact.

5. **Handling Aspects**. Having established that the aircraft stalled and failed to recover at the time postulated by the Board, further examination of the stall recovery action was required. My major concern was the apparent lack of an early positive attempt to carry out the full stall recovery actions. The Board has established that Flt Lt GILBERT should have received stall warning indications at time 218.5 secs (on the DARU trace) and the initial point of stall was at 221 secs (9 secs before impact). However, while full power and full opposite aileron were applied at the point of the stall, it is a further 2 secs before any release of elevator back pressure is evident. Beyond this point I accept that the situation was irrecoverable. The absence of other information is significant but, most importantly, I find it hard to comprehend the crew's apparent lack of appreciation of their deteriorating situation or the delayed reaction by the handling pilot. Thus, while the possibility that an undetected problem with the stall warning sensors cannot be discounted (AAIB evidence only suggests that the 2 independent warning indicators were serviceable prior to impact), I believe that a further and significant contributory factor was that, for whatever reasons, the pilot failed to carry out appropriate and timely stall recovery action, when stall warning from both stick shakers and stall warning lights should have alerted him some 2.5 secs before the stall.

6. **Trimming**. Trimming is an instinctive and necessary technique for all Nimrod pilots during manoeuvres, and in this situation the extreme position of the elevator would have made recovery action more difficult but not impossible. Therefore, I agree with the Board that it was a contributory factor and I endorse the Board's recommendation that future Nimrod Display pilots are warned of the inherent dangers of trimming to low speeds during the display sequence.

7. **Technique**. The Board has established that Flt Lt GILBERT and his flight deck crew had discussed their perceived problem with the second dumb-bell between their first and second display at Sunderland. The problem was quantified as excess energy at the top of the manoeuvre which was ascribed as the major reason for a display line violation during the first display. The captain's solution was to reduce the energy level and the other members of the flight deck crew did not contradict the suggestion of an early reduction in power. It is evident that at no stage did the crew highlight their problem or discuss their proposed solution with anyone in a supervisory position. The first evidence that the crew had modified their display sequence is found in the DARU information from the second display at Shearwater, where an early reduction in power is apparent. This trend was continued at the third Shearwater display and finally, with fatal consequences, at the CIAS display at Toronto, where this early reduction in power was accompanied by a marked increase in pitch. The table at fig 1 details the data stripped from the DARU at the relevant airshows and emphasises the step change that occurred at Toronto.

	SHEARWATER DISPLAY 2	SHEARWATER DISPLAY 3	TORONTO CIAS
MAX ALT (ft)	1600	1425	1450
PWR OFF ALT (ft)	1250	1100	950
MIN IAS (kts)	138	138	122
MIN RPM (%)	78	77	77
MAX PITCH (Deg)	21	20	24
MAX 'G' BELOW 140 kts	1.25	1.4	1.6

Fig 1

The technique the crew had developed was clearly flawed in a number of areas. A high nose attitude and low power setting would inevitably lead to a rapidly decaying IAS; subsequent aerodynamic loading, either through pilot input or as a result of the trim position, would result in the aircraft being placed on, or close to, the stall boundary. In this specific case, the aircraft slowed to a

minimum of 122 kts (3 kts below the GASO stated absolute minimum speed for display of VAT + 5 (calculated at 125 kts), 16 kts slower than previous displays and 28 kts slower than the technique taught, and was then aerodynamically loaded with disastrous consequences.

8. **Nimrod Display Sequence**. The certified Nimrod display sequence is, in effect, a series of flypasts linked by representative operational manoeuvres. Flown correctly it is not an especially demanding exercise and well within the aircraft limits and flight envelope; however, display flying brings with it its own unique pressures which test the mettle of aircrew involved. However, examination of the extant GASO reveals 2 elements of poor advice in the second dumb-bell manoeuvre recommended technique. Firstly, although the technique demonstrated to Flt Lt GILBERT was inherently safe, the lack of a minimum speed or gate is most certainly a contributory factor in this accident. Secondly, the reference to applying full power momentarily at the beginning of the dumb-bell is misleading. The lack of a minimum IAS for this manoeuvre and the reference to momentary application in power may have seduced Flt Lt GILBERT into developing his flawed technique; the GASO sequence has been withdrawn pending complete review.

SELECTION AND EXPERIENCE OF NIMROD FLIGHT DECK DISPLAY CREWS

9. I agree with the Board that the selection procedure for display crews was carried out in a thoroughly professional and conscientious manner although it is self evident that the final judgement on crew suitability was flawed. Up to and including the 1995 display season, it had been the norm to select a crew from each and every operational sqn in order to meet the large number of display commitments, whilst the display crews maintained their operational currency. The emphasis was placed on recommending, albeit implicitly, a constituted crew that was seen to be both capable and harmonious. Against these criteria, I agree with the assessment that Flt Lt GILBERT and his crew were suitable candidates for selection. However, the demands and pressures of display flying are significantly greater than routine operational flying and the calibre and experience of the display aircrew must be assessed against a wholly different, and more stringent, criteria. Whilst Sqn constituted crews represent a cross-section of experience within the sqn and are carefully balanced, to limit the display selection field by taking a constituted crew from every sqn was wrong. Therefore, I conclude that the crew selection procedure was a factor in the accident and disagree with the Board.

10. Inextricably linked to the selection procedure is the experience levels of the Nimrod display flight deck crews, and, in reviewing the composition of this particular flight deck, one is struck by the presence of 2 first tourists in this

vital area. I agree with the Board that display crews must be selected on their proven ability as aircrew but this must be balanced with experience. Annex BE to the reconvened Board details the experience levels of those crews nominated for display duties from 1991 through to the present day. However, further investigation by my staff has revealed that the table does not reflect the changes ordered by the then AOC 18 Gp to 5 of the 19 crews, and in each case a more experienced crew member was substituted. Thus, although no rules were laid down, it is apparent that experience was considered an important factor in the past and that Flt Lt GILBERT's flight deck crew were cumulatively one of the least experienced crews to have displayed the Nimrod.

11. I firmly believe that a more experienced co-pilot or air engineer would have at the very least questioned the modification in display technique and would, almost certainly, have demanded corrective action at a stage which could have prevented the accident - conversely, the co-pilot and engineer may have done so but because of their inexperience it is possible that the captain did not give due weight to their warnings. Thus, I conclude that individual and collective experience did affect the outcome of this accident and was, therefore, a factor.

TRAINING

12. **Pre-Season Training**. I agree that the training Flt Lt GILBERT and his crew received was, with hindsight, inadequate. Whilst a supervised work-up programme was carried out, the lack of a prescribed, formalised syllabus of both air and ground training, allowed GILBERT and his crew to embark on their display season without a solid base on which to develop safely their technique; more formalised training may have prevented the inappropriate modification to the flying of the second dumb-bell. I have instituted a review of pre-season display training, to provide a mandatory syllabus which will be contained in my GASOs.

13. **Stall Training**. While I believe additional stall training is necessary before commencing a display season, I am convinced that the regime into which the aircraft entered prior to this accident would be familiar to any RAF pilot. All Service pilots undergo extensive stalling training at BFT/AFT and should, thus, glean a healthy respect for, and an appreciation of, stalling. I accept that the pilots in this accident would have had no exposure to fully developed manoeuvre stalls in the Nimrod because they are never carried out due to the unpredictability of the handling characteristics in such a large aircraft and the significant impact on the aircraft fatigue life. Yet, all Nimrod pilots undergo a comprehensive syllabus of unaccelerated stalls on their conversion or refresher courses on the NOCU. Furthermore, all current Nimrod pilots are required to undergo mandatory stall refresher training every 6 months in the dynamic simulator. Therefore, while there is clearly the need for a formalised

syllabus for display pilots, I believe there is already in place a robust training regime which caters for the routine operation of the Nimrod, and that front line pilots are aware of the symptoms and warnings of an imminent stall and that they are practised in the correct recovery technique.

SUPERVISION

14. The supervision of Flt Lt GILBERT during the work up, ratification and execution of his display duties was meticulous and consistent with the procedures developed within the Gp over a number of years. Furthermore, all elements of supervision have been shown to have conformed with extant regulations. However, with hindsight, the Board has rightly identified that supervision was a factor. The introduction of a mentor into the supervisory chain, who would train and monitor progress at all phases of the season, in the air and on the ground, is a necessary and practical improvement. An on-board supervisor could safely carry out his duties from the flight deck jump seat in its rear position, without interfering with the Air Engineer's primary monitoring duty. The seat is a recognised crash position with access to oxygen and intercom and is regularly utilised by the QFIs on the NOCU during conversion sorties. Moreover, this Inquiry has revealed that the ground observer is unable to identify anything other than blatant errors of technique; thus, I agree with the Board that on-board supervision should be introduced and that this should be supported by video debriefing, CTS tape strips and supervised NDS sorties. However, from available evidence it must be noted that Flt Lt GILBERT developed his modified technique at a late stage in the display season when he was overseas and, therefore, away from the normal supervisory chain. Consequently, even these measures may not have prevented this accident.

15. The presence of non-pilots in the supervisory chain was not a factor in this accident. At all stages in the display flying process the non-pilot supervisors sought counsel from suitably qualified senior pilots, allocated them an appropriate level of delegated responsibility and provided firm guidance. The issue of overseas authorization is clearly addressed in STCASIs and I see no merit in revising this procedure. However, I strongly support the Stn Cdr's policy of sending a suitably qualified fit cdr on overseas display deployments with the primary role as detachment commander and protecting the display crew captain from inappropriate external pressure.

OTHER FACTORS

16. The Board has examined a number of other possible factors which may have affected the outcome of this accident, including:

a. **Competence**. Within the narrow confines of the IFS definition of competence there is no doubt that the crew were competent to undertake the sortie. However, I will return later in my remarks to the competence of the crews' actions that led to the accident.

b. **Fitness**. I accept that the crew were fit to undertake the flight. However, I am concerned that there is evidence of self-medication by a number of the crew although specialist medical evidence has established that it was not a factor. It is therefore appropriate for all RAF aircrew to be reminded of the legitimacy and hazards associated with self-medication.

c. **Planning, Briefing, Weather, Incapacitation, Disorientation and Distraction**. The crew prepared meticulously for the sortie and conducted a thorough brief in a logical manner and at a sensible place. The weather was almost ideal and the presence of a 10 kt on-crowd wind component was not beyond the demonstrated capability of Flt Lt GILBERT. The Board states that all pathological and video evidence shows that both pilots were making control inputs up until the point of impact and I am content to support their assertion that incapacitation is an unlikely factor in this accident. The investigation into the possibility of either disorientation or distraction being factors is thorough, and I endorse the Board's finding that except for a possible system or instrument failure, that they were not contributory factors.

d. **Extraneous Equipment**. The presence of a well secured FAP on the aircraft is irrelevant to the eventual outcome. However, I fully support the recommendation for removal of all extraneous equipment prior to displaying the aircraft.

e. **Stall Warning System**. The dual-purpose nature of the warning provided by the stick-shaker and red indicator lights on the pilot's instrument panels could be confusing in certain flight regimes of the aircraft particularly during the display sequence; although, to ascertain why the warning has operated should require only brief reference to relevant flight instruments. However, I am convinced that the stall warning and the G warning systems should be decoupled so that in the event of stick-shaker activation there can be no ambiguity as to the cause and recovery action taken instantly. I note that embodiment of Modification 1028 to provide a discrete audio excess 'g' warning could commence in mid 1997, achieving fleet embodiment by mid 1998. On the question of a more advanced stall warning system, I note the BAe task to establish the feasibility of installing a new system, but I support the Stn Cdr's comments that an extensive additional warning system is unnecessary and, I believe, too expensive considering the remaining in-Service life of the aircraft.

f. **Aircrew Manual Advice**. The advice contained in AP 101B-0503-15C, the Aircrew Manual - Flying, Book 3 (ACM Bk 3) has been proven, by the Board, to contain inaccurate and outdated advice on stall warning speeds. However, I must emphasise that the stall recovery actions detailed in the text are valid and provide unequivocal direction. To address the existing flaws in the ACM Bk 3, I have instituted a review of relevant advice and procedures. RAF Handling Sqn expect to incorporate the changes in an amendment scheduled for publication by early Jun 96.

g. **Use of the Signal Pistol**. I concur with the Board's finding that the use of the Signal Pistol at an unauthorised point of the display was another factor. The visual impact of the Verey is minimal and certainly does not justify the distracting effect it has on the Engineer's primary duty of monitoring aircraft systems and performance. Moreover, its use leaves the Air Engineer unsecured in a low level manoeuvring environment. Therefore, use of the Signal Pistol will be suspended as part of future Nimrod displays.

h. **Pilot's QRF**. The conclusion at Annex Y that the Nimrod pilot's seat is fitted with a QRF which does not conform to Def Stan requirements is disturbing. I fully support the Stn Cdr's recommendation that SM60(RAF) be tasked with providing restraint harnesses and QRFs which conform to the appropriate Def Stan requirements, and I am pleased to note that modification action is well advanced with embodiment likely to commence in Sep 96 with a fleet embodiment timescale of about 7 months.

j. **DARU**. The Board recommended that the data currently recorded by the DARU be extended to include greater detail and, in particular, a voice track. I believe that augmenting the data recorded by the DARU and embodying a CVR would assist investigations into any future accident or incident, and I note that work currently underway could result in modification work commencing in late 1997 with fleet embodiment completed by the end of 1998. Equally, I accept the Board's view that the GPS position could be an important parameter in any future inquiry and believe that, despite the incompatibility of the GPS data protocol with the current DARU, the Support Authority should continue to investigate the possibility of recording this data.

k. **Birdstrike, Technical or Structural Failure**. In the absence of evidence to the contrary, it is impossible to discount the possibility of either birdstrike, technical or structural failure as a contributory factor in this accident. It is this uncertainty, however unlikely, which mitigates my conclusion in the assessment of human failings.

HUMAN FAILINGS

17. **Flt Lt GILBERT**. There can be little doubt that the changes Flt Lt GILBERT made to his display sequence were premeditated and made without reference to his supervisors. Further, although he appears to have first made the changes to the second dumb-bell at Shearwater, DARU evidence shows that the changes were significantly exaggerated at Toronto. It is also clear that, up to the point of departure from controlled flight, Flt Lt GILBERT did have the opportunity to recover the situation. The weight of evidence clearly suggests that Flt Lt GILBERT mishandled the aircraft. However, without irrefutable evidence, I cannot discount the possibility that he was misled or distracted by a transient aircraft system or instrument failure. Furthermore, the incorrect and confusing advice on stall warning speeds provided in the ACM Bk 3 and the lack of a minimum speed quoted for this manoeuvre in GASOs cannot be ignored. Therefore, I am forced to conclude, albeit with some reservation, that the only safe verdict is that he made an Error of Judgement.

18. **Flt Lt HOOPER**. Flt Lt HOOPER was responsible for ensuring that the aircraft was correctly configured for each element of the display and, further, was responsible for the monitoring of height, attitude and speed. Evidence shows that he accepted the modification to the display; however, his training and experience may not have alerted him to the inherent dangers of such a course of action. Most importantly, however is the fact that there is no evidence to suggest that Flt Lt HOOPER did not meticulously carry out his duties and warn the captain of the developing situation and, consequently, I believe that there can be no human failings attributed to him.

19. **Sgt MOXHAM**. Sgt MOXHAM was responsible for the safe operation of the aircraft's systems as well as monitoring the aircraft's height, attitude and speed. I agree with the Board that, at the critical moment, Sgt MOXHAM's attention was probably concentrated on the operation and reloading of the signal pistol but in the absence of any evidence to the contrary, it cannot be shown that he did not warn the captain of the developing situation and, therefore, I believe that there can be no human failings attributed to him.

20. **Supervisory Chain**. I agree with the Board's and Stn Cdr's findings that the display crews for the 1995 season were selected, supervised, trained, authorised and briefed entirely in accordance with GASOs. Within these extant statutes, these actions were carried out meticulously. It is only with the benefit of hindsight that we can now identify the faults that lay within that system of supervision and, therefore, I believe that there can be no blame attached to any individual despite the obvious corporate failure.

21. **HQ 18 Gp Staff**. The absence of a formalised training syllabus, guidance on the training required and the lack of a target speed provided within GASOs were correctly identified as failures by the Board. However, I agree with the Stn Cdr that these failures should not be solely ascribed to the HQ 18 Gp Staff but shared by everyone involved in the process over many years of Nimrod display flying. Although I believe that no human failings can be attributed to individual staff, it is a salutary reminder of the corporate responsibility of the command chain.

ACTIONS

22. Given the demanding nature of the many diverse roles carried out by the Nimrod force, their flight safety record is indeed a commendable one. However, this accident has served as a lesson to us all and highlighted the need to carry out a thorough scrutiny of all aspects of Nimrod display flying. Specifically the following actions are in hand:

a. I have tasked my staff with reviewing the Nimrod display sequence, developing a formalised and comprehensive display training programme, reviewing the selection and supervision processes and carrying out a detailed study into stall training in Nimrod aircraft. The results from these studies will be incorporated into future GASOs and will be supplemented with direction on the removal of extraneous equipment, along with advice on the inherent dangers of trimming to low speeds during display sequences.

b. I am advised that RAF Handling Sqn have completed a draft revision to the ACM Bk 3 advice on stalling and associated speeds. Once this has been scrutinised and verified it will be incorporated in an amendment due in Jun 96.

23. Of the remaining recommendations made by the Board, I strongly endorse the modification to de-couple the stall/'g' warning system, the requirement for improvements to the DARU, modification to the pilots' seat harness and QRF in line with Def Stan requirements and the issuing of a warning to all aircrew on the legitimacy and hazards associated with self-medication. However, I believe that the costs associated with the introduction of an AoA device will outweigh its utility.

CONCLUSION

24. I believe that the Board has correctly identified the cause of this accident in that the aircraft stalled at a height from which recovery was impossible. Although the weight of evidence suggests a degree of culpability, in that Flt Lt GILBERT mishandled the aircraft such that it stalled at a critical phase of flight, the lack of absolute and conclusive evidence, and the other mitigating factors, drive my assessment that he made an Error of Judgement. Therefore, I am content that a safe verdict has been found and that the actions that will follow from the lessons learned will allow a complete reappraisal of display rules, crew selection, training and supervision. In addition to the pilot mishandling, the seeds of this accident can be found in many different areas and it should be a cautionary lesson to all who are involved in displays, however remote, that the integrity of such flying is only as good as the weakest link in the chain.

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3 Jun 96