Boeing E-3 SENTRY

Variants and Capabilities

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The Sentry AEW Mk1, usually referred to as the E-3D, has been in RAF service since Mar 91 and has arguably been the most important addition to our inventory for many years. Like most systems procured during the cold war, the E-3D is now being employed by the RAF in a radically different manner from that originally planned. The requirements of the 'old world order' would have seen the E-3D tasked primarily in an AD AEW role, working closely with ADGE and NATO fighter assets, to protect against Soviet intruders. However, modern requirements now demand that the E-3 be employed in an AWACS role and in a far greater variety of air power disciplines than previously envisaged by defence planners. Operations in the Former Republic of Yugoslavia (FRY), Bosnia and Kosovo, and Iraq have confirmed AWACS as essential to any military scenario and a true "purple" asset, critical to all 3 services. Such operations have exposed an increasing number of RAF personnel to joint operations which include E-3 aircraft from a number of different nations. It therefore seems timely to examine exactly how AWACS can assist in discharging Air Power roles.

HISTORY

History is a useful starting point in order to understand why some of the E-3 systems work as they do. The USAF initiated development of the AWACS in the late 1960s as a replacement for the Super Constellation based EC-121. The primary role envisaged for the AWACS at that time was defence of the Continental US and Canada against long range ASM attacks by Soviet bombers. The primary sensors were therefore optimised for long range surveillance and detection.

Boeing was awarded the contract to develop the E-3 from the Boeing 707-320B airliner with a strengthened fuselage to accommodate the Westinghouse (now Northrop Grumman) developed radar and IFF systems. The first E-3A was delivered to the USAF in 1977 and since that date some 68 E-3 variants have been delivered to the USAF, NATO, Saudi Arabia, the RAF and French AF (FAF). With the ending of 707 production, the AWACS platform was switched to the Boeing 767, with the Japanese Air Self Defence Force (JASDF) taking delivery of 4 'E-767' during 1998/99.

VARIANTS

All 707-based AWACS are externally almost identical; however, equipment fit and capabilities vary widely and greatly impact on how units interact with the E-3. The variants in service are as follows:

a. **USAF E-3B/C.** All 33 USAF aircraft have all now been upgraded to E-3B or C standard with improved communications and data processing capabilities. These aircraft have 14 mission crew consoles with colour displays, compared to the 9 of other E-3s. The additional crew positions and extra radios give USAF AWACS an enhanced capability to control large Composite Air Operations (COMAO) and can often offer up to 9 weapons control positions. However, USAF E-3B/Cs have only recently started to be equipped with an ESM and JTIDS Link 16 (L16) capability. Manned by USAF personnel with a small number of Canadian Armed Forces aircrew for NORAD tasking, the E-3B/C has an austere Maritime Surveillance Capability (MSC). They are primarily operated on Op Northern and Southern Watch, in addition to US ops concerned with North Korea and the Caribbean.

b. **NATO E-3A.** Based at Geilenkirchen in Germany are 17 aircraft belonging to the E-3A Component of the NATO AEW Force (NAEWF). These are flown by multi-national crews composed of personnel from all NATO nations with the exception of Luxembourg and Iceland. The aircraft are registered in Luxembourg. NATO E-3As have an austere MSC and all aircraft have recently undergone an upgrade to add ESM, L16, Havequick (HQ) II radios and improved data processing with colour mission displays. Due to the terms of the North Atlantic Treaty, NAEWF E-3As are limited to operations within NATO areas.

c. **Saudi E-3A.** Saudi Arabia received 5 E-3As from 1986 fitted with CFM-56 engines replacing the original TF33s. Saudi AWACS have no ESM, L16 or HQ systems, although they retain colour displays and an austere MSC.

d. **RAF E-3D.** Following cancellation of the Nimrod AEW project in Dec 86, the RAF received 7 E-3Ds from 1991. These form the E-3D Component of the NAEWF, but also retain national tasking commitments. CFM-56 powered and equipped with an AAR probe in addition to the standard E-3 boom receptacle, RAF AWACS were delivered with full ESM, JTIDS L16, HQ II capabilities and the latest data handling and colour displays. They

NATO E-3A

have an enhanced MSC, but are currently limited to the standard 9 mission console fit. This typically allows for 2 control positions on a normal sortie. RAF E-3Ds are UK manned and, despite most E-3D ops involving the continuing NATO commitments to the FRY, national tasking can result in RAF AWACS deploying worldwide.

e. **FAF E-3F.** France received 4 E-3Fs from 1991 which are a purely national asset despite being committed to FRY ops. The French aircraft are virtually identical to RAF E-3Ds with the exception of lacking an ESM capability, although this deficiency will be rectified from 1999.

RAF E-3D

f. **JASDF E-767.** The initial E-767s for Japan have the same systems as the 707 AWACS variants. However, the radar already incorporates some upgrades being planned for USAF, NATO and RAF E-3s under the Radar System Improvement Programme (RSIP). Although lacking an AAR and ESM capability, the aircraft will be delivered with a slightly different internal configuration allowing for 12 mission consoles.

SENSORS

The primary sensors for the E-3 are the radar and IFF systems mounted back to back in the trademark 30 foot diameter rotodome or 'frisbee'. The rotodome rotates at 6 RPM when the sensors are active, giving a nominal update rate of once every 10 seconds for each sensor or every 5 seconds when both radar and IFF hits are received. Sensor characteristics require that the aircraft are normally flown at 29-35,000 ft and between 300-400 kts. Unless otherwise stated, all information now relates to the RAF E-3D variant.

RADAR

The Westinghouse (now Northrop Grumman) AN/APY-2 Search radar has both pulse doppler and pulse elements allowing for long range detection of both air and surface contacts. The radar is scanned mechanically in azimuth and electronically in elevation with modes as follows:

a. **Pulse Doppler Elevation Scan (PDES).** This mode uses pulse doppler (PD) techniques to overcome ground clutter and detect aircraft within the radar horizon. Moreover, PDES allows radar heights to be obtained on targets, although this has the effect of slightly reducing maximum detection range.

b. **Pulse Doppler Non-Elevation Scan (PDNES).** Although not providing a radar height capability against targets, PDNES increases the peak power of energy reaching the target and therefore maximises detection capability in a given area.

c. **Beyond The Horizon (BTH).** This mode employs the pulse radar transmitter to detect air targets at extreme ranges where ground returns are not significant.

d. **Maritime.** The MSC again uses the pulse radar to detect surface contacts out to the radar horizon with land returns digitally blanked. RAF E-3Ds have a unique Maritime Scan-Scan Processing (MSSP) mode which compares successive sweeps of the radar to remove clutter in high sea states. Moreover, MSSP allows for a basic sizing capability against surface plots. MSC can also be employed to track air contacts overwater.

e. **Passive.** Both PD and pulse systems have a passive mode where the system uses only its receivers to triangulate on an ECM source or to defeat hostile ELINT gathering attempts.

The radar is extremely flexible and different modes can be utilised simultaneously and with different sectors. For instance, PDES/BTH can be employed in a 270 degree sector with a 70 degree area of PDNES/MSC to cover naval tasking and a further 20 degrees of passive to locate an ECM source. In addition, further radar sectors can be established to simultaneously interleave air and maritime surveillance modes, or to optimise the radar against differing target radar cross section, speed and altitude characteristics. Examples of E-3 radar employment can be found at Figure 1. However, despite the inherent flexibilities of the APY-2 regarding modes, the sensors low update rate was not designed for the close tactical control that AWACS is now regularly tasked for during COMAO and Flag Exercises.

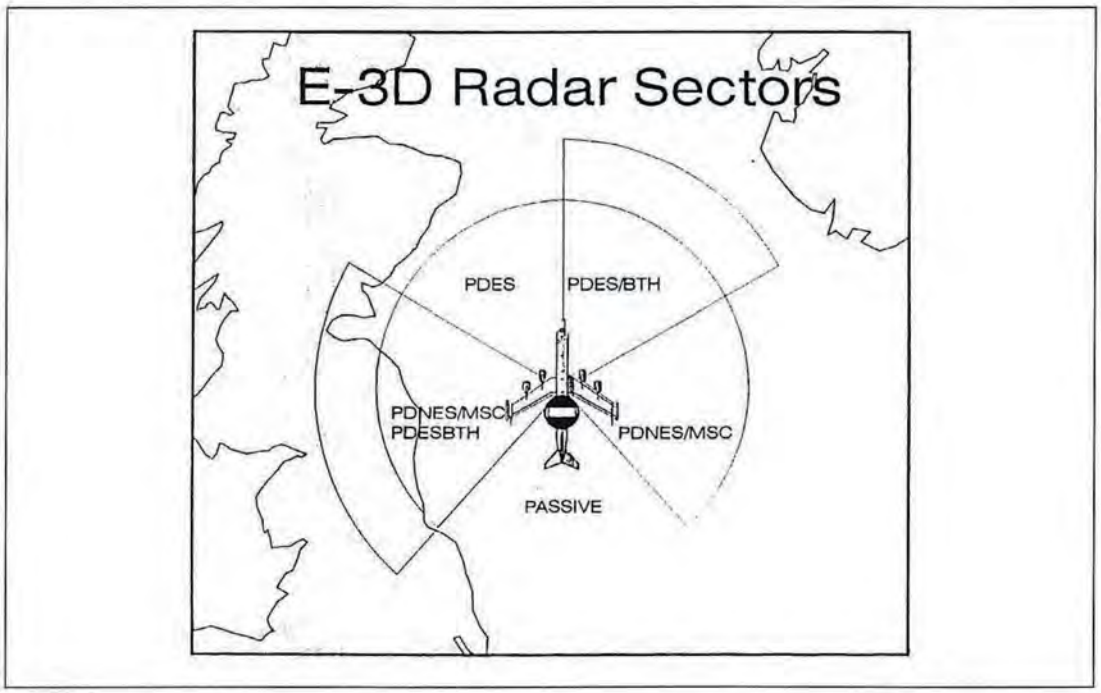

Figure 1

IFF

Secondary surveillance is provided by the AN/APX-103 IFF system mounted behind the radar antenna in the rotodome. This provides near continuous mode 1,2,3 and C decodes on any contact within range. Mode 4 interrogations are performed on individual tracks or along specific azimuths when requested by the operator.

ESM

RAF E-3Ds were delivered with the Loral 1017 Yellow Gate ESM system as fitted to the Nimrod MR2 fleet to provide a passive detection capability against emitters radiating between 0.6 and 18 Ghz. The excellent E-3D Pre Flight Message (PFM) emitter databases produced by EWOSE allow the ESM operator to optimise detection for different types of emitters such as SAM or naval radars. USAF, NATO and French E-3s are currently being fitted with a Boeing/UTL ESM system which offers better bearing accuracy than Yellow Gate.

COMMUNICATIONS AND DATA LINKS

COMMUNICATIONS

The E-3D has an extensive communications suite of radios as follows:

a. **HF.** The E-3D has 3 HF radios, all available for use by the mission crew.

b. **VHF.** Both E-3D flight and mission crews each have access to one VHF radio with an additional receiver hardwired to 121.5 MHz.

c. **UHF.** The E-3D mission crew have access to 9 UHF radios, which include 4 HQII radios and one SATCOM capable radio. An additional UHF radio is provided for the flight deck and this can be employed by the mission crew if required. A further radio is used to monitor UHF guard with an extra receiver available for ADF reception. Finally, the E-3D has a dedicated radio for providing HQII Time of Day synchronisation transmissions ('Mickey' fixes).

Despite this apparently expansive list, C4I and data link requirements mean that radios quickly become the limiting factor during normal sorties and it is a regular lesson of COMAO that E-3 mission crew should be involved in the detailed mission planning from the outset. In flight, each mission crew member will be monitoring up to 4 radios, plus UHF guard, and up to 4 internal intercom systems, so things can get a little busy during a complex sortie. Although radio priorities and allocations are carefully considered by the mission crew, inevitably there will be occasions when a call is missed! To reduce the planning constraints during large force employment was one of the main aims of expanding the UHF radio and console fit of USAF AWACS.

DATA LINKS

The E-3D has an excellent data link fit enabling exchange of information with a large number of assets and, after the primary sensors, data links are undoubtedly the most important systems on the aircraft. The current data link fit is as follows:

a. **Link 4.** A UHF directional, insecure, one way USN fighter link to enable the transmission of Near Real Time (NRT) target information to certain USN tactical aircraft.

b. **Link 11 (L11).** This secure, NRT link uses both UHF and HF to transmit and receive the Surface and Recognised Air Picture (SRAP) and other EW data between naval, ADGE, and some airborne C2W assets.

c. **Link 14 Radio TeleType (RATT).** A non-real time, low capacity HF data link, RATT is mostly employed by E-3s for exchanging classified Free Text Message (FTM) information when JTIDS is not available.

d. **Interim JTIDS Message Specification (IJMS).** A high capacity, NRT, secure and frequency agile system used to exchange SRAP information with ADGE, AWACS and some other airborne C2W assets. In addition to FTMs, IJMS also enables use of an ECM Resistant Voice (ERV) system.

e. **JTIDS L16.** L16 has all the advantages of IJMS whilst having an enhanced ERV system and also enabling exchange of data with suitably equipped tactical aircraft such as the Tornado F3, F-14D and, in the future, F-22, EF2000 Typhoon and Sea Harrier FA2. Moreover, western navies intend to move from L11 to L16 as their primary mode of data exchange with USN and RN major surface combatants already starting to field the system operationally.

CREW COMPOSITION

E-3 aircraft have a unique crew composition with many crew members being from the ADGE or ground technical trades. This originally arose because of the need for modern AEW platforms to employ similar systems and techniques to those associated with Fighter Control (FC) units. Moreover, the complexity of the E-3 led to it being designed to operate with Airborne Technicians (AT) to maintain and reconfigure systems in flight. As a result, a visitor to an RAF E-3 unit will see FC and AT brevets employed alongside the more usual N, AE and E insignia. This mix of aircrew experience on the E-3D fleet is undoubtedly one of its major strengths. FCs bring knowledge of AD, data link and control operations while AEs add their own maritime EW and ESM expertise. Added to this are a small number of mission crew navigators who bring experience from a wide variety of backgrounds such as F-4, Nimrod, Shackleton, Buccaneer and C-130. This has led to a broad foundation of knowledge on the RAF E-3D fleet, ideal for the increasingly diverse nature of operations. A diagram showing the internal layout of the E-3D is at Figure 2.

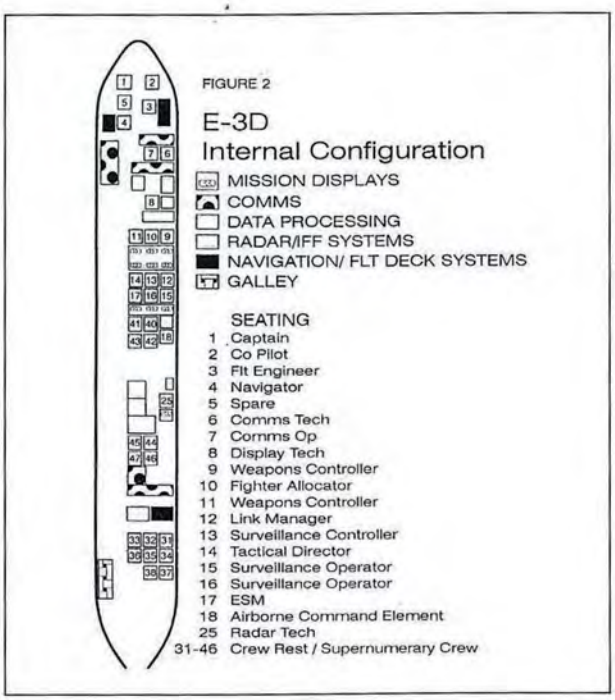

Figure 2

FLIGHT CREW

The E-3 flight deck crew consists of pilot, co-pilot, engineer and navigator. The pilot is always the captain although – whilst on station – the majority of the decisions regarding aircraft positioning are made by the Tactical Director (TD). The flight deck is primitive by modern airliner standards and has no Electronic Flight Instrumentation or Flight Management Systems. No tactical displays are available to the flight deck and they are reliant upon mission crew information to aid their situational awareness (SA).

MISSION CREW

Apart from USAF AWACS all E-3s have a 9-man mission crew with 4 supporting personnel. The following is a description of a normal E-3D crew, although different nations each have slight variations. A typical E-3D mission crew will therefore consist of the following:

a. **Technicians.** Immediately behind the flight deck, the Communications Technician (CT) works closely with an AEOp Communications Operator (CO) to initialise and load crypto for the aircraft radios and data links. This can be an exacting task during a dynamic sortie and the CT and CO will liaise closely with other mission crew to meet the ever changing comms requirements. Slightly further aft, the Display Technician (DT) loads and maintains the mission computer and displays, also ensuring that all data is recorded for any post flight analysis. Finally, towards the rear of the aircraft, the Radar Technician (RT) maintains and monitors radar performance, liaising closely with the Surveillance Controller (SC). The role of the RT will considerably change as the E-3D RSIP upgrade is implemented over the next 2 years.

b. **Weapons Team.** The Weapons Section control any of the assets that can be allocated to an E-3. Although traditionally being AD in nature, these assets are rapidly becoming more diverse and may include a COMAO of OCA, DCA, SEAD and recce aircraft or Special Forces C-130s and helicopters. For normal missions, the weapons team consists of 2 Weapons Controllers (WC) directed by a Fighter Allocator (FA). The WCs may be SNCOs or commissioned while the FA will himself be an experienced commissioned WC. The WCs can offer full control services and legally have to have completed a recognised FC course. Most controllers are therefore FC personnel, although there are a small number of ex FJ and Shackleton navigators who have completed a WC course.

c. **Surveillance Team.** Surveillance tasking and its associated data transfer to other C4I units such as CAOCs is normally the priority tasking for E-3Ds. Typically, 2 Surveillance Operators (SOs) compile the air and surface picture using various ID criteria, while a third SO operates the E-3D ESM system. The Link Manager (LM), a SNCO upgraded from SO, ensures that all data gathered is transmitted over the various data links while information is also received from numerous other link equipped assets in the correct format. Next to the LM and heading the surveillance section is the SC, an officer upgraded to SC from the SO cadre. The SC optimises the radar and IFF and ensures all surveillance tasks are completed. Although surveillance personnel can offer a bullseye broadcast service and liaise with many airborne assets such as U-2s, SIGINT and MPA platforms, they are not qualified to offer a full control service.

d. **Tactical Director.** The responsibility for directing the whole mission crew falls to the TD, typically a flt lt or sqn ldr who will already have extensive E-3D experience in the weapons or surveillance specialisations. The TD also works closely with the flight deck to ensure the aircraft is positioned correctly to meet all tasking while taking into account potential threats. He and the captain are the key link in ensuring the whole 17 man crew work as a team to fulfil all tasking

The composition of the 9-man mission crew is configured around classic AEW operations. For COMAOs, 2 WCs are often inadequate and an additional WC is carried at the expense of an SO. However, this greatly reduces the E-3D's ability to contribute to the SRAP – the core function of the aircraft. Additional consoles and radios to E-3B/C standard would prevent off-setting SOs for WCs and allow the E-3D to conduct true AWACS style operations.

TASKING

Clear and concise tasking is essential given the large and diverse nature of the assets with which E-3s will work on most sorties. This tasking is normally generated by a CAOC or Task Group Commander and the receipt of signals covering conduct of operations, data-link connectivity, and EW should be the minimum required for effective mission planning by the E-3 mission crew. Apart from when operating with USAF AWACS, planners should assume that, routinely, the E-3 will be able to provide only 2 control positions.

COMMAND AND CONTROL

Uniquely within the RAF, the E-3D Component is under the Operational Command of the NAEWF Commander, a 2-star post at SHAPE. Full Command is retained by CinC HQSTC, but day-to-day allocation of assets is controlled by NAEWF staff. The E-3 flying programme is organised quarterly, which, despite much fine tuning on a monthly and even weekly basis, can make additional tasking or changes to the programme difficult.

MISSION PLANNING

Mission planning for E-3 crews normally takes place the day prior to a sortie due to the large volume of signal traffic received from numerous agencies for most missions. At this stage, much liaison is conducted with sqns and tasking agencies by the E-3 crew to clarify certain points or to request slight modifications to tasking. Following mission planning, the whole crew will again come together for a wrap-up brief where the crew will review the exact tasks and duties for the sortie. On the day of the mission, the TD, FA and SC will normally come in about 60 minutes prior to the brief ($2^1/_2$ hours prior to take-off) to review last minute changes to tasking. There will then be another short crew briefing where these changes and latest intelligence is briefed.

POSITIONING

E-3 positioning is critical to its operation and involves a large number of considerations such as sensor coverage, data-link and comms connectivity, self defence, associated assets, in addition to the normal weather and fuel factors. Ideally, TACON agencies should not aim to direct an E-3 to a specific orbit location, but should rather inform the E-3 of what is required. The E-3 TD will then decide the exact orbit position to ensure that these tasks are achieved. Inevitably, during the course of a typical mission, orbit changes will be carried out as the tactical picture changes, although peacetime ATC restrictions often severely hinder such manoeuvres.

Following take-off, it takes approximately 30-40 minutes for an E-3 to be ready to go on station following wake-up and check-out of the mission computer and sensors. This will normally be accomplished in the transit to the operating area and the route will take into account any threats to ensure the aircraft is not placed in danger. If a long transit is required to the operating area, tactical transit procedures are adopted where the E-3 will work with friendly assets, such as surface combatants or ADGE units, en route, to build SA and to provide added protection. On reaching its operating area, an E-3 will typically adopt a racetrack orbit about 60x30 nm in dimension between FL 290 and 350, although tactical considerations can see the pattern and level of an orbit varied greatly. Doctrinal requirements dictate that an E-3 orbits at between 50-150 nm from a potentially hostile border. However, modern operations involving COMAO in particular require that the E-3 will often orbit closer to threats than was originally envisaged and it is one of the primary considerations as to exactly how close the E-3 can be allowed to operate to TD's potential threat systems compared to the requirements of the tasking.

SURVEILLANCE TASKING

Prior to going on-station, the surveillance team will start to build the air picture using radar, IFF and ESM data. This can be done automatically if relieving another E-3 by simply assuming the data-link parameters from that aircraft via Link 11 or JTIDS. Moreover, numerous JTIDS FTMs can be obtained from the off-going aircraft or other JTIDS equipped units giving all the tactical information required by E-3 such as frequencies, callsigns and intelligence updates. Indeed, with JTIDS, a complete station handover can be completed without voice comms. Once established on task, the primary role of the E-3D is normally the production of the SRAP which is then exchanged with other assets such as maritime forces, ADGE sites and SIGINT platforms. This effectively results in a 'montage' of data – often covering thousands of square miles – from numerous assets and systems that is available to both the E-3 crew and their customers. Such data is often complementary. For instance, a USAF E-8C JSTARS platform may detect ground activity at a hostile airbase's HAS site, allowing a closer watch to be kept on that airfield by the E-3 for air activity. The accurate and timely fusion and dissemination of information from such a wide variety of assets to ensure friendly forces have relevant and accurate SA of the battle is pivotal to the E-3D's role.

WEAPONS TASKING

One of the primary users of the SRAP produced by the E-3D surveillance section will be the aircraft's weapons team. As surveillance maintain the SRAP, the WCs will be controlling assets allocated to the E-3D. This could involve vectoring RN Sea Harrier FA2s onto hostile targets identified by their surveillance colleagues or coordinating a COMAO strike against an enemy GCI complex. An average sortie in Bosnia will see an E-3D WC control assets as diverse as an AH-64 Apache, Turkish F-16s on a CAS mission or a USAF RC-135 orbiting over the Adriatic. In addition, E-3 WCs will often be tasked to coordinate with a UAV ground controller or control an AAR towline, although such duties are preferably allocated to ground based assets. As these duties are being carried out by the weapons team, the FA will be monitoring the situation closely to ensure that assets are correctly employed and replaced in a timely manner.

Increasingly, JTIDS L16 forms an important part of the E-3 controllers tactics. The E-3D fleet has been fortunate in having had extensive exposure to L16 ops with the RAF Tornado F3 force unlike many other E-3 operators who are only now starting to be equipped for L16 data exchange. JTIDS L16 allows a portion of the E-3 picture to be viewed directly in the cockpit of suitably equipped fighters, massively increasing the SA of these assets and reducing reliance upon traditional voice control. L16 undoubtedly gives the user a huge advantage in combat and regularly allows the F3 force to defeat technically superior opposition. However, like the Tornado crews, the E-3D fleet have found that JTIDS L16 also requires more complex and well-practised tactics to ensure it is employed to its full potential.

COMAO CONSIDERATIONS

One of the most challenging roles discharged by the E-3D is that encountered during a COMAO. RAF E-3s have regularly taken part in COMAO exercises when deployed around the world as well as during live operations in Bosnia and Croatia during the height of the fighting in the FRY. COMAO

will often dictate that an additional WC be carried at the expense of a surveillance crew member necessitated by the additional control requirements. Moreover, the mission crew seating will often be revised to allow greater coordination of surveillance and weapons tasks, particularly where L16 assets are employed. A typical COMAO seating plan, as opposed to the normal AEW seating plan shown in Figure 2, is at Figure 3.

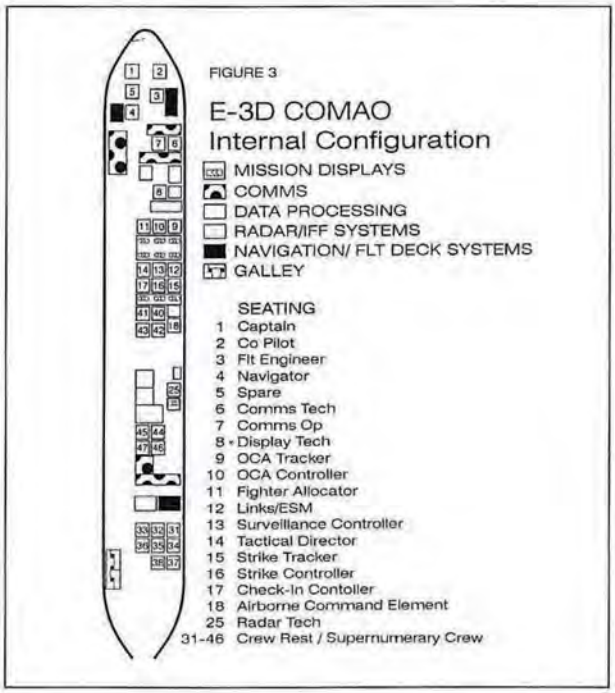

Figure 3

During a COMAO a WC will each be allocated to air-air assets (such as OCA Sea Harrier or Tornado F3s) and strike assets (such as Tornado GR1s and F-15Es). Normally, the air-air and strike controllers will each work different frequencies with the additional WC employed on a check-in frequency to identify, label and authenticate a formation before handing them off to their respective controller. Although the air-air controller will aim to provide his assets with full tactical control, due to the larger number of assets in the strike package – often with differing aircraft types, roles and positioning – the strike controller will generally only be able to provide a bullseye picture. When specific situations arise however, particularly where an element of the strike package is threatened, the strike WC will endeavour to provide tactical threat calls.

Meanwhile, both the air-air and strike controllers have their own dedicated SO to accurately track and label their respective packages. This increased integration of weapon and surveillance teams is essential to ease the workload of controllers, particularly during L16 operations, given the relatively low update rate of the E-3 sensors,. The duties of ESM and LM are often combined while the SC continues to monitor and manage the sensors, often also assisting in tracking hostiles or stand-off assets such as SIGINT, AAR and CSAR. Finally, the Tactical Director (TD) and FA manage the

bigger picture issues such as replacement assets and actual E-3D self-defence. Not surprisingly, USAF E-3s – with their additional radios and extra 5 consoles – are much better suited to COMAO, being able to discharge a true AWACS role. A full tactical control service is available to most strike assets due to the availability of additional controllers, without compromising normal C4I functions, including generating the SRAP, to associated units.

Obviously, such coordination of COMAO requires full integration of the E-3D mission crew into the planning cycle. Package leaders must be familiar with the E-3 communications and sensor capabilities and limitations to ensure an effective plan is devised and the E-3 mission crew are aware of all codewords and intentions. Moreover, the E-3 can also aid the package leader in achieving HQII mickey fixes, the relay of codewords and information on friendly assets. When L16 assets are involved, integration of the E-3 crew into sortie planning is of even greater priority to ensure a track ID, labelling and filter plan is devised. Finally, in the event of friendly assets being shot down or in distress, the E-3 can quickly coordinate CSAR efforts or vectors to – for instance – AAR, allowing the package leader to concentrate on the mission in hand.

ACE

A possible future aspect of E-3D operations is the inclusion of an Airborne Command Element (ACE) team on board to provide specialist advice to an E-3D crew for certain missions. For instance, an ACE team consisting of Support Helicopter experienced senior officers could be embarked to provide an airborne mission commander during a complex CSAR operation. Although not yet officially funded, the ACE concept is being studied by the Air Warfare Centre as a way of reducing decision making reaction time and E-3 reliance on secure communications and SATCOM.

SELF DEFENCE

The pivotal role of E-3 support to any military operation makes it an enticing target to any potential aggressor. The primary method of self defence for the E-3D is – not surprisingly – to avoid any threats entirely! The capabilities of the E-3's sensors mean that this can be achieved by standing-off from threats with little or no degradation to coverage of the assigned area. However, when this is not possible – or if the intelligence picture is incomplete – the following aspects must be considered:

a. **SAM Threats.** The highly mobile nature of modern SAMs, such as SA-12, mean that where the E-3 is forced to orbit on the periphery of hostile Missile Engagement Zones (MEZ), ELINT coverage must be provided. However, even with dedicated SEAD assets available, they will rarely be able to guarantee the reaction times required to prevent an E-3 being threatened. In the longer term, many nations are considering Defensive Aids Sub-Systems (DASS) including Towed Radar Decoys and a High Value Air Asset (HVAA) such as an E-3 would seem to be a strong candidate for the installation of such systems.

b. **Airborne Threats.** HVAA Defence (HVAAD) of the E-3D is normally achieved by a combination of using friendly assets, such as DCA CAPs or a ship's MEZ, and defensive retrograde (orderly retreat!) to defeat airborne threats. Defensive 'bubbles' will be considered by the E-3D TD and captain based on the perceived threats in each theatre

and – unless hard evidence suggests otherwise – the worst case threat assumed. Normally, an E-3D TD would look to employ friendly DCA to cover any threat. If this failed or was not possible, the TD would attempt to retrograde in a suitable direction to either run the threat fighter out of fuel, or to force him to fly through friendly MEZs. The normal C4I communications and links employed by the E-3D easily facilitate the required coordination for such procedures. Indeed, during exercises, E-3s will often practise HVAAD serials against very capable opposition and – apart from where peacetime restrictions come into force such as ATC requirements – a well flown and directed E-3D is rarely successfully engaged. However, the increasing capability of modern AAMs such as the AA-X-13 adds further weight to the DASS requirement on the E-3D if the aircraft's capabilities are to maintained against evolving threats.

The E-3 is the most capable AEW platform in the world. Its sensors give unparalleled surveillance capability of both air and surface contacts while its extensive data link fit allows this information to be passed securely and in NRT to a wide variety of customers. Moreover, the RAF E-3D crew composition with personnel drawn from a wide variety of backgrounds works extremely well, particularly as the aircraft is drawn further into COMAO tasking. However, the E-3's sensors are optimised for long range surveillance rather than close tactical control. Additionally, radios and control positions are at a premium which presently limit the ability of the E-3D to coordinate COMAOs. Nevertheless, the E-3 continues to be an essential element in any military operation worldwide, acting as a true force multiplier.

A future article on the E-3D will encompass the future development of the aircraft before examining a fictitious scenario to show how the E-3D can fit into modern operations. Clearly, this brief is unclassified due to the open nature of the RAF Air Power Journal; however, an E-3D Roadshow exists to increase understanding of E-3 operations and particularly how training and integration with other units can be improved. The paper and roadshow presentation were prepared whilst Flt Lt O'Dell was a TD on 8 Sqn, and he has since been posted as an instructor on the E-3D OCU within 23 Sqn. If your unit could benefit from an E-3 presentation, Flt Lt O'Dell can be contacted on RAF Waddington Ext 6678 and he would be happy to tailor a presentation to your own needs.