Identification of particular GRI equipment. He had a "...very good..." knowledge of JSP 846 and visited the MSSR and TACAN. He stated that "...nothing stood out to suggest a possible problem..." The survey was a routine biennial check of GRIs and their physical location, together with surrounding infrastructure, so that they could be mapped accurately for assessment. GRI details are also passed on to DIO as a result of such checks, so they can update their maps for statutory safeguarding. The survey does not determine whether or not GRIs are infringed or impaired in their operation. No formal survey report is produced but site maps are amended as necessary. The ADATS DT Chief Engineer stated that "...if we are asked to survey a specific site, to assess the possible impact of buildings or trees on a radio installation, we will do that and provide the requested advice. However, this was not the case with Kinloss..." He also stated that "...we do not maintain any lists..." of vegetation encroachment unless the formal EA process is followed and a report raised.

1.4.6.385 BM ATM Eng RO External Quality Audit. The 2011 and 2012 BM ATM Eng RO EQA reports of both RAF Lossiemouth and RAF Kinloss do not make reference to vegetation encroachment on the MSSR or TACAN. The BM ATM Eng RO has been unable to provide EQA reports from previous years as all paper documentation was in storage and could not be located; pre-DII electronic files are "...fragmented...". For a Stn the size of RAF Kinloss the EQA would normally consist of a three day visit comprising of a travel day, a read in and brief day, followed by a day to visit all of the GRIs. EQAs focus on assuring that the individual is suitably trained, has the correct equipment to complete the task and that all necessary processes are in place. Some BM ATM Eng RO personnel would check to see that equipment was not infringed; other BM ATM Eng RO personnel would check that unit staff were appropriately trained and following maintenance procedures but would not physically assess or comment on infringements. The Apr 11 report does note that gorse foliage around the High Resolution Direction Finding Antenna is still outside the "...guidelines..." of JSP 846. The Panel observed that during the recent EQA of another station, a tree infringement had been identified. The BM ATM Eng RO took no action to ensure that the unit either requested an EA from ADATS DT or had the infringement removed.

Continued Use of MSSR and TACAN

1.4.6.386 DDH Advice Note. RAF Lossiemouth was in the process of producing a DDH Advice Note which presented the case for the continued use of the MSSR and TACAN without either a infringement concession or JSP 846 compliance. The DDH Advice Note stated that "...switching off either of the NAVAIDS will have a significant impact upon RAF Lossiemouth operations...". The note goes on to state that "...both the MSSR and TACAN has (sic) been infringed by tree growth for a period of time in excess of 10 years with no apparent detrimental effect on performance..." and that the "...MSSR passed its 3-yearly flight check...the MSSR also passed its flight checks in all previous years..." The DDH Advice Note assessment was that there is a greater risk of an air incident occurring if the MSSR and TACAN are switched off rather than being used with mitigation measures in place. This assessment was due to the increased complexity of the controlling task using PSR only, which is not routinely exercised across the ATC branch, and the 55% dilution rate of RAF Lossiemouth controllers. Some of the mitigations are listed below:

a. Prohibit use of deliberate SSR only operations.

b. Increased routine flight checking of MSSR from a 3-yearly requirement to annually. This annual flight check would be carried out from late autumn after completion of the main growth season for the tree types.

c. TACAN based approaches and departures to be monitored using PSR and SSR.
d. Increased routine flight checking of the TACAN from annual to biannual.

1.4.6.387 Flight Checking. The aim of a SSR FC is to ensure that the antenna is optimally configured, to confirm the limits of solid radar coverage, to ensure the radar is maintained within specified tolerances and to ensure compliance with regulations. All due maintenance must be completed before a FC takes place. The MSSR FC is flown on a single radial which has been selected to give an unobstructed signal and to be clear of restricted airspace; radar coverage beyond that radial is assumed to be effective by virtue of effective site safeguarding as detailed in JSP 846. ADATS DT assume that a site is JSP 846 compliant unless the Infringement Control Process has been followed. The Apr 07 FC was flown on the 360° radial, the Mar 09 check was 070°, the Mar 12 check was 090° and the Jul 12 check was 080°, with runs conducted at 5000 ft and 20000 ft on each FC. The Jul 12 FC awarded the MSSR an unrestricted status. It is possible that trees were having an effect in sectors and heights other than the two tested, but this was not found. An annual TACAN FC would normally consist of orbital checks, beacon identification checks and Terminal Approach Procedure checks and all published TACAN let downs.

1.4.6.388 The Panel observed that MAA Certification Electronic Systems are responsible for ATM equipment regulation within the MAA, but are not involved with the concession process. ATC operators within the MAA are responsible for the regulation on the safeguarding of aerodromes, but “safeguarding is more about obstructions to aircraft and their operating areas/surface/airspace rather than obstacles impacting on the performance of ATM equipment...” There is no coherent regulatory policy on military aerodromes to continue to use infringed GRLs.

Analysis

1.4.6.389 The RAF Kinloss TACAN and MSSR have been encroached by vegetation for at least ten years outwith the requirements of JSP 846. It has not been possible to evaluate how the infringements have affected performance.

1.4.6.390 ADATS DT is unable to explain the provenance of the safeguarding restrictions defined in JSP846. It has not been possible to determine if they remain relevant to in-service equipment or require updating. ADATS DT believe that the JSP 846 site restrictions may be a product of a number of Design Authority GRI site requirements combined into a single standard.

1.4.6.391 The JSP 846 Infringement Control Process had not been followed at RAF Kinloss. RAF Kinloss C4I Sqn personnel had not requested EAs from ADATS DT and there is no evidence that a Concession Certificate had been issued by the BM ATM Eng RO. The BM ATM Eng RO stated that a concession may have been issued previously but not been present within their records. No such Concession Certificate has been found. In certain circumstances ADATS DT will recommend the issue of a concession for fixed objects, but in the case of vegetation it is impracticable as the infringement is likely to change as the vegetation grows and as weather conditions vary.

1.4.6.392 Knowledge and understanding of the JSP 846 safeguarding requirements varied across the members of the RAF Kinloss C4I Sqn. Some demonstrated a flawed understanding, but some knew them well. Even though some personnel knew the requirements well and knew that the MSSR and TACAN were infringed, they took no action to rectify the situation after the initial attempts in 2008 to remove vegetation. This may have been a result of misplaced confidence in that the FCs of the TACAN and MSSR would identify any issues that existed.
1.4.6.393 A number of RAF Kinloss personnel had a misunderstanding of the MSSR FC profile and the requirement to ensure the site is compliant with JSP 846 before the FC is conducted.

1.4.6.394 RAF Kinloss and BM ATM Eng RO personnel did not understand the purpose of the ADATS DT site survey, mistakenly believing that infringements would also be assessed.

1.4.6.395 Some RAF Kinloss C41 Sqn personnel mistakenly believed that ADATS DT approved of the continued use of the infringed MSSR and TACAN sites as ADATS DT had conducted 3rd and 4th Line maintenance, but not highlighted any issues since 2009.

1.4.6.396 As the BM ATM Eng RO EQA had not highlighted vegetation infringements, some RAF Kinloss C41 Sqn personnel mistakenly believed that the infringement did not warrant further action.

1.4.6.397 The BM ATM Eng RO EQAs are focussed on ensuring that individuals are trained and adequate procedures exist rather than actually checking to ensure that the tasks are completed correctly. The BM ATM Eng RO EQAs did not identify MSSR and TACAN vegetation infringements even though it is likely that ATM Eng RO personnel would have visited both the TACAN and MSSR during the past few years. It is likely that, during EQAs of RAF Kinloss, records would have been checked to ensure that unit personnel had completed site checks and that GRI range cards had been produced without physically checking GRIs for compliance with JSP 846.

1.4.6.398 Following notification of the TACAN infringement in 2009, the BM ATM Eng RO and RAF Kinloss C41 Sqn did not resolve or raise the issue further. As such, no EA or formal risk assessment was made. This denied the appropriate Duty Holder the opportunity to have assessed the risk and introduce mitigation measures to reduce the risk to aircraft operations.

1.4.6.399 In the Panel’s opinion, it is likely that ADATS DT personnel were aware of the MSSR and/or TACAN infringements from either 3rd/4th Line maintenance or following Cartography Section site surveys. Although infringement assessment was not an objective of the site survey, the nature and severity of the infringements are such that they could not have gone unnoticed.

1.4.6.400 Following EA requests from RAF Lossiemouth, ADATS DT have withdrawn their support for the safety cases of the Kinloss MSSR and TACAN. Given that the issue is serious enough for ADATS DT to withdraw its support now, and considering the likelihood that its personnel were aware of the infringements, it is not clear why ADATS DT did not act beforehand.

1.4.6.401 The RAF Lossiemouth DDH Advice Note contained mitigations based upon increased Flight Checks to allow continued use of the MSSR and TACAN, although the majority of RAF Lossiemouth personnel interviewed did not fully comprehend the purpose, scope and limitations of a Flight Check. The nature of the infringement makes MSSR performance unpredictable, which is why ADATS DT have ceased to underwrite it.

Conclusion

1.4.6.402 The Panel concluded that:

a. The MSSR and TACAN, both important enablers in ensuring safe aircraft
operations and airspace control, having been significantly infringed by vegetation for a period of ten years outwith the requirements of JSP 846;

b. policy and process not having been followed, there was a lack of understanding of own and other stakeholder responsibilities and assurance activities had not identified the safeguarding issue;

c. RAF Kinloss C4I Sqn. 1Gp BM ATM Eng RO and DE&S ADATS DT had not ensured that the hazard had been identified, reported and resolved. The risk to aircraft operations was not known by the DDH.

Therefore inadequate safeguarding of the MSSR and TACAN is an other factor that could contribute to another accident.

Information Management

1.4.6.403 JSP 747 states that “Information created or acquired by MoD staff in the course of their work must be regarded as a Corporate Resource of the MoD... There are many good reasons for recording information carefully;

a. Having the right information at the right time is crucial to good decision making;

b. reliable records form a sound basis for future work, analysis, audit or historical record;

c. records enable the MoD and individuals to explain and justify their actions”

1.4.6.404 JSP 747 goes on to state, “There are some activities which must have a written record, in particular key business decisions affecting allocation of significant staff time or public money, together with the evidence in which such decisions were made.”

1.4.6.405 Throughout the course of the SI, the Panel was required to gather evidence from a wide cross section of Defence sources and civilian organisations. The scope of the SI meant that evidence was requested from the early 1990s to the present day, and the requests were met with a mixed level of success. The reason for this was not because witnesses were unwilling to assist the SI, instead it was because of the practices and complexities of the information management system used by Defence over the last 20 years.

1.4.6.406 It is not the intention for the Panel to catalogue the changes to information management that have taken place within MoD over the last 20 years. The introduction of a more information technological age has seen the rise of the “electronic file” and the demise of the paper file and, as such, the method of storing information has changed dramatically over the last ten years. Many different systems have been introduced within the MoD, some of which were specific to certain areas of Defence and some of which were upgraded at different times. With a range of systems comes a range of training and understanding, and although personnel are taught to use a unified filing system to assist subsequent recovery, this does not always happen. The method of storing information has become a much more personal responsibility rather than a centralised administration function, and therefore information is stored in a much more diffuse method than previous times.

1.4.6.407 All of this creates a system where the effectiveness with which information is stored depends on the ability and rigour of the individual, on different facilities, in different locations, under different conventions at different times. An example of this was
demonstrated when the Panel requested evidence of CWS expenditure since the programme began. The Tornado Finance Manager stated, "Unfortunately the one thing I cannot give you is what has been spent to date. There may be snippets of this data in offline spreadsheets, (certainly not a full account of spend) but that's scattered across 41 CD/DVD's worth of data."

1.4.6.408 The Panel observed that there was no single repository to enable detailed and comprehensive audit of spending on the Tornado CWS.

1.4.6.409 When attempting to find the reasoning behind decisions, impact statements and options in the 2005 Planning Round, the Panel was informed by Strategy Management (the successor to Resources and Plans) that "I'm afraid it's bad news. The attached email shows how mistakes were made with the computer systems and data storage; subsequently the data has possibly been lost, which is why no one is able to find them. I believe this will affect all S options pre 07. Consequently I was not able to find option S04C081A referred to in the history either. The attachment does detail how you could go about finding the option, but as it is over 5 years old, I'm afraid it may now be irretrievable."

1.4.6.410 The Panel observed that there were no easily auditable records for Planning Round options and impact statements before 2007.

1.4.6.411 The example of mistakes made with computer systems and storage was identified by a National Archives assessment that was made in 2009, which stated that "The MoD needs to ensure a cohesive approach to handle information that is currently held on redundant or soon to be redundant IT legacy systems. Staff raised concerns about how the information held...would be archived or disposed of, as and when migration occurs...There is a risk that the information held is not destroyed or migrated at the appropriate time."

1.4.6.412 These mistakes had already happened by 2009, an example being in 2005 where there were two IT systems in place to run the equipment options in Resources and Plans. The supplier removed the database from one of the systems during the migration to DII without a full consultation taking place and all information was subsequently lost.

1.4.6.413 DCDS(MilCap) responded to a request for information within his department by stating, "I have tasked...our teams to review their archiving processes. The intent is to ensure that an appropriate governance structure is in place to prevent future difficulties in retrieving valuable decision making documents". He went on to say "...the difficulties in information storage, management and retrieval are a generic MoD challenge, rather than specific to Finance and Military Capability planning". The Panel concurs with this statement as the identification of documentary evidence over the breadth of subjects within the report was challenging.

1.4.6.414 The Panel found a variable quality of records, with no one section of MoD being any better or worse than one another. The constant change of positions, departments, locations and storage systems exacerbated the problems of recovering evidence.

1.4.6.415 The MoD Information Strategy states, "the need to improve Defence's Records Management regime is well recognised. There have been several well publicised examples of where records management in MoD has been inadequate, resulting in financial cost and reputational damage to the Department. This has culminated in the announcement of a Records Management Improvement Programme directed by Min(AF) and led by the Chief Information Officer."

1.4.6.416 The Panel observed that ineffective information management within MoD placed a burden on this SI which elongated timescales and delayed analysis.
Risk Management and History of the Tornado Collision Warning System

Introduction

1.4.6.417 This sub-section is divided as follows:
   a. Risk Management in 1Gp and RAF Lossiemouth.
   c. Tornado CWS Programme 2010 - 2012
   d. Mid Air Collision (MAC) Mitigation

Risk Management in 1Gp and RAF Lossiemouth

1.4.6.418 This sub-sub section is divided as follows:
   a. What is Risk Management?
   b. Risk Management Regulation and Direction
   c. How was MAC Articulated?
   d. What Mitigations were in place?
   e. MAC Mitigations in place on 3 Jul 12
   f. Analysis
   g. Conclusions

What is Risk Management?

“What’s your target for safety? ... No accidents...of course it is, but practically we’re in a risk taking business, we’re in a risky business...”
Air Chief Marshal Dalton, Chief of the Air Staff

1.4.6.419 The goal of risk management is “to show that safety risks can be tolerated and are at levels that are As Low As Reasonably Practicable (ALARP); merely identifying and mitigating risks is not in itself sufficient”. This is what makes Risk Management different from Risk Identification. Aviation Duty Holders (DH) are legally accountable for the safe operation of systems in their Area of Responsibility (Aor) and for ensuring Risks to Life (RtL) are reduced to at least TOLERABLE and are ALARP. Risk management is an essential element of an effective Air Safety Management System (ASMS) and DHs have many tools at their disposal to manage the risk such as, a standardised Risk Register (RR), hazard risk matrix and a referral/escalation process to manage RtL in a consistent manner. It allows DHs at all levels to enable risks to be compared and ranked and scarce resources targeted accordingly.

31 Def Stan 00-56 (Part 2)/4 Annex B
1.4.6.420 At each level there is a different focus to risk management. The Delivery Duty Holder (DDH) primarily manages single risks, while the Operational Duty Holder (ODH) focus is on reducing the aggregated Rtl by monitoring safety trends across his AoR. The Senior Duty Holder (SDH) ensures an effective end-to-end aviation safety management system is resourced, implemented and appropriately managed in his AoR.

1.4.6.421 Risk management, therefore, is the constant process to drive the risk to ALARP. It is not just the identification and mitigation of the risk, it is the coherent ASMS that ensures all risk activity is sufficiently managed. The three DH levels operate in a complementary manner, ensuring that risks are held at the appropriate level where they can be managed and resourced accordingly and provide legal accountability.

1.4.6.422 The 1Gp Air Safety Management Plan (ASMP) explains that “...The primary aim of Risk Management is to ensure and demonstrate that all risks associated with the overall operation of an aircraft system have been reduced to a level that is broadly acceptable and ALARP, or, if this is not reasonably practicable, to a level that is both tolerable and ALARP...”

Risk Management Regulation and Direction

1.4.6.423 MRP RA 1210 is the regulatory article that stipulates risk management and the tools and methods available to DHs to effectively manage single risks but more importantly the aggregated risk.

1.4.6.424 It states the following essential steps are required to manage Single Risks successfully:

a. Hazard identification and Analysis
b. Risk assessment (including risk estimation)
c. Hazard risk matrix
d. Risk reduction
e. Risk monitoring and review

1.4.6.425 MRP RA 1210 also requires that ODHs review their Safety Statements\(^{29}\) prior to implementing any significant change in an Air System (e.g. major capability upgrade) and as a formal element of ODH succession activities to ensure the incoming ODH is content with the level of Rtl being carried and the effectiveness of any extant mitigation measures.

1.4.6.426 The 1Gp ASMP gives direction and guidance to DDHs on Rtl, the concept of approach to Risk Management and Risk Registers (RRs), with an admission that “…1 Gp are piloting the process…” and that “…When Defence work is more mature, this section will be reviewed…” 1Gp ASMP states that the Unified Risk Register (URR) is “…a tool for documenting risks that have been classified and for recording potential mitigations…” and

\(^{29}\) A Safety Statement is a formal declaration by the relevant ODH that, based on its Air System Safety Case, all credible Rtl associated with a specific Air System are at least tolerable and ALARP. (MMA RA1205). Each Air System has a number of ALARP Statements that summarise the state of risk (assessment and mitigations employed) wth each DAAT-focused risk subset.
directed that ALARP statements should be generated for each of the 36 accident subsets by the Nov/Dec 12 Air System Safety Working Group (ASSWG).

1.4.6.427 The RAF Lossiemouth ASMP "...formalises our processes for managing Air Safety across RAF Lossiemouth, providing clear guidance on how we identify and report hazards, and assess and control the risk..." The Plan gives direction and guidance to all members of the Sfn on the implementation of safety management and directs the key members of the ASMS in their roles and responsibilities. It states that "...RAF Lossiemouth will adopt the 1 Gp URR..." but "The aspiration is for all RAF Lossiemouth supporting registers and RR management tools to be brought into one area for management but due to the differing requirements and histories of the legacy Risk Matrices this will take time to implement..."

1.4.6.428 Although risks may be held at higher levels, the DDH at RAF Lossiemouth felt that he had a role in their daily management, stating "...even if the risk isn’t held by me, I’m very much contributing to...the active management of that risk..."

How was Tornado MAC articulated?

1.4.6.429 A subset of the Defence Aviation Accident Taxonomy (DAAT) is Mid Air Collision (MAC) which is the 1Gp ODH’s top risk, the only risk elevated to SDH and the only risk elevated to the Secretary of State (SoS) for Defence. This highlights the importance with which this risk was regarded. The extant ALARP statement dated 1 Sep 11, for MAC-Non Cooperating Military aircraft (MAC-NCPMIL) describes the mitigation in place for this risk. It was drawn from a previous iteration of the RR and was in the process of being refreshed in order to conform with the format required for the new URR. The risk of MAC-NCPMIL was judged to be TOLERABLE and ALARP by the ODH but still remained his top risk.

1.4.6.430 Within the DAAT there were subsets of MAC for both Non-Cooperating military and civilian aircraft. (MAC-GA – Mid Air Collision with General Air Traffic). The Panel could see the reasoning behind this, however as both subsets involve non-cooperating traffic in similar environments (Class G/F airspace) and can result in similar outcomes, the Panel observed that there could be a misinterpretation of the risk by DHs if they were not considered as a sum rather than discrete entities. The non-cooperating element of the MAC-GA risk must be taken into consideration along with the MAC-NCPMIL and then the totality of the risk can be managed. The Panel did not feel that the DAAT should be amended, as the sub-sets are germane, however there should be recognition that any risk calculations of MAC-GA is in addition to the MAC-NCPMIL (and vice versa).

What Mitigations were in Place?

1.4.6.431 Tornado MAC ALARP Statement. The Sep 11 ALARP Statement was similar to its predecessors, signed by the previous ODH on 27 Apr 11. Of note, the previous ODH had produced two ALARP statements for the same risk. One stated "...further technical mitigation of this risk is based on the funded Collision Warning System (CWS) programme for the GR4. Full fleet embodiment of CWS will further reduce the likelihood of RTL (ie more improbable); however this will be at a cost of ~£50m...", the second was identical with the exception that the CWS element of mitigation had been removed. Both were signed by the

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33 A DH makes an ALARP statement based upon good practice justification, qualitative judgements and quantitative assessment. It is essentially the "stopping condition" for risk reduction so justifying and recording how it is reached is an important and vital step in safety management.

34 MAC-NCPMIL – MAC with a non-cooperating military aircraft. This would cover all instances where no cooperation was planned or intended by either party.

35 Non-cooperating is described in the DAAT as "This would cover all instances where no cooperation was planned or intended by either party. Liaison to separate activities by time or geography would not count as cooperation"
ODH stating he agreed with the reasoning and confirmed that the risk was both TOLERABLE and ALARP.

1.4.6.432 The Sep 11 ALARP Statement included the CWS paragraph, but it had been amended to state, "...however this would be at a cost of ~£60m. The introduction of CWS would not mitigate a collision against a non-IFF equipped/operated aircraft. The Main Gate business case for Tornado CWS is due to be reviewed by the Secretary of State in Nov 11 and, if endorsed, would be funded through PR12..." The remainder of the document is identical to previous iterations and was signed by the current ODH.

1.4.6.433 The specific mitigations for Tornado MAC-NCMIL are described in para 1.4.6.604.

1.4.6.434 In Apr 10, ODHS were given direction on how to manage MAC risks by ACAS. This included "ensure that only essential flying activities are being conducted with an understanding of how one is required to achieve them...as well as identifying 'specific-to-type' risks (such as lookout field of view issues and quality of crew lookout training/performance), all assessments are to consider sortie/mission profiles and operating patterns...the process of recording risk assessments and ALARP judgements is to be clearly auditable..."

1.4.6.435 In Jun 11 an MAA assurance visit of 1Gp identified that "...there was no evidence that any areas were not ALARP with respect to MAC risk. Though there was still significant difficulty in generating the evidence that they were..."

1.4.6.436 In Aug 11 an MAA assurance audit of 1Gp identified that "...RRs at all levels were immature, with configuration control a particular weakness."

1.4.6.437 In Aug 12 the DDH Lossiemouth stated "...if I go back to July I do feel that our position that was reflected in the ALARP statement and the bits that were in it were immature in their approach"

1.4.6.438 In Aug 12 OC XV(R) Sqn stated that he felt the 1Gp RR was "...embryonic..."

1.4.6.439 In Oct 12 the Tornado Safety Case Manager stated "there's still a journey to go because some of the ALARP statements are fairly rudimentary in terms of analysis, but at least they've been done."

1.4.6.440 The Tornado Safety Case Coordinator, when asked in Oct 12 when the RR would no longer be immature, stated "...I think we're probably a year or two away from that..."

1.4.6.441 The 1Gp Safety Training Assurance and Regulation (STAR) organisation stated "...our people working in these safety cells doing the active risk management for the platforms have very little...if any, risk management training...They're just...another post that needs to be filled...you've got to go and write some ALARP statements on x, y, z...there's not even a central tool or analysis method..."

1.4.6.442 On getting education and direction, the 1Gp STAR organisation stated, "And one really frustrating part is, I've managed to get a couple of guys...onto the MAA's Defence Air Managers Safety Course a couple of months ago, and the risk management lecture, which was the focus that everybody was wanting to go and hear, was given by somebody who stood up at the beginning of it and said, 'I'm no risk expert,' and there was just complete deflation in the audience."

1.4.6.443 The ODH stated "it's a constantly maturing process...we're more mature today;"
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last July it was more mature than when I took over in Aug 2011 and it’ll be more mature next year...there are areas, I think MAC risk comes in...and you look at that...what we’ve seen and unearthed subsequently there are things that we, we could have and should be driving, I think, more mitigation into that risk...”

1.4.6.444 The SDH stated “…in practical terms we are still only in the infancy of putting the thing into place, so my view would be it was fit for purpose but it was maturing.”

Tornado MAC Mitigations in place on 3 Jul 12

1.4.6.445 Risk Registers (RR) are not mandatory reading for aircrew or stn personnel. DDH Lossiemouth described the content being translated for a wider audience into orders, literature and posters to generate “…brain activity in engineers, aircrew, anybody who’s connected with those risks...firstly to get them to realise they’re entering a higher risk location or situation and, secondly, to understand when they are doing something that adds or reduces from the mitigation…”

1.4.6.446 The ODH stated “I would hope that that [sic] is something as part of a station process that there is awareness and actually, because part of the mitigation is in…the activity and the person who is providing that mitigation…his awareness that…[he is] part of the mitigation of that particular risk…” He went on to say “so all you’re doing in the RR is capturing that which is…directed elsewhere…I wonder if there are things there that are only existing in the RR…” this worry was mirrored by OC XV(R) Sqn when he stated “…at the moment [the RR] is just something that people are collating that they can draw out on instances like this where they go, “do you know you’ve had this risk sitting up here?” Well do you know what? That would be great, you need to tell me about that.”

1.4.6.447 The DDH said “We’ll see in the FOB things that are really linked off the RR but people don’t know they’ve come off the RR.” Although the DDH states in his introduction of the RAF Lossiemouth ASMP “…I look to all RAF Lossiemouth personnel to become intimately familiar with the contents of this ASMP and implement it accordingly…”, he does not expect the same intimate knowledge and understanding of the RR and associated mitigations, as they know the rules, regulations and processes in place to reduce their risk activity.

1.4.6.448 Aircrew interviewed were conversant with the plethora of rules, regulations and processes that form the mitigation for MAC within the RR, although they had not read the mitigation in the RR. Visibility of the associated ALARP statement did not progress beyond individuals with responsibilities directly related to the ASMP. OC XV(R) Sqn stated “…I’ve never read the 1 Gp RR. I’ve never had access to it…”

1.4.6.449 OC XV(R) Sqn believed that the method of linking risk mitigation to the 1Gp RR was a “bottom up” approach wherein risks are highlighted through the Ops Wing RR that will be fed through the Sqn into 1Gp. He stated “…I don’t necessarily see, or I haven’t seen, something that comes straight out of the 1Gp RR that comes straight back down to me.”

1.4.6.450 Assurance of Risk Mitigating Activity. Stns are audited and checked by the 1Gp STAR organisation for standards and practices to assure the DDH and ODH that ASMS and flight safety activities are taking place. During a 1Gp STAR assurance visit of RAF Lossiemouth in Sep 12 the report stated “…during discussions with Sqn Execs, Duty Auths and EngOs, few were aware of the mitigations stipulated by the DH-chain’s TOLERABLE and ALARP statements.”

1.4.6.451 The ODH chairs the ASSWG, which is the forum that evaluates the airworthiness, operation and maintenance of each platform, looking across the Defence

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Lines of Development (DLODs) and produces a statement providing assurance that Air Safety RIL are currently TOLERABLE and ALARP or identifies where they are not. This then allows a plan to be formulated to deal with the risk.

1.4.6.452 Although the risk for MAC-NCPMIL is held at ODH level, it is the DDH and the supporting Air Safety Management System that manage the risk. The Lossiemouth DDH stated, "...although [the ODH/SDH] will try and effect a change to the bits that we've had to pass the risk up for, we very much hold the responsibility for mitigating the rest of the risk..."

1.4.6.453 Risk ownership may appear confused by this process, where it is kept at a higher level but actively managed at a lower level. The DDH, although clear on his own role in the risks stated "...I think there was some scope for confusion because if you follow those risks up through ALARP statements they say they are owned by somebody and managed by somebody else..." In reality it is not this clear cut, and there are aspects of the risk managed by two (or all) levels.

Analysis

Risk management is vital to ensuring that RIL is ALARP. If risks are not actively managed, then it is representative of Charles Haddon-Cave's description of "paper safety at the expense of real safety."

1.4.6.454 There is clearly articulated regulation for the management of risk within MRP RA 1210. 1Gp were compliant with the structural requirements mandated within MRP RA 1210. This was through the DH construct and the use of the ASMP to articulate the way risks should be managed to TOLERABLE and ALARP: the 1Gp risk management framework was fit for purpose.

MAC was the number one risk in 1Gp. The ALARP statements were the top priority for refreshment, but little changed in their content. It was not possible to determine whether this was a result of the perceived maturity of the risk and previous work, lack of rigour in re-analysis, or a consequence of inadequate/insufficient training and experience at doing so.

1.4.6.455 Although the MAA had directed the unification of RRs in 2010, units felt the direction and guidance they had been offered was vague. The role of the regulator, however, was not to resource the training and development of risk managers (this should have been sponsored and resourced internally), instead it is to define the regulatory framework and desired outcomes. The RRs suffered from numerous format amendments and configuration control, making the job of consolidating, updating, collecting and managing risks a difficult task, however MAC risk was not a new risk and should have been the most mature.

1.4.6.456 The URR was not regarded as a mature document. The MAC ALARP statements had been sent to the two Main Operating Bases (MOBs) for refreshment, analysis and testing, with the higher risks being the priority, but it had not yet become the tool for managing risks; it was a repository for collecting risks. The Panel believes that so much focus was placed upon the format and collation of risks that the management of them fell to regurgitating previous safety statement mitigation without analytical refreshment. Haddon-Cave described a similar situation with Nimrod Safety Cases as, "intended to be an aid to thinking about risk but have become an end in themselves." The Panel believes that the MAC ALARP statement represented capturing current practice with little additional analysis and mitigation.

1.4.6.457 A new format of RR should not impact on a well managed and articulated risk.
The ODH acknowledged that the RR captured what was directed elsewhere first, and articulated the potential disconnect between a RR and the risk reducing activity.

A risk management process “fit for purpose”, in accordance with MRP RA 1210, should adequately identify, mitigate and actively manage risks to both TOLERABLE and ALARP.

Although 1Gp and RAF Lossiemouth had ASMPs, there were fragile procedures in place to ensure the mitigations recorded in the RR were relevant or visible to those carrying out the activity. OC XV(R) Sqn knew the processes in place to try and minimise the risk to MAC, but had no visibility or understanding of the DDH/ODH ALARP statement/register. The mitigation may have been based upon good practice, but the assurance of the activity, at all levels, was not linked to the ALARP mitigation.

The ALARP statement in Sep 11 was identical to its predecessor, with no evidence of it having been refreshed. There were two ALARP statements signed by the ODH, one with a CWS programme in being and one without. There was no additional mitigation stated for a lack of CWS programme, in fact there was a statement that fitting a CWS would be grossly disproportionate. The Panel concluded that the ODH believed the risk was ALARP either with or without a CWS programme, or was pending staffing for either eventuality.

No changes were made to the MAC Safety Statement as a result of the handover between ODHs. The transfer of risk is covered in para 1.4.6.554

Conclusions

The Panel concluded that:

a. although the risk management process was going through a period of transformation, it should not prejudice good practice of actively managing RIL. The risk management framework in place was fit for purpose, but the processes within it were ineffective.

b. the MAC risk was identified, and mitigation had been captured, but there was not sufficient active management of this risk during the progression of the ALARP statement.

c. personnel used MAA direction and the maturity of the RR as an excuse when MAC had been identified as a major risk since the early 1990s and should have had the most mature mitigation in place.

The final conclusions to Risk Management are at para 1.4.6.606.

Tornado Collision Warning System (CWS) Programme History 1998 – 2013

This sub-sub section is divided as follows:

a. Key Dates
b. Requirement
c. Analysis

Key Dates
1.4.6.466 **Introduction.** The main themes of the Tornado CWS programme from its inception in the early 1990s to the SDSR in 2010 are technical challenges and finance driven delays. The key dates summary highlights the impact that these themes have had on the In Service Date (ISD) of the CWS on to Tornado GR4.

**CWS Funding and Planning Round Summary**

1998  
SDR 98 commitment. CWS project initiated.

1999  
Defence Procurement Agency (DPA) paperwork stated a “...slippage of programme due to requirement definition problem...”

2000  

2001  
No change to funding line.

Planning Round (PR) 02  
- Option from PR02 (E132482) slipped the programme by two years. **ISD delayed to 2006 by MoD Defence Management Board (DMB).**

PR 03  
Enhancement Option E164 – E3TA035 sought funding for a CWS technical demonstrator programme for future integration on Fast Jet and training aircraft.

Oct 03  
Additional funding approved for concept phase (£4m). **ISD delayed to 2008 by MoD DMB. £2m in-year enhancement option to maintain progress.**

PR 04  
Savings Option E5 – S04C081A DLO – Defer Tornado GR4 CWS ISD from 2008 to 2009 (£20m). Also an enhancement option E4DT018 which sought a further £10m to provide programme affordability. **Option E5 – S04C081A taken, ISD delayed to 2009 by MoD DMB.**

PR 05  
Savings Option A10 – S05C031A Defer Tornado CWS by one year extended the project assessment phase, which was due to commence in 2005, by one year (from Apr 09 to Apr 10). **Savings measure A10 delayed ISD from 2009 to 2014 due to withdrawal of £51.125m by MoD DMB.** STP05 funding profile necessitated an artificially slow development plan. £1m “keep alive” in-year funding allocated for STP 04 shortfall.

PR 06  
No Planning Round. This was a review year. £5.4m spent on assessment phase.

PR 07  
Enhancement Option D07 – S07CC049A sought £26.1m to fund the implementation of a GR4 fleet-wide CWS for 2010 ISD (buying back the ISD from 2014 to 2010). **This enhancement relied upon a favourable outcome of the Comprehensive Spending Review (CSR) which did not occur. MoD DMB did not fund enhancement and the ISD remained 2014. £5.2m spent on assessment phase.**

PR 08  
Savings Option E08DT143S descooped the Tornado CWS by assuming a Commercial Off The Shelf (COTS) solution based on Traffic Collision Avoidance System (TCAS) II. It was stated that the descooping would **advance the CWS ISD from 2014 to 2012.**

**PR 08 in detail:**
Apr 08    MoD concerned bespoke option would be unlikely to pass Main Gate Business Case (MGBC) approval.

May 08    MoD re-evaluated Honeywell TCAS II and concluded that it would meet requirement and offer potentially reduced integration and support costs.

Sep 08    MoD halted bespoke development after attempts to correct programme failed. COTS TCAS II solution chosen.

PR 09    No record of CWS measure found. An option was raised but not taken forward.

PR 10    No record of CWS measure found. Option E10DT159S was not taken forward. Firm Price Quotes from Industry for TCAS II (this COTS solution offered an ISD of 2012) with full fleet embodiment by 2015 at a cost of £61.3m also reduced the programme from a Category (Cat) B to Cat C programme (a Cat C programme does not require Investment Appraisal Board approval).

PR 11    E11DT072S – Secretary of State (SoS) decision to Delete Tornado CWS but with review in the 3 Month Exercise (3ME).

3ME    Review of the CWS programme.

PR 12    Programme resurrected (although during 3ME, industry personnel re-allocated and a 9 month delay injected into the programme). New costings increased funding requirement.

3 Jul 12    Mid air collision between ASTON 1 and ABBOT 2. No CWS fitted on any GR4 aircraft. Programme still in assessment phase, yet to submit a MGBC.

Money spent to date (FY 99/00 – 12/13) - £30.085m

Additional predicted cost to completion of programme - £48.269m

2015    Current Tornado CWS ISD.

2019    Tornado Out of Service Date (OSD).

Requirement

“Between 1979 and 2001 there were 44 mid-air collisions involving RAF military aircraft, in which 51 aircraft were destroyed, including 12 GR1/4s. Four of these incidents involved military and civilian aircraft.”

1.4.6.467    In 1990 a collision between a Jaguar GR1 and a Tornado GR1 highlighted the limitations of the human eye when detecting another aircraft on a constant relative bearing at a closing velocity of 900kts. The accident report stated that “purpose built electronic collision warning equipment will be evaluated and developed for the RAF over the next few years.” This is the first accident report that mentions a collision warning system, with previous recommendations focusing on conspicuity, planning and training.

1.4.6.468    A demonstration programme was initiated in 1991 to establish whether the system could work on a Fast Jet (FJ) and, once proven feasible, the requirement for a CWS was written into policy in the 1998 Strategic Defence Review (SDR 98).
1.4.6.469 SDR 98 stated that the political imperative to implement a Tornado CWS programme and funding was provided under the management of the Tornado Integrated Project Team (IPT). Although a specific SDR commitment, SoS did not declare the funding to be non-discretionary; therefore CWS was prioritised and funded as part of the normal planning process (meaning it could be delayed by Central Staffs and the profile of implementation altered during its development).

1.4.6.470 **Justification in 2003.** The UK Airprox Board Report 10, for the period Jan 03 – Jun 03, when describing an incident between a Tucano and a Tornado GR4, stated “The Airprox occurred in the Class G airspace of the LFS (Low Flying System) where ‘see and avoid’ applied.” The RAF Headquarters Strike Command (HQ STC) commented, “This incident re-emphasises the high priority needed for the fitting of TCAS to Tucanos, following the successful trial, and the need to progress the trials for CWS for fast-jets”.

1.4.6.471 **Justification in 2004.** The Tornado Systems Requirements Document (SRD) identifies the system requirements that must be satisfied to enable the platform to perform its intended role without degradation to any extant capability. This document stated:

“Following a mid-air collision between a Tornado GR1 and a civilian helicopter in Jun 1993, the MoD commissioned DERA to conduct an operational analysis study. The objective of the study was to assess the effectiveness of the ‘See-and-Avoid’ principle and to evaluate various measures that might enhance flight safety in the UK Low Flying System (UKLFS). The study predicted that a military/military collision would occur every 2 years, and a military/civilian collision once every 6 years. The study also concluded that the provision of CWS on fast jet aircraft could reduce the collision rate by two-thirds. This firmly underpins the requirement for CWS and projects a level of expectations of return.”

1.4.6.472 The SRD stated that the ISD for Tornado CWS was planned for 09/10. At that time the RAF had a fleet of 139 Tornado GR4 with an OSD of 2025.

1.4.6.473 Director Air Staff stated that, “…in an increasingly litigious society, the MOD would find it difficult to defend the non-equipment of Tornado and successor fleets with a CWS, and could, worse case, be forced by the Civil Aviation Authority (CAA) to constrain training to tactical areas.” He summarised the priority as, “We are supported by Defence Air Safety Cell in our belief that CWS provision for Tornado is overdue and find it increasingly difficult to maintain the line we have taken with the CAA that progress on introducing CWS is being made. Assistant Chief of the Air Staff (ACAS) believes this issue has the highest priority after critical operational requirements.”

1.4.6.474 **Justification in 2005.** The Tornado CWS Initial Gate Business Case (IGBC) stated that the military requirement for CWS was:

“Any further collision accidents during training, notwithstanding the immediate human and material consequences, are assessed as having an adverse impact on the MOD’s wider operational interests through an inability to train as desired.”

“If no mitigation is put in place, historical data suggests there is a statistical probability of losing another 9 Tornadoes and 5 civilian aircraft before the Tornado OSD in 2025.”

1.4.6.475 The only non-equipment option suggested, that would not have placed constraints on access to airspace as an alternative to purchasing the Tornado CWS, was “to provide enhanced training to both aircrew, particularly in ‘See and Avoid’ techniques, and Air Traffic Controllers. However ‘See and Avoid’ techniques are of limited effectiveness...”
because of the constraints of the human eye\(^{36}\) and the majority of collisions and airprox have been in uncontrolled airspace where there would be minimal benefit from training for Air Traffic Controllers."

1.4.6.476 **Civil Aviation Authority Interest.** In 2005 the CAA Airspace Policy Committee reviewed a study into the risk of collisions between Commercial Air Traffic (CAT) and military FJs flying in uncontrolled (Class G) airspace in the NE of the UK. The report had recommended:

"that all FJ military aircraft, and any CAT not covered by the Airborne Collision Avoidance System (ACAS) II mandate, should be fitted with a Collision Warning System (CWS) capability wherever technically possible.... and the MOD has secured funding for the fitment of CWS to some of its FJ fleets and is continuing to seek viable technical solutions for the integration of such equipment into the complex avionics suites of current and future military aircraft."

1.4.6.477 A report from an attendee at the Committee meeting stated, "I was left in no doubt that pressure from the civil sector through the SRG, AAIB and UK Fit Safety Committee will increase markedly if MOD commitment to CWS is seen to wane....the inference is quite clear: Class G airspace is under threat. If we lose too much of it, we will rapidly find ourselves in difficulty over training."

1.4.6.478 **Ministerial Interest.** In Oct 05 the Capability Sponsor (Head of Capability\(^ {37}\) (HOC)) within MoD (Directorate of Equipment Capability (Deep Target Attack) (DEC(DTA)), responsible for Tornado capability management in MOD, described the subject of Tornado CWS as being "... subject to intermittent cross-departmental ministerial interest. The latest exchange of correspondence was 18 May 04 between the Secretary of State (SoS) and Alistair Darling SoS for Transport."

1.4.6.479 Following the IGBC in Sep 05, the Minister for Defence Procurement (MinDP) requested a meeting with stakeholders to discuss concerns over the projected ISD of the Tornado CWS. His particular concerns, along with the extended delay to the ISD, were, "in the event of a mid-air collision, the MOD's legal responsibility, presentational issues and political impact." This appears to centre on what is now described as "societal risk". Societal risk is discussed further at para 1.4.6.567.

1.4.6.480 **Short Term Plan (STP) 2005.** STPs covered a rolling four year period and ran alongside a ten year Long Term Plan (LTP) (which is now referred to as the Equipment Plan and covers a 20 year period). The LTP was not costed as a whole entity prior to 2005. Before significant reform starting in 2009, the LTP included too many parallel programmes which was described in Bernard Gray's 2009 review of acquisition as "a substantially overheated equipment programme, with too many types of equipment being ordered for too large a range of tasks at too high a specification." This meant that savings had to be made every year to manage both the costs of running Defence that year, and investments into new equipment in line with the rolling four year STP.

1.4.6.481 The first year of biennial MoD planning reviews was 2005 which "...free[d] up resources for other work next year, [but] meant that it was essential to have a programme for the next two years that contained less financial risk than had been possible in previous STPs". The Defence Management Board (DMB) had aimed to "strike a policy-led balance

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\(^{36}\) An Australian Transport Safety Bureau study judged the "See and Avoid" process to be only 47% effective when closing speeds are greater than 400 kts even in the optimal conditions.

\(^{37}\) The title of this post changed during the timeline 2005-2012, so for continuity and ease of reading, the same title (which came into being when the title Directorate of Equipment Capability (DEC) was retired) of HOC has been used.
between supporting current activity...and sustaining the long-term equipment modernisation programme." The Spending Review in 2004 allocated £2.5bn to the Defence Budget over the period 2004/5 to 2007/8, which it had been hoped would avoid substantial adjustments to the programme in STP 05.

1.4.6.482 It was within this context that planners were managing an “overheated” programme consisting of too many seemingly affordable items, which together could not be funded within the MoD budget. The standard mechanism when faced with the requirement to make difficult savings was for capability sponsors to delay the equipment programmes rather than to delete them.

1.4.6.483 Bernard Gray identified this behaviour and its effect:

“These forces and incentives create an over-large equipment programme, which contains within it a significant underestimate of the likely out-turn, making the programme even less affordable than it appears at any given moment in time. When this over-large and inflating programme meets the hard cash planning totals that the MoD can spend each year, the Department is left with no choice but to slow down its rate of spend on programmes across the board. The result is that programmes take significantly longer than originally estimated, because the Department cannot afford to build them at the originally planned rate. They also cost more than they would otherwise, because the overhead and working capital costs of keeping teams within industry and the MoD working on programmes for a much longer period soak up additional cash.”

1.4.6.484 Delaying delivery of a specific piece of equipment is a common means of saving money for several reasons. It is easy to withdraw uncommitted money (money earmarked for the project but not spent) from a project, producing an immediate saving in exchange for a delay. Depending upon the profile of the programme (in which year money has to be spent to purchase essential material), this may result in increased costs in the future as well as delaying the ISD of the equipment, however the costs could be re-profiled to fall outside the current rolling timeframe calculation (outside the STP). This gives the false impression of affordability for budget totals in timeframe. Using the same technique across numerous projects creates a “bow wave” of postponed costs ahead of the current rolling timeframe. The further a project is postponed, the more difficult it becomes to impose further delays, resulting in balloon costs. As costs balloon it becomes unaffordable to maintain all of the delayed projects and some must be cancelled. The Acquisition Review\(^{38}\) found, on average, that projects overran by 80% (or five years) and cost more than 40% more than initial estimates.

1.4.6.485 The process for arriving at specific savings options was standardised across MoD. \(^{2}\) PUS issued savings targets to Top Level Budget (TLB) holders, whose task was to identify savings that they could make and evaluate the impact of each (mostly activity based savings). Controversial savings options (from both a capability and reputational perspective) were referred to differing levels of consultation. Some were raised to the Policy and Programmes Steering Group\(^ {39}\) (PPSG), where Assistant Chiefs of Services were able to offer comment on each option and their accompanying impact statements, and attempt to influence the other members. Director General Strategy and the Finance Director held the majority vote in agreeing the “lower pain” options. The most difficult decisions required the approval of the DMB and SoS and were elevated for their consideration.

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\(^{38}\) This was carried out by Bernard Gray and reported to the SoS. (Gray, Bernard. “Review of Acquisition for the Secretary of State for Defence” 2009.)

\(^{39}\) The PPSG was chaired by the Finance Director who would present the final package to the DMB.
In 2005 it was necessary for the DMB to find an additional £2.1bn saving on top of the £1.2bn saving already agreed by the PPSG. The additional savings were required to cover cost growth in the Equipment Programme (EP), non-disclosory enhancements to the programme and financial risk (i.e. STP 05 cost more than was predicted in the last STP review in 2004).

**Capability Sponsor Warnings.** Prior to the STP 05, in May 04, HOC DEC(DTA) convened a stakeholder review of the Tornado CWS programme to highlight the incoherence between the aspiration to introduce the programme into service in a timely manner and the realities of painful cuts to meet spending controls. It was agreed that, notwithstanding the financial pressures on the EP, CWS should remain a very high priority programme, not only for the Tornado GR4, but for the rest of the FJ fleet too.

An additional £1m was provided by MoD to maintain activity on the programme; the budget was confirmed at a further £94m from what had been spent to date and the stakeholders supported a move to ensure the programme was protected.

During the STP 05 planning process in Dec 04, HOC DEC(DTA) wrote to stakeholders, this time highlighting the significant change in situation regarding Tornado CWS. Since its transfer from the EP in 99/00, and up until STP 04, the project had been deferred three times and was now under another savings challenge in STP 05. In outline, the savings option would remove £57m from the programme, leaving no funding for the next two years. This would result in an obvious delay to ISD and put at risk the commitment of the sole Industry supplier. He stated that there would be risk that the programme might not be achievable at all within the remaining funded profile and that it did not demonstrate commitment on behalf of the MoD to fulfil its corporate responsibility to the ministerial direction to fit a CWS.

**DTA Draft Impact Statement.** HOC DEC (DTA) wrote a draft impact statement to Resources & Plans(Centre) (RP(Centre)) prior to the option being submitted higher. This statement reported that:

"This savings option would result in the programme becoming financially and commercially unviable resulting in the cancellation of what is the sole programme to introduce a CWS on fast-jets. CWS represents the tangible evidence of the MOD demonstrating due regard for the safety of other airspace users by minimising the risk of collision. The cancellation, or any further delay, of CWS would result in increased pressure to deny dual usage of unrestricted airspace to fast jet aircraft placing a severe limitation on training. In the event of a further mid-air collision, the proven technical feasibility of CWS would place the MOD at severe risk of punitive litigation. Following the SDR requirement to equip GR4 with CWS, cancellation of the programme would require ministerial endorsement."

**Legal Advice to Savings Option S05C031A (STP 05).** Legal advice regarding the deferral of CWS was requested by and provided to the Director of the Defence Aviation Safety Centre (a predecessor organisation to the MAA), and was supporting evidence to counsel against deferring CWS in 2005. The advice incorporated a legal assessment of what is reasonable and proportional, and the burden of fitting CWS (with burden not consisting entirely of cost) and, although had a wide distribution, was not put before the DMB or included in the options statement by RP (Centre) financial planning staffs. The summary stated:

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41 Equipment Programme is synonymous with Equipment Plan

42 For ease to the reader the Panel have called the then Director DTA, HOC DEC DTA. There was structural and titular changes within MOD during 2004/5 and the organisations were no longer called DEC. This is represented within this report with DEC being removed from the title after 2005.
"...there are, in my view, serious risks in a complete cancellation of the programme. Those
risks would be considerably mitigated by continuing to examine at the very least the
feasibility of such a system. Only if we were to radically alter the way in which we conduct
operations so as to minimise the risk of collision.....would there be any clear and justifiable
reason for suspending the programme."

1.4.6.492 Savings Option A10 – S05C031A (STP 05). The savings option which deferred
Tornado CWS in STP 05 sat within the domain of Resource & Plans (RP) within MoD.
Although the programme was targeted at an RAF platform, it was the remit of RP(Centre), a
joint organisation. RP(Centre) would deal with support function options; as the CWS was
being managed in its Concept and Assessment phase from the Defence Logistics
Organisation (DLO), this fell to the Centre section of RP rather than to an individual
service. The option did have Single Service oversight from RP(Air) and RAF SMEs were
consulted during the creation of the impact statement, but primarily it was RP(Centre) that
staffed the option. The original option, its full impact statement and supporting
documentation could not be found. This was a result of the restructuring of the DLO, the
many changes in organisation within MoD and the differing information management
systems that had been implemented since 2005.

1.4.6.493 In Feb 04, Head of RP (Air) had sent reworked impact statements in order to
"impair clarity into the clipped versions currently included" to the Deputy heads of Defence
RP and RP(Centre). The impact statement for the deferral of Tornado CWS stated a delay of
two years and:

"The CWS requirement on GR4 was underwritten in SDR (specific mention). Funds
originally transferred from EP but previous attempts to cancel/defer have foundered because
of the importance attached to this high profile project...In addition to the continued risk of
collision, the measure will provoke considerable CAA concern and risk increasing restriction
of Tornado access to controlled airspace."

1.4.6.494 In Dec 04 Director General Resources and Plans (DGRP) was briefed (along
with the 2" (military) head of Resources and Plans) on the headline RAF issues within STP
05 that would create "customer areas of concern". The deferral of Tornado CWS was raised
under the "Ministerial Interest" heading.

1.4.6.495 Policy and Programme Steering Group (PPSG). In Dec 04 thePPSG
received summarised impact statements for options as part of a package to be discussed
and approved for onward transmission to the DMB. The PSPG was the forum to discuss the
impact of options, and for Assistant Chiefs to raise Single Service issues for consultation
and debate. The PSPG meeting would have been an opportunity for ACAS (as Air SME)
and other Assistant Chiefs to raise concerns regarding the deferral of the Tornado CWS
programme.

1.4.6.496 The PSPG impact statement for the deferral of Tornado CWS stated:

"This option would reduce early years funding for the Tornado GR4 Collision Warning
System, extend the project assessment phase, due to commence in early 2005, by up to 2
years and has the potential to delay the ISD by at least 2 years from Apr 09 to Apr 11. This
measure would extend the continued risk of a mid air collision, provoke considerable CAA
concern, risk increasing restrictions on Tornado GR4 access to controlled airspace and
attract Ministerial interest."

42 The DLO were the pre-cursor organisation to Defence Equipment & Support (DE&S)
1.4.6.497 There are no official minutes from the PPSG. The only auditable outputs are the paper by Director Finance that was presented to the DMB in Jan 05 and a note from Director Policy and Planning stating that the "impact of the overall package is such that it will be very difficult to claim that we are adhering to the policy...very high priority capabilities are being run down or foregone, while the balance of investment in relatively low priority air and maritime platforms continue to rise." The DMB paper set out the recommendations for aligning the Defence Programme and Defence Budget over the STP 05 and Equipment Programme (EP) 05 period. It is within this paper that the options debated at the PPSG were put forward as a means to achieve this. Tornado CWS deferral was put forward as an option for deferral.

1.4.6.498 Defence Management Board 05/05 26 Jan 05. The impact statement within the Finance Director's paper to the DMB indicated that the delay to the programme would be less than that identified in the PPSG impact statement, even though more money was being taken out of the programme. Within the information section of the option it stated that the impact in terms of time is a "deferral of Tornado Collision Warning System by 12 to 18 months." The monetary detail subsequently provided by the Finance Director stated that there would be a deferral of one year and a saving of £51.125m between 2005 and 2009. The summary of the impact statement was summarised for the DMB as follows:

"Defer Tornado Collision Warning System by 1 Year. This option reduces early years funding for the Tornado GR4 Collision Warning System by £50m over the STP period, extends the project assessment phase, due to commence in early 2005, by a minimum of one year and has the potential to delay the ISD by one year from Apr 09 to Apr 10. The option would extend the continued risk of a mid air collision, provoke considerable Civil Aviation Authority (CAA) concern and risk increasing restrictions on Tornado GR4 access to controlled airspace."

1.4.6.499 The option was within the package agreed by the DMB and put to SofS with no specific mention or caveat. The Panel observed that at that time, options with an impact on safety were not specifically identified as such or set apart from other options (but the impact on safety would have been considered within each individual impact statement). However, the impact statements were routinely abbreviated by the financial planning staffs as the planning process unfolded.

1.4.6.500 Differing Assessments of Delay. The impact statements for the PPSG and the DMB differ in their assessment of delay to the delivery of CWS. The PPSG statement stated a deferral of two years, the DMB preamble stated 12-18 months, but the impact statement heading and summary within the same document stated a one year deferral. The original and unabridged version of the option from RP(Centre) was not retained. There is no explanation for the reduction in assessed delay as the option was passed upwards. It is difficult to explain how the delay was decreased as the monetary savings were increased from the £49.250m originally stated in the PPSG paper, to £51.125m over the four year STP. That said, it does not necessarily follow that the more money that is removed from a programme the longer the deferral. The deferral would depend on which element of the programme the money was taken from.

1.4.6.501 Actual Delay. In May 05 HOC (DTA) was briefed that the option S05C031A had resulted in a longer delay to the ISD than had been presented to the DMB in Jan 05. This

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43 The PPSG approved "packages" to be considered by the DMB and then recommended (or not) to the SofS who had sole authority for their approval. Within the "packages" there were less contentious options that would pass DMB consideration with little debate as they had been agreed at the PPSG as "low pain", but they would still require DMB approval. In addition, there would be contentious "packages" (especially those identified as having Ministerial Interest) which the DMB would actively consider before deciding if they would be recommended to the SofS. In this instance, Tornado CWS would have been delegated to the DMB to consider due to its Ministerial Interest.
was consistent with warnings that had been given to stakeholders in Dec 04, and had been highlighted in a suggested impact statement from DEC(DTA) to RP(Centre), which had attempted to force the issue by recommending either to fully fund or delete the programme. This advice was not included in any impact statements to either the PPSSG or the DMB.

1.4.6.502 The briefing note to HOC DEC(DTA) explained that the deferral option had moved the ISD of the Tornado CWS from 2009 to 2014 rather than the 12, 18 or 24 months presented in various papers. Further money was required to bring the ISD forward again to 2010. Thus an enhancement option ("buying back the ISD") was prepared in 2007 (the next STP planning round due to the new biennial process) that was estimated at £47m (nearly the same amount as the savings in 2005).

1.4.6.503 The DMB were not aware of the full effect of the savings option on the ISD until the option had been taken; the full effect was included in the Initial Gate Business Case (IGBC) paper which proffered that an enhancement option would return the ISD to 2010.

1.4.6.504 Management Response to STP 05 ISD of 2014. The IGBC was circulated in Jun 05 to stakeholders for comment. This included the 1st Director of RP(Centre) who subsequently approved its submission to the 2nd Approving Authorities. The IGBC stated that the Concept Phase had been prolonged due to various (three) deferral measures, and that each year additional money had been requested44 in order to maintain industry activity on the programme.

1.4.6.505 The IGBC stated a 50% confidence that the ISD would be 2014 on current funding plans, however an uplift of £37.25m would be required in 2007 to make an ISD of 2010 (which was the DMB expectation) achievable. The report stated, "If this uplift is not secured, the expected ISD would slip to 2014 due to the reliance on a stretched STP profile and the DMB will be informed accordingly." The predicted combined cost for the Assessment Phase and Design, Manufacture and Delivery phases was (at 50% confidence) £96.07m.

1.4.6.506 The IGBC was submitted via the 2nd Mil Head of Resources and Plans45 (ACDS(RP)) to MinDP on 19 Sep 05. On 30 Sep 05 MinDP stated that he was "extremely concerned that current STP funds only allow an ISD of 2014 rather than 2010 given the statistical risk of further mid air collisions without this equipment" and requested a meeting with stakeholders to discuss it.

1.4.6.507 Other stakeholders had been aware that the reality of the option was different than that which had been presented to the DMB. Director Logistics in Air Command stated in his comments on the IGBC in Aug 05:

"Seeking a revised ISD of 2014 will clearly not meet DMB expectations. Whilst the submission recognises that the DMB would need to be informed accordingly of a revised ISD, early staffing by the Project and engagement with the Board will be important, and I would look to see a clear statement of intent to this effect."

1.4.6.508 On 4 Oct 05 MinDP convened a meeting with stakeholders to discuss his concerns over the projected ISD of 2014. He was briefed that it was "not widely known outside MOD that the funded ISD was 2014" but that with the intention to "make good funding to achieve a 2010 ISD" it was not misleading for external communications to take a line consistent with the S05C031A statement to the DMB.

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44 An additional £2m had been requested in 2003, which was in excess of the traditional guideline of 2% of the programme cost for additional in-year spending.

45 Assistant Chief of the Defence Staff (Resource and Plans) - ACDS(RP)
1.4.6.509 It was briefed and noted that during this meeting, under the agenda item "Legal Responsibilities", that "an explicit 'what if' scenario has not been put forward for legal review (i.e. the hypothesis of an accident occurring in 2012 when the project could have realistically made a 2010 ISD)."

1.4.6.510 MinDP was content for the IGBC to proceed through the normal route on the basis that the he would be kept updated on the progress of the project and that "there is clear Ministerial visibility of the option for additional funding in the next planning round."

1.4.6.511 On 6 Oct ACDS(RP) wrote to the 1* Civ Head of RP (Centre) noting that:

"I had not realised that it would take some extra funding (in fact 75% of the money we saved in the STP 05 measure) to bring the ISD back to 2010."

1.4.6.512 Without any supporting documentation or the original RP(Centre) impact statements and option paperwork, it is impossible to explain why advice from the HOC DEC (DTA) was not put into the PPSG or DMB impact summaries, and why it was a surprise to the 2* head of department, MinDP and the DMB that option S05C031A had a four year delay to ISD rather than a one year to 18 month delay.

Analysis

1.4.6.513 The lack of CWS fitted to Tornado GR4s by 2012 is a direct consequence of STP 05 activity, although its foundations were laid by the consistent deferrals in the previous three Planning Rounds. The deferral option S05C031A did not delay the introduction of the capability by 12 or 18 months, but instead laid the foundations for an ISD of 2015.

1.4.6.514 At the time, the DMB were in receipt of misleading advice and were unaware of the reality of the option, although it is not certain that the decision would have been affected had they known the actual implications. There is no explanation as to why the DMB were not told of the reality of the likely deferral on the ISD. The evidence from both the 2* head of RP and MinDP shows surprise at the real delay to ISD and that they had been under the same impression as the DMB that the ISD would be 2010.

1.4.6.515 The risk of the plan to re-inject money and activity into the programme in the form of an enhancement option at the next review (two years later) to regain the ISD to Management Board expectations was never articulated. The IGBC stated an option to achieve an earlier ISD but did not explain the likelihood of success (which is normal for an IGBC, which just states factual options).

1.4.6.516 In the event, the 2007 enhancement option was placed within a package of options that were conditional upon an optimistic CSR outcome. It was not within the recommended enhancement package. Even with a good settlement, the advice was that "there would be scope to accommodate some of the enhancements" which would not have guaranteed the CWS ISD option to succeed. The CSR settlement was worse than expected, requiring the DMB to accelerate savings decisions and make more savings on top of the highest pain packages. This resulted in the enhancement option being rejected.

1.4.6.517 The poor information management within MoD Head Office prevented the Panel from conducting a full analysis of the 2005 STP decision, and why the presented timescales differed.
1.4.6.518 The “bespoke” Tornado CWS programme from 2003 – 2008 was an example of Bernard Gray’s description of the MoD’s inability to procure at an 80% solution. The bespoke CWS fell into the “Bid Hi Spec, Bid Full Spec” description that Gray felt drove significant technical risk into the Equipment Programme. The belief that a bespoke LL system for FJ was technologically possible held a significant amount of risk.

1.4.6.519 Notwithstanding the technical feasibility, it is the Panel’s view that the net effect of the deferral decision at the 2005 DMB resulted in Tornado GR4s not having a CWS fitted at the time of the accident. Moreover, the differences between the original impact statement submitted to RP(Centre) by DEC (DTA), the version subsequently presented to the DMB and the actual deferred profile ISD are stark.

1.4.6.520 In SDR 98 the MoD gave a commitment to fit Tornado GR4 with CWS by early in the next century. The last opportunity to have equipped them in time was the STP 05 decision. The Panel concluded that due to:

a. the delay to ISD from 2010 to a date after the accident on 3 Jul 12; and

b. as explained in Section 1.4.4, the inclusion of at least one CWS fitted aircraft in the accident sequence would have alerted them to the other;

that the mis-management of the procurement process to equip a CWS to GR4 was a contributory factor.

Tornado CWS Programme 2010 – 2012

1.4.6.521 This sub-sub section is divided as follows:

a. PR10 Tornado GR4 CWS Delete Option

b. Strategic Defence and Security Review/Planning Round 11

c. Transfer of Risk

d. Societal Concern

e. Analysis

PR 10 Tornado GR4 CWS Delete Option

1.4.6.522 Tornado CWS was put forward for deletion in 2009 (PR 10) but had had strong support for the programme from HOC (DTA) and AOC 1Gp due to the remaining OSD of the aircraft, and was not deleted.

1.4.6.523 HOC (DTA), who was the Head of Capability for Tornado, wrote to the Head Equipment Plan at the time recommending that:

a. While there was Cost Benefit Analysis (CBA), it was immature and not recommended for use.

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47 Cost-benefit analysis (CBA), is a systematic process for calculating and comparing benefits and costs of a project, decision or government project. CBA has two purposes, to determine if it is a sound investment/decision (justification/feasibility) and to provide a basis for comparing projects. It involves comparing the total expected cost of each option against the total expected benefits, to see whether the benefits outweigh the costs, and by how much.
b. CBA cannot form the sole argument for an ALARP decision, other factors should be considered, including:

(1) severity of impact between a FJ and CAT
(2) previous strategic direction (SDR)
(3) reputational risk
(4) impact of possible post-accident consequences such as access to controlled airspace and loss of military self-regulation.

1.4.6.524 He suggested that the Joint Capability Board direct “...that the Tornado CWS programme was reprieved...” and highlighted that if there were a GR4 mid-air collision whilst no CWS mitigation existed, there could be “...highly significant reputational risk if the MoD has cancelled a previously SDR directed project, which we have repeatedly reprieved from cancellation.”

1.4.6.525 Strategic Defence and Security Review (SDSR). In May 10 the Government announced a major review of the UK defence posture which had not been attempted since the SDR 98. The dual purpose of the Review was to produce an updated security policy and to address a £38bn overspend in the MoD’s procurement budget.

1.4.6.526 The SDSR set a savings target of £58bn over ten years but, due to a number of factors, there still remained a significant variance of approx £21bn over ten years.

1.4.6.527 With a variance in 2011/12 in the region of £850m “The Board concluded that the only way to address this was through consideration of all the uncommitted expenditure that year.”

Strategic Defence and Security Review/Planning Round 11

1.4.6.528 Why was CWS deleted in SDSR (PR11)? In 2010, the start of the planning round process began with several Joint Capability Board (JCB) reviews where the HOCs would demonstrate what money was committed within their programmes and tentatively suggest areas where savings could be made. It was at one of these reviews that the 3” Deputy Chief of Defence Staff (Capability) Chair stated that DTA (along with the other areas) was directed to raise savings options on all uncommitted money.

1.4.6.529 Tornado CWS was the largest uncommitted money within the Tornado programme (in Deep Target Attack that managed the capability).

1.4.6.530 The situation had changed since the previous planning round, with a much more stringent savings total to achieve and the potential for an earlier Tornado OSD, calling into question the pure financial cost benefit analysis (CBA) of fitting a CWS.

1.4.6.531 The timeline of events is summarised below in Table 9.

<table>
<thead>
<tr>
<th>Date (a)</th>
<th>Event (b)</th>
<th>Detail (c)</th>
<th>Comment (d)</th>
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<tbody>
<tr>
<td>16 Nov 10</td>
<td>Desk Officer brief</td>
<td>Paper identifies that Tor CWS nearing Main Gate</td>
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## Tornado CWS - PR11 Option Timeline

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Detail</th>
<th>Comment</th>
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<tbody>
<tr>
<td>26 Nov 10</td>
<td>Option E11DT072S Version 1.0 issued for costing by HoC DTA</td>
<td>&quot;Operational Implications&quot; box on Option template reads: &quot;Without CWS, the Tornado does not fulfil the SoS directive to reduce collision risk to a level commensurate with the civilian aviation sector.&quot;</td>
<td>Option raised by HoC DTA following DCDS(Cap) direction that Options be raised against all uncommitted funds.</td>
</tr>
<tr>
<td>14 Dec 10</td>
<td>HoC DTA writes to D(PA) [EC-23-21-PAO CPG - PR11 Option To Delete Tornado GR4 Collision Warning System (CWS)]</td>
<td>Notes that:</td>
<td>If risks are regarded as not TOLERABLE or ALARP then as MAA DG regulations (MRP RA 1020) state that Aviation DHs should, &quot;Cease routine aviation operations if RfL are identified that are not demonstrably at least Tolerable and ALARP&quot;</td>
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<td></td>
<td></td>
<td>...AOC 1 Gp, as the Operational Duty Holder (ODH) of any Tornado collision risk, was content for the option to be raised, but is likely to submit an objection to Def Res and the DESB on 12 Jan 11.</td>
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<td></td>
<td></td>
<td>...an ALARP-based Cost-Benefit Analysis (CBA) does not support expenditure on the Tornado CWS programme.</td>
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<td></td>
<td>...AOC 1 Gp, the RAF and Defence have other environmental and Service reputation factors to consider in any assessment of the FJ mid-air collision risk.</td>
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<td></td>
<td></td>
<td>Also highlights that &quot;Risks considered intolerable&quot; by the ODH are (in accordance with MAA direction) to be elevated to Chief of Service. CAS could then decide to further elevate intolerable risks to SoS.</td>
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</tr>
<tr>
<td>17 Dec 10</td>
<td>AOC 1 Gp writes to Hd Def Res [20101217-CWS_DESB-1 Gp-R-V4, PR 11 Option to Delete Tornado GR4 Collision Warning System (CWS), dated 17 Dec 10.]</td>
<td>AOC 1Gp summarises his position stating his intent to raise the issue to the SDH for his judgement.</td>
<td>Opportunity to withdraw option.</td>
</tr>
<tr>
<td>21 Dec 10</td>
<td>Option E11DT072S Version 2.0 issued for costing by HoC DTA</td>
<td>Option reads: &quot;Without CWS, the Tornado does not meet the SoS directive to reduce collision risk to civilian aviation levels. Although changes to Tornado numbers/OSD have decreased the statistical risk of collision, the reputational risk remains highly significant. The current ALARP[Temporal] risk assessment for Tornado is predicated on the future embodiment of CWS.&quot;</td>
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<tr>
<td>4 Jan 11</td>
<td>ACOS SPP writes to Hd Def Res [20110104-R-Progs2-Safety Risks]</td>
<td>Notes that &quot;the AIR TLB has particular concerns over the Health &amp; Safety risks arising from the Option E11DT072S &quot;Tornado – Delete Collision Warning System&quot;.&quot;</td>
<td>Opportunity to withdraw option.</td>
</tr>
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</table>
## Tornado CWS - PR11 Option Timeline

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<tr>
<td>10 Jan 11</td>
<td>DG MAA writes to Hd SSD&amp;C (copy DESB) [DG/03/04/DESB - SDSR &amp; PR11: Potential Air Safety Risk]</td>
<td>When commenting on the Option to delete Tornado CWS: &quot;...If this Option is pursued, it is likely to breach the ALARP criterion for Tornado GR4 mid-air collision risk and will clearly merit Ministerial visibility.&quot;</td>
<td></td>
</tr>
<tr>
<td>12 Jan 11</td>
<td>DESB meeting</td>
<td>Both D CINC Ops and DG MAA make a strong case for the Department to not pursue the Option to delete Tornado CWS on ALARP grounds.</td>
<td>Opportunity to withdraw option.</td>
</tr>
<tr>
<td>2 Feb 11</td>
<td>DSPG 1/11 02 Feb 10</td>
<td>DG MAA specifically identifies E11DT0725 to DCDS(CAP) and DG STRAT and informs them the CBA work undertaken to date is deeply flawed, that taking the Option would inevitably undermine the ALARP status of Tornado activity and, moreover, require the acceptance of the Dept of highly significant societal risk. DCDS(CAP) and DG STRAT undertook to review the Option’s status but, in the event, decided to retain it in Submission to the DB.</td>
<td>Opportunity to withdraw option.</td>
</tr>
<tr>
<td>8 Feb 11</td>
<td>DG MAA writes to 2PUS copied to CAS [DG/03/01/MOD STRAT - PR11 E11DT0725 - Delete Tornado Collision Warning System]</td>
<td>Offers that “…the CBAs offered thus far in support of an ALARP argument are flawed and could not, of themselves, underpin such a judgement” And concluding &quot;...there is the issue of 'societal concern' to be considered, sharpened by the fact that we are now in a post H-C world.&quot; Recommending that the Option be reviewed.</td>
<td>Opportunity to withdraw option.</td>
</tr>
<tr>
<td>11 Feb 11</td>
<td>AOC 1Gp writes to CAS [20110211-GR4CollisionMitigation-AOC1Gp-RM]</td>
<td>“My recommendation is that I hold the risk as ODH without a CWS solution, on the understanding that the SoS endorses that as the departmental position, or we fit CWS.”</td>
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<tr>
<td>4 Apr 11</td>
<td>SoS writes on conclusion of PR11 [MSU 4 / 1 / 2 / 2 dated 04 Apr 11]</td>
<td>Confirms that the savings associated with Option H-1 (Tornado – Delete Collision Warning System) are to be taken.</td>
<td>Opportunity to withdraw option.</td>
</tr>
<tr>
<td>4 Apr 11</td>
<td>PR11 Implementation Note (RP-10-11 dated 4 Apr 11 refers).</td>
<td>Contains the caveat “Savings to be taken but option reviewed in the 3 month review” which was applied following direction from SoS on the conclusion of PR11 set out in MSU 4/1/2/2 above. Specifically, this direction noted that the savings in H-1 (E11DT0725) were to be assumed but DCDS(Cap) would provide advice on the safety considerations (through CAS) to SoS.</td>
<td>Although CWS is to be reviewed in the 3 Month Exercise (3ME), all funding is withdrawn, all work stops and the programme is effectively cancelled.</td>
</tr>
<tr>
<td>6 May 11</td>
<td>DG MAA writes to SoS, copied to PUS and CAS [MAG DG/03/01/MOD STRAT - PR11 – Implementation Of Tornado CWS Option</td>
<td>Notes the Regulator’s advice that: &quot;...implementation of PR 11 Option H-1 has undermined the argument that Tornado mid-air collision risk is As Low as Reasonably Practical (ALARP), thus contravening MOD Air Safety regulations and the intent of SoS’ Safety</td>
<td>Opportunity to withdraw option.</td>
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</tbody>
</table>
## Tornado CWS - PR11 Option Timeline

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<tr>
<td>6 Jun 11</td>
<td>ACDS(S&amp;P) writes to 2PUS [ACDS SP/004 - Tornado Collision Warning System]</td>
<td>Explains that the reasoning behind the review detailed in the PR11 Implementation Note was “to prevent unnecessary expenditure on projects associated with Tornado should the 3ME look to reduce fleet numbers or more importantly to advance the OSD to a date before a CWS could be introduced (2013 at earliest).”</td>
<td>Possible reduction in Tornado OSD to make implementation of CWS impossible, not just VFM. Final outcome of 3ME is extension of Tornado OSD.</td>
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<tr>
<td>9 Jun 11</td>
<td>2PUS convenes a meeting with CAS, DCDS(Cap), ACDS(S&amp;P), and DLS</td>
<td>Meeting convened to agree the advice to be provided to SoS. The erroneous claim of a viable CWS programme remaining in place is reiterated.</td>
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<tr>
<td>13 Jun 11</td>
<td>DG MAA writes to 2PUS, copied to CAS [MAA DG/03/01/MOD STRAT - Tornado CWS]</td>
<td>Re-emphasises that work on TCWS programme in industry has ceased and that no active CWS programme is in place. Note concludes “...my opinion is that currently Tornado activity cannot be legitimately considered ALARP.” Recommends 2nd PUS conducts a review of Dept's planning processes to mitigate the risk of such an issue recurring.</td>
<td>MAA DH Regulations state (RA1020) “Cease routine aviation operations if RTL are identified that are not demonstrably at least Tolerable and ALARP.”</td>
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<tr>
<td>14 Jun 11</td>
<td>2PUS writes to D(ER) [2ndPUS&amp;VCDS/8/1/4 - Tornado GR4 Collision Warning System (CWS)]</td>
<td>Tasked with co-ordinating advice for SoS to provide consolidated Departmental advice to inter alia “Quantify the risk of “mid-air collision” that SoS is being asked to accept, explaining the link between the CWS project and ALARP.”</td>
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<tr>
<td>14 Jun 11</td>
<td>CAS writes to SoS [CAS/02 dated 14 June 2011]</td>
<td>Transfers risk relating to Tornado flying to the Secretary of State.</td>
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<tr>
<td>20 Jun 11</td>
<td>2PUS writes to SoS [2ndPUS&amp;VCDS/8/1/4 - PR11 - Tornado CWS]</td>
<td>Invites that SoS “notes that, given the current status of the project to fit Tornado GR4 with a Collision Warning System (CWS), CAS’s considered position, consistent with advice from DG MAA, is that the risk of a mid-air collision involving Tornado aircraft is no longer as low as reasonably practicable (ALARP);”</td>
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<tr>
<td>20 Jun 11</td>
<td>SoS writes to 2PUS [Subject: RE: 20110620-Tornado-CWS-PR11-8-1-4-R-LIMDIS]</td>
<td>“The Defence Secretary has therefore directed that the CWS project should now be reinstated to make the risk of a collision involving Tornado ALARP and to minimise further slippage to the in service date of the system.”</td>
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<tr>
<td>7 Jul 11</td>
<td>2PUS writes to Hd SSD&amp;C [D/VCDS&amp;2ndPUS/8/1/4 - PR11 Tornado CWS – Further Work]</td>
<td>Hd SSD&amp;C tasked to deliver review of the planning and programming situation that led to Tor CWS being deleted.</td>
<td>Report due end Aug 11</td>
<td>No copy or evidence of review having</td>
</tr>
</tbody>
</table>
Table 9. Tornado CWS – PR11 Option Timeline

1.4.6.532 Assistant Chief of the Defence Staff (Strategy and Plans) (ACDS(S&P)) was asked by 2nd PUS “Was the basis upon which the option was assessed in PR11 flawed (in terms of the cost-benefit analysis and the information regarding risk that the duty holder was willing to take)?”

1.4.6.533 He responded officially, stating:

“…neither the final PR11 option nor advice presented to Ministers...indicated that it was acceptable to the Duty Holder...At the time, it would have been financially irresponsible to commit funds to a project when the future fleet size and Out of Service Date (OSD) was under consideration. Given that the Tornado CWS project has been subject to numerous delays and cancellations since STP03 and that the 3 month delay did not materially affect a 2013 ISD, this may be considered a reasonable judgement.”

1.4.6.534 This indicated that although the DHs were not content with the option, the fact it had been delayed so much since the programme’s inception meant it did not matter that another delay would occur again. The belief that the 2013 ISD was protected was incorrect as the programme was unfunded at this juncture and would require extra investment to resurrect it.

1.4.6.535 This highlighted the misunderstanding that senior members of the MoD held over the decision to delete the funding of CWS and the ISD. Had the CWS programme been funded through SDSR, the proposed embodiment programme was scheduled to have seen the first Trial Installation aircraft (TINST) delivered in Q4 2012, with production embodiment aircraft being delivered from Sep 13 onwards. The reality was that as soon as the money was withdrawn from the programme, industry teams were re-allocated and work ceased. Informing 2nd PUS that the three month delay (which actually took nine) would not affect the ISD was misguided.

1.4.6.536 Safety Caveats. Prior to the Haddon-Cave report in 2009, there were admissions that although safety was not dismissed, it did not have the same emphasis or concern. Head Air Resources and Plans (Hd Air RP) in 2005 stated, “…was [the MoD] dismissive of safety, was it dismissive of the importance of it? No…I don’t think it’s fair to say the MoD was...somehow reckless or negligent in dismissing it...we were all alert to what a Collision Warning System was aiming to prevent...and was Collision Warning System any different to any other [option]? No, I don’t think it was. Do they have the same emphasis it’s got now? No.”

1.4.6.537 When asked what his view of MoD’s policy of safety related savings options post Haddon-Cave was, Hd Air RP stated, “…were they as tight as post-Haddon-Cave? Clearly not. Nothing could possibly be as tight as post Haddon-Cave...”

1.4.6.538 The Defence Environmental and Safety Board (DESB), as the title suggests, considered the safety, environmental protection and sustainable development implications of PR 11. The background to this consideration was stated as:

“Following concern that safety issues were not clearly identified in PR10, the former 2nd PUS introduced a requirement for Top Level Budgets (TLBs) to identify safety concerns in their PR11 submissions for discussion at the DESB. The DESB discussion took place on the 12 January.

The backdrop to DESB’s discussions was the Haddon-Cave report which highlighted the Department’s legal duty under the Health and Safety at Work Act to reduce safety risk to

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MAA

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levels which are ALARP and TOLERABLE to the Duty Holder:"

1.4.6.539 Under the heading of Specific Issues, Tornado CWS and the option E11DT072S to delete it, was identified as a particular concern. Deletion of the CWS would increase the risk of collision between a Tornado and another military or civil aircraft to levels which Director General Military Aviation Authority (DG MAA) did not believe to be ALARP.

1.4.6.540 In the PR 11 paper supporting the finalising of the Planning Round, there is a specific section titled Safety. Within this section fell the detail "there are a number of savings measures with specific safety implications. The two key measures of concern were the deletion of the Tornado Collision Warning System and ...on the former the Board agreed this would need to be considered in the context of the Tornado out of service date."

1.4.6.541 In the DMB annex that states the impact of the options, Tornado CWS fell within "25 percent other equipment measures – SDSR savings package" and the capability implication was stated as, "Risk of a Tornado mid-air collision has already been reduced by the SDSR reduction in numbers, but we would not be able to reduce this further (by 50%), to a level commensurate with the civil aviation sector." There was no specific safety caveat.

1.4.6.542 The Panel observed that, although the DESB commented on the safety implications of deleting CWS, there was no evidence of substantive debate at the DMB surrounding the subject, although, as can be seen within Table 9, the significance of the issue had been highlighted to the SDH and to wider decision makers prior to the decision to delete the programme.

1.4.6.543 In a note to SofS in May 11, after the CWS option was taken and the Programme was being considered for deletion or resurrection, DG MAA stated:

"Given that the implications of continuing to delay and defer the Tornado CWS programme are a matter of record, it is perplexing that the subject Option was raised again this year...the abbreviated impact statement presented to the [DMB] did not identify [Tornado CWS] as a Safety-related measure and the Safety implications articulated in the full impact statement under 'Other (Risk/Industrial/Allies) were omitted...It should be of concern that significant planning options with a potential impact on safety still do not appear to be attracting appropriate treatment or visibility during the latter, decision making stages of the planning process. It might be argued that, in this regard at least, we have not learned some of the key lessons of the Nimrod Review."

1.4.6.544 The SDH stated, "I believe that there wasn't enough priority given to the safety issues across the piece, yes. I believe that was true because of the scale of what we were trying to deal with...I don't think it would be fair though to say that safety was not considered..."

1.4.6.545 Basis of advice to delete Tornado CWS. Although HOC (DTA)\textsuperscript{68} was directed to provide options in late 2010 against all uncommitted money, there was a belief that the Tornado CWS would not be deleted. Dep Hd (DTA) stated, "...we understood, and I think the 09 note\textsuperscript{69} reflects this, we understood what the impact [of this Option could be and the issue here was not the immediate sort of risk to life type of risks, this was the reputational risk that went with it. This was 15 years of failure to implement a Tornado CWS which effectively made it less and less and less cost effective over time."

\textsuperscript{68} HOC DTA is the successor post to DEC DTA

\textsuperscript{69} EC-14-07-03-02 dated 12 Nov 09 from HOC DTA to HEP
1.4.6.546 HOC (DTA) approached the ODH, who was AOC 1Gp, and presented the situation regarding the mathematical effect of a reduced fleet on the CBA of fitting a Tornado CWS and confirmed that the option would go ahead. In Feb 11 the ODH wrote to the Senior Duty Holder (SDH), who was Chief of the Air Staff, and stated:

a. "The TGRF currently employs numerous measures to mitigate the risk of mid-air collision. The risk to date has been accepted as TOLERABLE and ALARP against original fleet drawdown plans (Pre PR09) and the future embodiment of CWS."

b. "To offset the lack of a future CWS capability there are no practical further mitigation measures that could be usefully employed without causing disproportionate effect elsewhere."

c. "My assessment is that neither the mathematical approach (whichever you choose) to this problem, nor unquantifiable mitigation measures provide a clear decision path, which must purely hinge on the appetite of the department for the reputational risk."

d. "My recommendation is that I hold the risk as ODH without a CWS solution, on the understanding that the SoS endorses that as the departmental position, or we fit CWS."

1.4.6.547 The potential additional measures to mitigate risk were considered, although having significant impact, as being:

a. Activity reduction (low flying activity)

b. Procedural Restrictions (standard routes)

c. High Conspicuity Paint Schemes

1.4.6.548 The ODH’s focus was not specifically the alteration of the CBA mathematics that affected the ALARP risk, instead it was the reputational risk to the department. He stated, "bottom line was I wrote to the SDH and said, "Look... I know that this has been an issue for some time. It’s been ministerially promised that we will deliver collision warning system. The HOC, on one hand, is saying that he can mathematically prove that we’re safe or within the ALARP boundary. The DG MAA disagrees. Notwithstanding any of that mathematical nonsense, I think there’s a societal risk here for us, there’s a reputational risk and I think there’s a ministerial political risk on the promises made...and I left it at that."

1.4.6.549 With both the HOC (delivery of capability) and the ODH (the user of the capability) agreeing that a reduction in OSD now made the CBA calculations in favour of not fitting a CWS, the option to delete CWS was now supported by the two prime elements of the capability. The focus of attention, as highlighted by the ODH, was not the risk of the accident happening, but instead the reputational harm a collision without CWS would create. The ODH commented later, when requesting an update on the decision, "Our calculation of a Tolerable and ALARP [situation] without CWS was audited by the MAA recently without adverse comment. So assuming that the SoS is happy to hold Societal risk we can save some money!"

Transfer of Tornado MAC Risk

1.4.6.550 MRP RA 1210 Annex C directs the levels at which risks should be held and states that all risks must have a DH owner and must be indicted in the RR. The ownership of risks is usually held at the level whereby the DH can suitably manage the risk and also
remain accountable for RtL. As the DDH at RAF Lossiemouth explains: "...when you get to a point where you can take no more effective action, you’re being blocked typically by the absence of policy or money, it’s about the right time to pass it on. Or indeed, if it exceeds your ability to hold [the risk] because the consequences are too dire..."

1.4.6.551 MRP RA 1210 states, “the purpose of referring a Single Risk is not limited to transferring ownership. It also informs a superior DH’s assessment of aggregate RtL across both the related activity and his wider AoR, the importance of the activity being undertaken and re-evaluation of whether the RtL is at least tolerable and ALARP. Even when a superior DH accepts a risk referred upwards, the requirement to demonstrate that it is both at least tolerable and ALARP remains.”

1.4.6.552 One of the key principles for risk elevation is that once escalated, the superior level DH must provide formal feedback to the lower level DH on the treatment and outcome of the subject risk. It is the responsibility of the accepting DH to ensure that the RR is annotated accordingly and to establish a review process to monitor the risk and associated mitigating action.

1.4.6.553 DDH elevation of Tornado MAC risk to ODH. There is no record of the Tornado MAC risk being generated at DDH level or its elevation to the ODH. The RAF Lossiemouth Senior Operator stated, “…it appears the risk was handled at Gp level and nothing was originated at DDH level” and “we do not have anything on record that covers DDH to ODH elevation of MAC.”

1.4.6.554 ODH elevation of Tornado MAC risk to SDH. In Dec 10 the HOC wrote to Director (Precision Attack) informing him that “Risks considered ‘intolerable’ by the ODH are to be elevated to the Chief of Service. CAS could then decide to further elevate intolerable risks to SoFS.” The ODH had already highlighted his concern to the SDH regarding the possible deletion of CWS in Dec 10, but wrote to the DESB in the same month requesting them to note that although the deletion of CWS was in line with CBA and financial evaluation there were policy and reputational issues that overshadowed the cost benefits and …“deleting CWS would therefore make the risk of a GR4 mid-air collision ALARP but would not necessarily make the situation tolerable”. In the same document he raised the issue to the SDH for his judgement. Regulatory Instruction (RI) 02/10 states that Aviation DHs should “Cease routine aviation operations if RtL are identified that are not demonstrably Tolerable and ALARP”; however, operations were not ceased in this instance.

1.4.6.555 The process of elevation did not follow RI 02/10 where the DH formally notify their superior DH chain of their intention to cease specified operations, instead the ODH wrote to CAS in Feb 11 stating that “there are no practical further mitigation measures that could be usefully employed without causing disproportionate effect elsewhere” and recommended that “I hold the risk [for MAC] as ODH without a CWS solution, on the understanding that the SoFS endorses that as the departmental position, or we fit CWS.” This did not represent extant process, as activity was not suspended when it was deemed no longer either TOLERABLE or ALARP.

1.4.6.556 There is no evidence of the SDH formally accepting the risk or of a review of the mitigation as stated in RI 02/10; however, the SDH did acknowledge holding the risk when passing it to SoFS. Instead of a Safety Statement review, on request the ODH offered GR4 collision risk mitigation in his Feb 11 note, and stated “all risks have endorsed mitigation strategies and controls in place; although all currently include CWS as a future mitigation.”

50 TOLERABLE can describe a boundary between acceptable and non-acceptable risk. RA 1210 Annex A describes the TOLERABLE category for all aircraft types as 1st party risk of death per annum for population at risk being less than or equal to 1 in 1000. The word tolerable is used in relation to these criteria or is sometimes used literally.
1.4.6.557 RAF Inspectorate of Flight Safety stated that, although they were the organisation to do the analysis of an elevated risk for the SDH, "...that's not happening, there's no coherent process...there's no guidance, direction from here saying we need to do this...It doesn't happen. So we are developing tools, techniques, procedures, processes, we're going to write them into policy to make this effective."

1.4.6.558 SDH Elevation of Tornado MAC Risk to SoFS. In Jun 11 the SDH elevated the risk of MAC involving a Tornado GR4 to the SoFS, stating that he believed the programme to install a CWS on the Tornado GR4 no longer existed (even though it was being reviewed within the 3ME, all funding had been removed and the Industry team had been re-allocated).

1.4.6.559 He stated that "Consequently given that all other possible non-equipment mitigation measures to reduce the risk of Tornado GR4 mid-air collision with any other aircraft have been exhausted, the cessation of the Tornado GR4 CWS programme now means that the risk of a Tornado GR4 mid-air collision can no longer be considered ALARP."

1.4.6.560 The SDH emphasised, "this is a society/duty of care risk not an airworthiness risk...However we cannot consider that with an unbounded risk due to having no reasonably practical and affordable technical solution in progress that it can be considered to be operating at the ALARP risk level."

1.4.6.561 2nd PUS advised SoFS to respond to the SDH elevation of risk by reinstating the CWS programme. He admitted that the Programme was "...no longer in being..." and fitting CWS to the Tornado GR4 is assessed to reduce the risk of collision from a 1 in 3 to a 1 in 6 chance before its OSD in 2021 and would make the through-life risk ALARP. He advised that the catastrophic risk of collision with a commercial airliner "...gives rise to the strongest societal concerns."

1.4.6.562 The SoFS directed that the CWS project should be reinstated to make the risk of a collision involving Tornado GR4 ALARP and to minimise slippage to the ISD of the system. He also noted that the risk ownership would now remain with the SDH, given the return to ALARP.

Societal Concern

1.4.6.563 MRP RA1210 defines Societal Concern as "a recognized factor in risk management when there is potential for public condemnation arising from accidents, particularly those involving significant numbers of people and/or vulnerable groups. This factor is generally significant in the context of aviation risks and acutely so for the management of RIS in UK military aviation. Measures introduced to mitigate this class of risk need to be considered on a case-by-case basis and take into account the political dimension."

1.4.6.564 In 2005, the IGBC stated "There is also an unquantifiable consequence associated with the loss of life, both military and civilian, which could involve significant financial compensation and adverse publicity."

1.4.6.565 HOC (DTA) stated that "AOC 1 Gp, the RAF and Defence have other environmental and Service reputation factors to consider in any assessment of the FJ mid-air collision risk."

\*The CBA was not an MAA CBA nor was there a MAA fiscal calculation in being, instead the ODH was referring to DTA and 1 Gp calculations.

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The ODH raised such concern as "reputational risk...a risk to the Department's reputation..." and stated "Successive Boards of Inquiry (BOIs), the Haddon-Cave QC Report and SDR98 have all advocated the incorporation of a CWS to Tornado GR4. Despite the embodiment cost for CWS being twice the MAA fiscal calculation for maximum spend to achieve ALARP; the political and reputational implications for the Department of deleting CWS, cognisant that it halves the probability of an accident, may be significant."

The SDH called it a "society/duty of care risk" and "...it is a judgement call all the time as to what is a societal concern or not..."

DG MAA requested the savings option was reviewed with a view to being removed in Feb 11 due to the "...issue of 'societal concern' to be considered, sharpened by the fact we are now in a post H-C world...indeed the very fact that the measure has been tabled, again, leaves us open to accusations of dragging our feet over the programme's implementation."

DG MAA stated to the SoS that "...continuing Tornado activity in the absence of a funded CWS programme exposes the Dept, and potentially individuals, to significant risk of litigation and reputational damage in the event of a catastrophic collision." He went on to say, "Moreover, in the event of a catastrophic collision, the fact that the Tornado Force may now be approaching OSD is unlikely to be accepted as compensation for the apparent failure of the Dept to implement the programme hitherto – herein lies the very significant 'societal risk' that the Dept is viewed publicly as having been derelict in its duty of care to both its personnel and the public at large."

In advice to 2nd PUS, DG MAA reiterated, "...given that the Dept committed to equipping Tornado with a CWS in SDR98, the 'societal' element of the risk associated with not having done so some 13 years or more later must be considered as high."

The MGBC stated, "As Airprox incidents continue to cause concern and a technical solution and relatively efficient integration opportunity is currently available, any mid-air collision could damage the reputation of the Department; particularly as the independent regulator has expressed concern. The Health and Safety Executive (HSE) define Societal Concern due to the occurrence of multiple fatalities, in excess of 50, in a single event as a societal risk."

2nd PUS wrote to SoS in Jun 11 to advise him how to respond to CAS's elevation of the risk and declaration that the Tornado GR4 MAC risk was now no longer ALARP with the "blight" of the CWS programme. He recommended that the CWS programme should be reinstated, but also indicated the precarious position the department were in:

"...it is important that the Secretary of State recognises that having a programme in being is not in itself a guarantee that the Department would avoid censure in any legal proceedings. Should an accident occur before CWS is fitted, then we should expect difficult questioning on the time it has taken, since first proposed in 1998, to move the programme ahead. That is not, of course, a reason not to take all reasonable steps now to mitigate the risk going forward."

Review Note. In Jan 12, running in parallel with the high level engagement from DG MAA regarding the "blight" of the CWS programme, a Review Note was published to gain IAC endorsement of "necessity and proportionality" which had been directed by SoS at the settlement of PR 11, when the programme was originally put on hold.
The Review Note sought to make the case for the necessity and proportionality of the CWS project primarily on the grounds of mitigation of societal risk (whilst acknowledging that risks against individuals and reputation are substantially reduced and those risks against policy eliminated).

Investment Appraisal Committee (IAC). The IAC concluded that the project remained necessary and proportionate and should proceed promptly to Main Gate. The committee highlighted that "Another potentially important factor was the issue of societal concern and, given that the risk of Tornado mid-air collision was extant, the Department had previously committed to fitting a CWS to the fleet and funded a programme, a decision not to proceed with the programme would need to be supported by a clearly articulated exposition of the residual risk being accepted, why and by whom." This supported the actions of DG MAA and the SDH in their engagement with SoSs and the resurrection of the programme in Jun 11.

Analysis

SDSR represented a step change in MoD funding and posed significant fiscal challenges to all of Defence. Radical reform of the equipment programme was directed and savings measures were required in order to balance the financial deficit. This formed the context for uncommitted money being the first means of making targets.

DHs still wanted a CWS, as a viable solution existed to reduce the number one risk that they held. A CBA (in conjunction with the bringing forward of the OSD) made a financial argument not to fit it, on a purely mathematical basis.

Although Tornado CWS was singled out with a safety caveat, it was viewed in conjunction with a CBA where senior decision makers within the MoD had an understanding that the risk was improbable given the bringing forward of the OSD (allowing it to be deleted, albeit with further investigation); DG MAA argued that with the history of the programme being ministerially endorsed, gaining strong CAA support, matching the civilian standard and the SoS's intent on safety, he acknowledged a MAC event was possible, and that the risk existed whether a CWS programme was funded or not. His main argument was that, given this background and the potential outcome of a MAC with CAT, then whether the mathematics supported it or not, CWS must be fitted or the Dept would be open to "...significant risk of litigation and reputational damage in the event of a catastrophic collision."

Although the Defence Strategy and Plans Group discussed the safety issue of CWS (and was informed by the independent regulator (DG MAA) that significant societal concern was a near certainty), the option was not withdrawn. Instead it was put within a broad savings package with no safety caveat. Had the option been withdrawn at this stage, the ISD would have remained at 2013 (vice 2015) and would not have incurred extra cost (nearly £1m).

Once the option was taken, the only way to resurrect it was to demonstrate to SoSs it was necessary and proportional. In doing so, this established that there was still a risk of it happening (which had never dissipated) as just because total flying hours had reduced (OSD brought forward), a MAC could occur at any time between the decision to take the option and the OSD.

There was no detailed refreshment of the ALARP statement during the transfer of risk between any level, although the extra mitigation letters broadly follow the process. This went some way to refresh the current mitigation, however as its focus was on further mitigation it did little to qualify the extant mitigation. This missed an opportunity to identify...
whether or not the current mitigation minimised the risk.

1.4.6.582 None of the DHs formally accepted further mitigations or articulated taking responsibility for not enforcing them.

1.4.6.583 Since the earliest deferrals of the CWS programme, there have been impact statements written that could describe Societal Concern. Between 2000 and 2008, the primary focus of this concern was driven by CAA pressure to reduce the risk of MAC and the threat of restrictions of airspace and self regulation. Post the Haddon-Cave Report the concern of “potential for public condemnation” due to the duration of time the CWS has taken to be fitted and the risk subsequently reduced, became the priority.

1.4.6.584 The crossover between societal, reputational (be they Service or Department) and Ministerial concern is almost indiscernible as it depends upon the focus of attention and relies upon an element of blame from the public response (hence condemnation).

1.4.6.585 Societal Concern is fickle, and unquantifiable. Large scale fatalities could have short term effects, both with the wider society and within the MoD. Conversely, few casualties can have wide ranging and lengthy societal impact, making a judgement on potential concern difficult.

1.4.6.586 The judgement by the SDH to elevate the risk of MAC to the SofS highlighted the potential for significant reputational damage had the collision occurred with no CWS programme in existence. Having a programme that reduces the risk in development does not reduce the likelihood of the risk being realised until the equipment is in use. Haddon-Cave stated in his Report, “The ‘R’ in ALARP has a temporal element: a reasonable time is allowed to implement appropriate measures to mitigate identified risks. If this were not the case, few commercial or military aircraft would ever fly.” The “temporal” part of the R in ALARP is the reasonable time it takes to develop and integrate the risk reducing system, in this case the CWS on Tornado GR4. It will take, on current predictions, 25 years from its recommendation and 17 years from ministerial direction to reach Tornado CWS ISD.

1.4.6.587 The requirement for a Tornado CWS was created from several fatal MACs and ministerially endorsed. The non-discretionary nature of its funding meant it fell prey to the difficult decisions made in the MoD regarding resources and priority, with the backdrop of significant technological challenges in creating a bespoke system for the Tornado GR4. The history of delay, however, also meant decision makers were pre-disposed to making further savings, combined with a belief that the programme “was not warranted” as stated by the SofS during PR 11.

1.4.6.588 The impact of savings, delays and design changes meant the industry supplier became disillusioned with the project.

1.4.6.589 The constant deferral and savings measures before 2008 demonstrate the MoD’s lesser priority on safety issues prior to the 2009 Haddon-Cave report. The renewed focus in SDSR was not enough to save the Tornado CWS from nominal deletion due to fiscal constraints and a CBA that could be interpreted to support its deletion.

1.4.6.590 The Panel observed that it took intervention from a functioning risk management process and an independent regulator to re-instate the programme, albeit with further delay and at extra cost.

1.4.6.591 The Panel observed that the review of the planning and programming situation that led to Tornado CWS being deleted as directed by 2nd PUS could not be provided by MoD; the author stated there was “nothing separate” delivered on the subject but that he “pulled
together all aspects on the issue”.

Mid Air Collision (MAC) Mitigation

1.4.6.592 This sub-sub section is divided as follows:

a. MAC Risk Management and Mitigation

b. Conclusions

1.4.6.593 **MAC Risk Management and Mitigation.** The rules and regulations directed by the regulator had been in place since Apr 10, and the MAC risk was the first risk to test the analysis and risk transfer process. The process did not follow the Regulatory Article literally, the transfer of risk resembled the articles but fell short of ceasing activity or diligently refreshing mitigation.

1.4.6.594 With no record of elevation from the DDH to the ODH, there is no evidence to suggest that analysis of the extant mitigation took place once the ODH took responsibility for the risk. Mitigation by further measures was analysed, but there is no evidence to suggest that procedures in place to mitigate MAC (either with or without a CWS programme in place) were tested with a view to testing the activity against the ALARP mitigation rather than the normal assurance process in place for good aviation practices.

1.4.6.595 During elevation to the SDH, further mitigation measures were suggested and discounted due to their severe impact. There is no record of the SDH actively considering further measures and accepting the responsibility for not taking them. It was this view that nothing more could be done, that supported the belief that the current mitigation was “fit for purpose” and therefore the risk was ALARP.

1.4.6.596 The means of assuring that mitigation is in place, and fit for purpose for Safety Statements, is by a suitable organisation that understands the linkage between the risk management (the RR and Safety Statement) and the activity. This is done by the ODH (who is assured by his STAR organisation) and by the DDH (who is assured by his STANEVAL organisation, and visibility of external auditors) but neither assurances have a Safety Statement focus. Only the MAA audit, to date, has made linkages between activity and management.

1.4.6.597 With OC XV(R) Sqn having no visibility of the RR or Safety Statements, the DDH is reliant on the personnel carrying out the activity to do so conversant with the processes currently in place, but without an understanding of the linkages to the management of that risk. This relies upon the risk mitigation to be current, achievable and adhered to. The Panel questioned if crews were directed to do a certain task, but did not know its origin or benefit, would they be more or less likely to adhere to it? The Panel believes that if crews know why they are carrying out a task, they are more likely to follow the procedure and policy. This also provides immediate feedback to supervisors (STANEVAL) if the procedures work and are relevant.

1.4.6.598 None of the extant mitigations worked as effective barriers for the accident. The Panel questioned if this was a function of misunderstanding of the processes that were in place to mitigate for a MAC, that there was more that could have been reasonably done, or it was a case of MAC being the number one risk and therefore more likely to happen (a 1 in 3 chance before OSD in 2021)?

1.4.6.599 The ALARP statement for MAC-NCPMIL detailed the mitigation in place at the time of the accident. This was divided into the DLODs:
Neither infrastructure and Logistics were considered in this instance.

1.4.6.600 The ALARP statement is evaluated against this accident below in Table 10.

<table>
<thead>
<tr>
<th>Mitigation</th>
<th>Accident Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training:</td>
<td>Training:</td>
</tr>
<tr>
<td>1. 'See and Avoid' Principle and lookout.</td>
<td>1. &quot;See and Avoid&quot; did not work.</td>
</tr>
<tr>
<td>2. High quality candidates.</td>
<td>2. High quality candidates.</td>
</tr>
<tr>
<td>Equipment:</td>
<td>Equipment:</td>
</tr>
<tr>
<td>1. Radar in Air –Air Mode.</td>
<td>1. Radars not in Air-Air mode.</td>
</tr>
<tr>
<td>2. Use of IFF to provide warning to TCAS fitted aircraft.</td>
<td>2. Both IFF fitted, serviceable and operating. Neither TCAS fitted</td>
</tr>
<tr>
<td>3. Use of FLIR to detect aircraft.</td>
<td>3. FLIR was on but other aircraft not detected by crews.</td>
</tr>
<tr>
<td>4. Anti-Collision lights.</td>
<td>4. Anti-collision lights were on, but were not sighted.</td>
</tr>
<tr>
<td>Personnel:</td>
<td>Personnel:</td>
</tr>
<tr>
<td>1. Two-crew cockpit can employ the 'See and Avoid' concept more effectively by ensuring one crew member as a minimum is always looking for potential conflicting traffic.</td>
<td>1. &quot;See and Avoid&quot; did not work in this instance due to weather, workload, student experience, mental model, obscuration, lack of alerted search and diffusion of responsibility.</td>
</tr>
<tr>
<td>Doctrine and Concepts:</td>
<td>Doctrine and Concepts:</td>
</tr>
<tr>
<td>1. 'See and Avoid' Principle.</td>
<td>1. &quot;See and Avoid&quot; Principle did not work.</td>
</tr>
</tbody>
</table>
2. 1 Gp ASOs seek to reduce the risk through regulations on use of conspicuity aids.

3. JSP550 includes Joint orders that seek to avoid collisions through minimum briefing items including where collision hazard may be elevated.

4. TGRF Handbook includes orders to seek to avoid collisions through SOPs for low flying planning, division of lookout and mandatory sortie briefing items.

5. Station FOBs for RAF Marham and Lossiemouth mandate the use of local 'booking out' procedures to highlight where formations may conflict with one another and to allow local deconfliction to take place.

Organisation:
1. The Military Aviation Authority (MAA) has a well established system of publicising flight safety issues to all aircrew.

2. ATC seeks to enforce aircraft spatial positioning and avoidance within controlled airspace; likewise for civilian routes.

3. The UK Low Flying Booking Cell coordinates all military submissions for the use of the Low Flying System.

Information:
The Air Safety Information Management System and Flight Safety publications aim to raise the profile of Human Factors (Aircrrew) by highlighting previous, often anonymously-submitted incidences.

Table 10. ALARP statement is evaluated against collision of ASTON 1 and ABBOT 2.

1.4.6.601 This demonstrates that there were several mitigations in place to avoid MAC, nearly all either did not work, were not applicable or were not adhered to.
The refreshed ALARP statement (started in Jun 12, but was not endorsed by the ODH until mid 13) reflects significant review, including a recognition that "current technical mitigations are based on systems used primarily for alternative purposes other than for bespoke aircraft-aircraft spatial positioning and avoidance." This included IFF, FLIR, RADAR, RHWR, data link and the future CWS. There is also recognition of CADS, the electronic planning (deconfliction) aid.

The Safety Statement also describes an RAF Flight Safety-led "Mid Air Collision Campaign Plan" that details numerous mitigations that have been identified as a result of the RAF Flight Safety Mid-Air Collision Risk Analysis and Feedback Paper and the 1Gp Airprox Deep Dive Paper. Headings within the Campaign Plan include Prevent, Detect, and Avoid.

The significant amount of work (Safety Statement refreshment) since the accident and obvious difference in content and substance of the new ALARP statement demonstrates the stark omissions to the previous statements.

Conclusions

In Nov 89, Anthony Hidden QC, in the Clapham Rail disaster report stated, "There is almost no human action or decision that cannot be made to look more flawed and less sensible in the misleading light of hindsight. It is essential that the critic should keep himself constantly aware of that fact." The Panel accepts that:

a. It is not possible to completely remove the risk of colliding with another aircraft regardless of the controls and mitigations put in place; and

b. In response to the accident there has been immediate and significant review and amendment of the MAC safety statement and 1Gp risks, however;

(1) an immature RR focussed on process and format at the expense of output. Existing mitigations were displayed differently rather than being validated and augmented with new ones;

(2) had the correct process of risk elevation taken place (with associated adjustment of activity, however limited) the risk could have been properly considered and its importance would have been highlighted earlier;

(3) although there was a structure to examine safety related savings options within MoD, it was not sufficiently empowered or robust to ensure CWS was not delayed and deleted;

(4) a review into the planning and programming events that led to Tor CWS being deleted was not done, and lessons have not been learned;

(5) the MAC risk mitigations fell short of what is considered Reasonably Practicable, and was therefore not ALARP;

The Panel therefore concludes that shortcomings in risk management was a contributory factor.

The Panel has reluctantly had to bound its investigation into CWS. In part this is to prevent more work imposing undue delay in publication of a report into the subject accident, but also in recognition of the Panel’s limited expertise in commenting on the top-level processes of the MoD. What is clear, however, given the work done to date, is that
important questions remain unanswered and significant lessons will remain unidentified and therefore unlearned if no further analysis is conducted. The Panel will therefore be recommending that the Secretary of State for Defence commissions an investigation into how CWS was ministerially endorsed in 1998 and at a cost of £74m, will enter into service 17 years later, four years before the Out of Service Date of Tornado GR4. This review should use the lessons of CWS procurement, to assure him that safety enhancements are appropriately managed with MoD.

52 2PUS writes to Hd SSD&C [D'VCDS&2'PUS/8/1/4 - PR11 Tornado CWS – Further Work] Hd SSD&C tasked to deliver review of the planning and programming situation that led to Tor CWS being deleted.