AWACS: THE PIVOT OF AEROSPACE POWER

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On December 7, 2006, the United States Defence Security Cooperation Agency (DSCA) notified the US Congress for the foreign military sale to Pakistan of three excess P-3 aircraft with the E-2C Hawkeye 2000 airborne early warning (AEW) suite.[1] The Pakistan Navy has already been operating the P-3C Orion which is a long range, high endurance maritime surveillance, reconnaissance, anti-surface warfare aircraft; it has also contracted with the USA for the supply of eight P-3C aircraft, the first of which was received at the PNS aviation base PNS *Mehran* on January 18, 2007[2]. The new deal with Pakistan is to refurbish and modify the three P-3C aircraft with the E-2C Hawkeye 2000 AEW suite. Pakistan has tried to acquire airborne early warning and control (AEW&C) aircraft since 1979 when it first made an attempt to negotiate for the Boeing 707 based E-3C airborne warning and control system (AWACS) from the USA, on the pretext that it wanted to bolster its defences against Soviet and Afghan government air attacks across its western borders.[3] Twenty years later, in 2006, the *primary purpose has been altered as development of an effective air defence network of its naval forces* and to provide AEW, surveillance, enhanced command and control and communication capability. *The secondary requirement is to assist US forces in Operation Enduring Freedom and provide control capability over land* against

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1. "Pakistan-E2C Hawkeye 2000 Airborne Early Warning Suite for P-3s," News Release from Defence Security Cooperation Agency, downloaded from www.dsca.mil on January 9, 2007.
2. Associated Press of Pakistan; "Release of P-3C Orion Planes to Pakistan Sign of Cooperation with US," downloaded on January 19, 2007, from www.app.com.pk
3. Air Commodore Jasjit Singh, *AWACS: The New Destabiliser* (New Delhi: Lancer Press, 1987), p. 33.

transnational terrorist and narcotics smugglers. In the mid-1980s, the E-2C Hawkeye trials on the Afghan border failed because of the limitations of terrain masking and performance limitations in mountainous areas. Even a US Navy website has posted, "Hawkeye's degraded performance over land is one of the weaknesses."[4] However, the Hawkeye-2000 variant is considered to have enhanced performance over land and is reported to be capable of detecting ground targets in a low track density environment. Therefore, even if the main purpose of the Hawkeye is to augment the Pakistan Navy's anti-shipping, anti-submarine warfare capability, it is important for the Indian Air Force (IAF) to note that, in addition to its maritime capability, the E-2C Hawkeye 2000 AEW suite can be effectively used over land.

Pakistan has also finalised a deal worth $1.15 billion with Sweden for a provisional contract to supply the S100 Argus turboprop airborne early warning system. Pakistan is planning to acquire six to seven such AEW systems with a combination of PS-890 Erieye radar and SAAB 2000 aircraft.[5] "Pakistan has made down payment for the Swedish system and expects the delivery to begin by 2009 at the latest," a military official has said.[6] This signifies that Pakistan is in a hurry to bolster its air defence and air offensive capabilities over land as well as over sea.

In an another important but expected development, Pakistan signed a memorandum of understanding with China on November 24, 2006, during the visit of Chinese President Hu Jintao, for a long-term collaboration in defence production, including development of an airborne early warning surveillance system. Considering the timeframe for the development of a new project and the gestation period, in all probability, Pakistan will invest and collaborate in the development of the ongoing Chinese AEW programmes KJ-2000 on the IL-76 airframe and KJ-200 on a modified airframe of the Y-8; this project is also known as Balanced Beam.

The diversified and long-term plan of acquiring AEW&C indicates that

4. US Marine Corps Reference Planner Part II,0 "Equipment Limitation," downloaded from http://www.fas.org on January 21, 2007.
5. "Sweden Finalises SAAB 2000 AEW&C Contract with Pakistan," posted on June 26, 2006, and downloaded on December 27, 2006 from www.defenceindustrydaily.com
6. Reuters http://today.reuters.com/news/articleinvesting and http://www.tribuneindia.com downloaded on November 27. 2006.

Pakistan wants to cover itself against the possibility of economic or military sanctions and acquire four to six AEW systems in the short-term (the next three to four years). For its long-term requirement, Pakistan will develop AEW&C systems with China. In the long term (2015-2020), Pakistan will have at least 6 Erieye systems, 3 Hawkeye systems and at least one or two systems developed in collaboration with China. However, in the short-term (by 2015), Pakistan may acquire a total of 10 to 12 AEW systems, and even with modest serviceability of 40 per cent, it will have 4 to 5 aircraft flying at any given time. This may sound alarmist; however, the fact that Pakistan is making a fast track approach in a diversified manner cannot be ignored. If we consider a five-year period for the present deals to materialise, by 2012, the Pakistan Air Force (PAF) could keep a constant watch on Indian airbases during peace as well as in war time. Similarly, the operational activities of the Indian Navy would also remain under the constant vigil of Hawkeye 2000 AEW, P-3C Orion and Atlantique maritime reconnaissance aircraft.

Development of such a capability by Pakistan and China would have serious implications during peace as well as operations. The subject had been dealt with comprehensively by Air Commodore Jasjit Singh, as early as 1987 in his book *AWACS: The New Destabiliser*, and most of the issues addressed by the air commodore in 1987 are still valid and unanswered, except that now, India is also in the process of modernising its air force and developing capabilities to meet the growing challenges to its national security. The Indian Air Force is also acquiring Phalcon AWACS on board the IL-76 platform and the Defence Research and Development Organisation (DRDO) is in the process of developing an indigenous AEW system. The first Indian AWACS is likely to be inducted by December 2007. At this juncture, there are issues we need to address, such as the strategic implications of AWACS for India, the operational role and effectiveness of AWACS, how many AWACS do we require for our own security, what is the comparative performance of Phalcon, Erieye, Hawkeye, etc. and then consider the implications of Pakistani AWACS/AEW for India, and try to answer a bigger question, "Do we really need to be concerned" and if "yes", what do we need to do?

ROLE AND EMPLOYMENT OF AWACS

"Origins of AEW&C systems can be traced to a research programme of the US Navy (USN) initiated as 'Project Cadillac' in June 1942. Project Cadillac resulted in tests, beginning in August 1944, of a modified Grumman TBM-3 Avenger torpedo bomber, fitted with AN-APS20 radar in a large ventral radome and accommodation in aft fuselage for the radar operator."[7] The post-World War II saw the development of AEW platforms in the shape, initially, of a modified torpedo-bomber and maritime patrol aircraft. An increased threat from the Soviet anti-ship cruise missile, the AS-1 Kennel, and the increasing need felt for a role optimised system led to the design of the first aircraft specifically for the AEW mission: the W2F-1, primarily for the US Navy. After development and upgrades, the aircraft entered the US Navy in 1964, under the designation of E-2A Hawkeye.[8] However, it was in 1977 that the US Air Force (USAF), acquired the E-3A Sentry AWACS, using a modified Boeing (707-320B), that was meant to provide early warning against strategic threat and support strategic defence against Soviet bombers.

Since then, the role, employment and capabilities of AWACS have transformed to adapt to the changing nature of warfare. In the 1980s, AWACS assumed a broader role as a command and control centre for a larger number of fighter aircraft operating within the radar coverage of AWACS. By assisting the interceptor aircraft in controlling defensive intercepts, AWACS assumed the role of an augmentation platform for ground-based radar units. In the 1990s, during the Gulf War, AWACS provided control and battle management support to offensive counter-air forces in a theatre-wide offensive.[9] The subsequent technological upgrades like advanced computer technology, secure communication, maritime surveillance capability, improvement in radar, radio and display systems have further enhanced the role of AWACS as a command and control platform. As a

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7. Shashank Sinha, "Dawn of AEW&C Operations in Indian Military," an IDC Analysis, New Delhi, June 29, 2006, downloaded from www.indiadefence.com/AEW story.
8. Air Commodore Jasjit Singh, *Air Power in Modern Warfare* (New Delhi: Lancer International, 1985), pp. 112-113.
9. Major Thomas W. Nine, "The Future of USAF Airborne Warning & Control; A Conceptual Approach," downloaded from www.fas.org/man/dod-101/sys on January 3, 2007.

tool of power projection, the US has used AWACS for coercive politics. Air Commodore Jasjit Singh wrote in 1987, "...the US has made increasing use of AWACS for political purposes, leading, in fact, to some people coining the term '**AWACS diplomacy**' to describe the phenomenon."[10] The USAF has employed AWACS in different roles and for different purposes, extending from purely defensive operations to coercive diplomacy and implementation of international sanctions. Some examples are quoted below: [11]

- Deployment of AWACS to maintain North American air sovereignty in Alaska and as part of NORAD
- Deployment of the E-3A Sentry in Saudi Arabia in March 1979 in the context of the conflict in Yemen
- Deployment of AWACS in Saudi Arabia, Turkey and Bosnia for enforcing international sanctions.
- Deployment in Egypt in October 1981 (in the immediate aftermath of the assassination of President Anwar Sadat) and again in February 1983 (to forestall through coercive politics the allegedly impending Libyan backed coup attempt in Sudan).
- Deployment of the E-3C Sentry in Operation Desert Storm (1991) for weapon control, battlefield management, surveillance and electronic support measures (ESM) and in similar roles in Operation Iraqi Freedom, 2003.

STRATEGIC IMPORTANCE FOR INDIA

Air Battle Management

The flexibility and versatility of AWACS is evident in the expansion of its role and exploitation of its capabilities by the USAF. The strategic importance of AWACS emanates from its ability to extend multiple functions like early warning, surveillance, ESM, command and control and signal intelligence (SIGINT) and battle management from one airborne platform. It affords the capability to single-handedly conduct air operations over geographically dispersed locations and diversified terrain. India's land frontier measures more

10. Jasjit Singh, n.3 pp. 25-26.
11. Jasjit Singh, Ibid., p.26 and Thomas, n.9, p.8.

than 14,103 km and it has a 7,600-km-long coastline.[12] Defending such a vast area of diversified terrain by ground-based radars is neither practical nor cost-effective. AWACS would overcome the limitations of ground-based radars and function with relatively improved efficiency from the plains of Punjab, Rajasthan, the coastal areas and over the Indian Ocean. This capability affords significant strategic advantage for conduct of air operations over the entire area of national interest.

Prioritisation of Operations

At the same time, it is also to be understood that, to cover such a vast expanse of land, coastline and island territories, a large number of AWACS would be required. India is acquiring three AWACS; as to the question of whether three AWACS would be adequate to meet India's defence needs, the answer is "no", but the issue will be dealt with later. AWACS cannot be apportioned in a particular role; in a given theatre, it can support a variety of operations over a single mission. The demand-to-availability ratio for AWACS will always remain critical, especially in the Indian context, considering the vast geographical expanse and distances between different theatres of operations. Considering the numbers, *AWACS will remain a strategic asset directly under the control of Air Headquarters (Air HQ) and the operational demands of Command HQ would have to be prioritised considering the overall military objectives and time critical operations.* Therefore, it is important for field commanders and operators to understand that the availability of AWACS should not be taken for granted for every operation, in every given theatre.

Air Dominance Operations

Primarily, AWACS would be used to achieve air dominance over the adversary's air space and in joint battle with the army and navy to attain time critical military objectives. Initiative, surprise, concentration of firepower, shock effect and attaining operational advantage over adversaries would remain the guiding

12. Lt. Gen. J. F. R. Jacob (Retd), "The Defence Scene and the Budget: An Appraisal," *The Indian Defence Review*, 1995.

principles for the utilisation of AWACS. Therefore, it will be important to identify the specific areas of AWACS utilisation in the IAF's operational plans and in joint planning by the three Services. The command and control and air battle management function would be carried out by AWACS over land or over sea in coordination with ground-based/shipborne air defence systems and other force multipliers.

AWACS in Nuclear Strategy

Strategically, a very critical role for AWACS could be envisaged in unconventional warfare. In a seminar on Nuclear Strategy (January 8-12, 2007) at the Centre for Air Power Studies (CAPS), India's most eminent proponent of air power, Air Commodore Jasjit Singh, while speaking on, "Survivability Challenges" in the nuclear environment had mentioned, *"AWACS is a platform which increases the survivability and credibility of nuclear attack."* Considering India's "no first use" policy, Indian nuclear strategists have to reconcile to absorbing the first strike and launch a punitive/retaliatory strike within a reasonable timeframe. In this case, the first imperative would be to safeguard our weapons and delivery systems. Aerial delivery of nuclear weapons is the most viable option to create a desired impact at a given time and place. Although it is understood that after absorbing the first strike, the balance of air dominance may shift in favour of the adversary and our strike capabilities will face tough resistance, that's where the integration and networking of force multipliers is to be exploited and such contingencies must be considered in our counter-strike strategies. AWACS, integrated with other force multiplying platforms, could play a strategically vital role in guiding and positioning our delivery vehicles over the selected target area.

AWACS for Continental Air Force

In its Platinum Jubilee year (2006 - 2007), the Indian Air Force, is being shaped to expand from a subcontinental to a continental air force, which would be capable of safeguarding national interests and economic assets over the larger area of national interest in the Indian Ocean, Central Asian region and Southeast Asian

region. In this process of evolution, the importance of an air expeditionary force needs no emphasis. For an expeditionary air force, AWACS would perform the role of an airborne command and control centre, for handling contingencies beyond own territory/territorial waters, similar to the evacuation of the peace - keeping force from Sri Lanka, or the landing at Male airfield (Maldives in 1988) amidst the uncertainty about the status of the airfield, or the protection of aircraft and ships evacuating the Indian population from Jordan in 1990 and Lebanon (Cyprus) in 2006. AWACS, therefore, could be effective as an instrument of power projection or "AWACS diplomacy."

OPERATIONAL ROLES FOR AWACS

AWACS is a strategic asset with significant operational capabilities and tactical employment. The flexibility of the role and employment of AWACS has blurred the line between the strategic role and operational utilisation of AWACS. "Historically, military planners have found situational awareness of potential hostile targets and of friendly forces to be a key component in obtaining and sustaining military superiority over adversaries. Radar had the effect of forcing air operations down to lower levels, to stay below the radar horizon and, thus, evade detection... an airborne platform, thereby, nullifying the benefits of a low-level approach has been perhaps, the single, greatest force multiplier in air operations."[13] Airborne surveillance radar that can maintain situational awareness about potential targets and friendly aircraft over hundreds of square miles of air space in any direction became a reality with the introduction of AWACS. AWACS not only addresses the line of sight constraints of ground-based radars, it extends the airborne command and control station with long range communication facility in support of national air power. AWACS, flying at 30,000 ft, approximately to 100-150 km inside own territory would give 250 km of EW and control capability in enemy territory, for six to eight hours which could be extended with aerial refuelling. The impact of AWACS on air operations is explained in the subsequent paragraphs.

13. Squadron Leader Ajai Singh, "The Air War with AWACS Symmetry," *The Indian Defence Review*, 1995, downloaded www.bharat-rakshak.com/LANCER/index.html on November 25, 2006.

Radar Cover and Tactical Control of Offensive Missions. The extent of radar cover would facilitate conduct of air dominance operations in enemy territory. Fighter sweeps and free escorts could be employed more effectively under positive radar cover deeper into the enemy territory from low altitudes to medium and high levels. Radar cover of existing ground-based radars is restricted by line of sight, although at medium (10,000 ft) and high altitude, ground-based radars can give cover from 250-400 km. But the ability of ground radar to pick-up low-level targets flying at 100 metres (300 ft) is restricted to 45-50 km, therefore, large numbers of radars are required to cover a smaller area, and still the early warning is inadequate. On the other hand, a single airborne platform like AWACS or aerostat provides a seamless low and medium level cover up to 400 km or more.

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Command and Control Centre: In peace-time as well as in war-time AWACS remains an instrument of power projection and application. As an airborne command and control centre, AWACS, along with multi - role air superiority fighters (MRASF) could be utilised for coercive diplomacy or to actually open a new front of war and take the adversary by surprise. For example, a high intensity air battle may be in progress in a given theatre, and to dilute the adversary's resources and attention, integrated force of AWACS, air-to-air refuelling (AAR), and MRASF is brought to bear on the adversary by carrying out a heavyweight air attack in a different sector, thereby, taking the enemy by surprise and seizing the initiative.

Medium Level Ingress: The sole purpose of low-level flight profiles, where fighter aircraft flew at 50 to 100 metres (150 to 300 ft) above ground level

(AGL) was to avoid and delay the detection by air defence (AD) sensors and give minimal reaction time to AD weapon systems. The gap free low level radar cover of 250 km or more in the adversary's territory would afford instant detection, greater reaction time, and swift offensive action by fighter sweep or free escorts would make the low level ingress tactics redundant. For the most part of Pakistan, the lack of geographical depth would place all its main airfields like Sargodha, Chaklala, Kamra, Rafiqy and satellite airfields i.e. Murid, Mianwali, Multan, Chander within the detection ranges of AWACS.

Own strike missions could afford to fly at medium levels under positive radar cover, thus, avoiding the three-tier low level radar cover of MPDRs which are restricted to 4.5 km (15,000 ft) in elevation coverage. This would also render en-route short range air defence systems (SHORADS) deployed in the tactical battle area (TBA) ineffective because most of these weapon systems have a slant range of 2.5 to 3 km (8,000 to 10,000 ft). Medium level ingress would afford prompt threat warning, larger radius of action, more freedom to manoeuvre and better endurance for strike aircraft.

Defence in Depth: Enhanced early warning and gap free radar cover would facilitate the area defence concept. Area defence affords optimal exploitation of speed, mobility, flexibility and firepower of fighter aircraft and greater freedom of action for terminal weapons deployed at vulnerable areas /vulnerable points (VA/VPs). This trend is fairly visible in the recent changes in deployment patterns, command and control structures and operational exercises of the IAF. AWACS would facilitate early interception, maintain continuity in application of firepower and afford opportunity for multiple interceptions and, thus, impose greater attrition and provide the classical defence in depth. As an offshoot of greater early warning

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aircraft on ORP, terminal defence weapons can now maintain a more realistic state of readiness and avoid a prolonged state of readiness I/II.

Air Space Management Over TBA: The problem of air space management emanates from the delayed/no detection and identification of tracks, very little reaction time and unreliable chain of communication. AWACS with onboard long range HF/V/UHF RT and large detection ranges would assist in resolving the problem of air space management. Detection ranges beyond horizon, early radio contact, medium level approach and timely communication give options of exercising positive control over AD weapons in TBA, maximise their freedom of action and reduce the chances of fratricide. Higher and larger vertical slabs would be available for helicopter operations of the IAF and army, transport support operations, special heliborne operations (SHBO) and combat search and rescue (SAR). However, this is not to say that AWACS is the panacea for this vexing problem. The permanent solutions for the integrated radar network, composite air picture and fibre optics communication links would streamline the battlefield air space management. Even then, air space management will continue to pose challenges experienced by the technologically superior Coalition forces in the Iraq War 2003, where a US A-10 attacked and killed nine US Marines on March 23 and a US F-16 CJ fired on a Patriot missile battery on March 24.[14]

The electronic intelligence and communication intelligence (ELINT and COMINT) system on board AWACS receives, analyses, locates radar and communication signals. AWACS SIGINT capabilities would supplement the existing intelligence infrastructure. AWACS can transfer SIGINT data either directly or through the ground exploitation system (GES) to a ground-based command and control centre for real-time analysis and decision-making. The enemy's electronic order of battle (ORBAT) can be

14. Anthony H. Cordesman, *The Iraq War: Strategy, Tactics and Military Lessons* (Dehradun: Natraj Publishers India, 2006), pp. 239-240.

updated for planning of air operations and the real-time radar picture can be correlated with electronic-ORBAT.

Monitoring and Analysis of Adversary's Air Activity: Information on the adversary's capabilities, and analysis of such information, is an ongoing process during both peace and operations. Monitoring of enemy air activity (known as general hostile area (GHA) analysis in the parlance of the Indian C & R organisation) during flying training and known periods of air exercises would give good insight into the enemy's tactics and capabilities. This capability was limited by line of sight of ground-based radars. Airborne platforms can monitor air activity 350 km or more during peace-time (because they can fly closer to the international border) and 250 km or more during war-time (for safety reasons, these platforms would operate at least 100-150 km inside own territory). The air activity when correlated with radar and radio activity monitored by SIGINT systems would form definite patterns of tactics and manoeuvres practised by the adversary.

AWACS IN HIMALAYAS

Effectiveness of radar, airborne or ground-based, in mountainous terrain is restricted by terrain masking. All radars, including AWACS, work on the line of sight principle and are prone to radar shadows owing to terrain masking. Positioning the radars on higher peaks and along prominent valleys to get longer detection ranges and early warning has achieved some success but it continues to suffer from factors like frequency of operation, beam pattern of radar, behavioural pattern of electro-magnetic (EM) waves in extreme weather conditions, low temperatures, high humidity and extremely dense clutter picture. The technologies like digital clutter processing, phased array technique, pulse compression, doppler principle and use of appropriate frequency bands have enabled more efficient high technology radars but they continue to suffer from the limited radar horizon which is just 15 per cent more than the visual horizon. The AEW platforms have further enhanced the line of sight and provide

greater ranges beyond the horizon. However, the problem of radar shadows and constraints of terrain masking in mountains persists.

Although AWACS overcomes the constraints of line of sight and provides higher probability of detection at farther ranges, the performance of AWACS would also be restricted and it will not be able to detect aircraft taking advantage of terrain masking in mountainous terrain. From its operating altitude of 30,000 ft, AWACS would be able to detect low level fighter aircraft at 400 km or more, thus, providing valuable early warning to area and terminal defence weapons. For example, a closer look at the terrain in Jammu and Kashmir (J&K) would illustrate that an AWACS flying 100-150 km inside own territory east of Kishtwar on an axis between 321440E, 770424N to 333612N, 760745E (50 km south of Nunkun) would give adequate early warning of Pakistani aircraft approaching Indian borders from the southwest (Lahore) and west (Islamabad). From a distance of 400 km, AWACS would have continuous radar cover till they approach the foothills of mountains 50-75 km east of Islamabad or west of the Line of Control (LoC). At this time, the distance of the aircraft from AWACS would be approximately 250-275 km. Hereafter, these aircraft would remain in the shadow of the Pir Panjal range till they emerge out of the valley 100-125 km from the AWACS anchor axis. Therefore, AWACS would give an early warning of 8-10 minutes before the aircraft could enter the radar shadow area and this early warning could be taken advantage of in a situation of air dominance, while it may be of no use if we are on the defensive.

AWACS will not perform optimally in the rest of the Himalayas because of the high mountain ridges in the areas of Gilgit, Skardu, Karakoram range, Leh and in the Aksai Chin area. In this area, AWACS would be ineffective for the purpose of detection and early warning unless hostile aircraft are flying above the ridge line. A similar situation would be faced above the Tibet plateau, which appears to be a flat surface; however, terrain, undulations range between 2,000-3,000 ft. Aircraft flying above the ridge line may be detected, but at low altitudes there would be large areas of radar shadows.

AWACS could be used more advantageously in conjunction with smaller ground-based radars like low level lightweight radar (LLLWR), ST-68 and

other GCI units integrated on a network to provide a composite air picture. While it is true that in mountainous terrain aircraft would invariable take advantage of terrain masking and follow the valleys to avoid radar detection and give as little early warning as possible, it is also true that such an approach is predictable, and smaller sensors like mobile observation posts and radars could be deployed to cover the approaches to these valleys. The other disadvantage of the approach through a valley is that the entry and exit points of the valley are known; they could be monitored by unmanned aerial vehicles (UAVs), smaller radars, and weapon systems could be placed to engage the threat immediately after exit.

ADEQUACY OF AWACS

In April 2004, India signed a deal of $1.1 billion for the supply of the three Phalcon AEW system installed on the IL-76 MD Candid aircraft.[15] At this rate, each AWACS is likely to cost $366 million which is an expensive proposition for a developing country like India. Perhaps that is why the initial acquisition has been restricted to three systems. The cost of AWACS has always been a restrictive factor, thus, a number of cost-effective options are now being examined the world over, These include:[16]

- Saab 340, Metro III and other aircraft fitted with the Erieye radar.
- Boeing-Bell V-22 Osprey AWACS aircraft may become very popular with VSTOL carriers operators.
- Westland Sea King AEW 2 helicopters with the Searchwater radar.
- E 801 Oko (Eye) on KAMOV Ka-31 of the Indian Navy.

While the options are many, India needs to acquire a cost-effective system that would sustain its long-term air defence requirements, maintenance and upgrade for futuristic requirements. Considering India's threat perception and geographical expanse, a large number of AWACS would be required to meet the contingency on two fronts.

15. "India and Pakistan AEW Options," an article on www.spyflight.co.uk/indiapakaew downloaded on December 26, 2006.
16. G. Jacobs, "AWACS for Air Supremacy: A Survey," *Indian Defence Review*, 1995, downloaded from www.bharat-rakshak.com/IAF/News on December 26, 2006.

For example, if we were to cover the 2,000-km-long border with AWACS flying 150 km inside own territory, concurrently three AWACS would give a lateral coverage of 1,900 km. In this case, the maximum overlap within own territory would be 200 km and 100 km in the hostile territory. Flying a racecourse pattern on a leg of 100-120 km, three aircraft would be required to cover the entire border. In addition, for the time being at least, one aircraft would have to be earmarked for naval AD requirements at any given time over the Indian Ocean; this would raise the figure to four aircraft for the western front. However, in the long-term, the Indian Navy will need to work out its own requirement for AEW systems in addition to its existing KA-31 AEW helicopters. *To maintain a single watch of eight hours on the western front by four serviceable aircraft, we may require as many as 10 AWACS.* The figure would increase to 20 aircraft if we were to plan another four AWACS for a contingency on two fronts or cater to 24-hour surveillance watch on the western front.

We are told that *five aircraft are required for maintaining a single orbit surveillance/control for round-the-clock operations.* The broad breakdown was that an aircraft on station departed from the allotted orbit only after the next aircraft had arrived on station. Therefore, at any given time, two fully serviceable aircraft are a must. Of the remaining three, one is on scheduled maintenance, another on modification and the third on minor rectification. Taking this analogy into consideration, 20 aircraft would be required to maintain 24-hour surveillance by four aircraft on station. Air-to-air refuelling capability and the IAF long-term plan to acquire six aerostat radars may ease the requirement of large numbers of AWACS; also depending upon the nature and geographical extent of the conflict, we may not always have to maintain a 24-hour watch. Still, once the hostilities break out, the optimum number of serviceable aircraft flying at any given time will go below four – that would mean a minimum figure of 12 aircraft for one watch, one front contingency. The numbers that we require to deal with the contingency are important, but more important are the numbers that we require to deal with the contingency and exploit the system for strategic advantages.

Outright acquisition of such large numbers of AWACS is not an option for a developing country like India. Therefore, the initial induction of three AWACS

is a stopgap arrangement, along with acquisition and deployment of aerostats. Two aerostats have already been acquired, and reports suggest that four more are in the pipeline. With six operational aerostats, the requirement of round-the-clock surveillance by AWACS would diminish. Indigenous development of AWACS technology is the best option to meet our air defence requirements in totality. DRDO efforts to develop an airborne surveillance platform (ASP) need to be supported by the IAF and Ministry of Defence (MoD). Cost-effective platforms like the DRDO's super vision maritime patrol radar (SV-2000 MPAR) for the advanced light helicopter (ALH) and Russian E-801M Oko (Eye) AEW system which is being used on the Indian Navy's Ka-31 AEW helicopter, [17] need to be assessed and used wherever possible to strengthen the available resources till we have the indigenous capability to produce, operationalise and maintain AWACS without external support.

A COMPARATIVE STUDY

From Bekaa Valley in 1982 to the Iraq War in 2003, all air battles have been fought under the conditions of AWACS asymmetry. The results of these air wars are to be assessed in the light that the opposition did not have access to AWACS even when it had an air force. In a condition of AWACS symmetry, it would be in order to carry out a comparison between the platforms and sensors to understand the strengths and weaknesses of various systems. A detailed comparative study based upon reliable intelligence and sources of information could be the foundation of our strategy on the outbreak of hostilities, even though it may be considered too early to do this because the information on the specification of sensors is very sketchy, be it the Phalcon, Erieye or Hawkeye 2000. However, the detailed specifications of platforms are available; hence, what could be compared are the known parameters of the platforms and sensors which have been operating in similar or marginally different configurations with other countries. The tabulated form of a comparison of platform and sensor parameters is placed at **Appendix A** to this paper.

17. Martin Streetly, "Electronic Eyes on Wings and Rotors," *Jane's International Defence Review*, vol.38, November 2005.

A brief description of the AWACS that are likely to take to the sky in Southern Asia is listed below:

• Phalcon AWACS on A-50 (Mainstay)	India
• Erieye AEW&C on EMB-145	India
• Kamov-31 Helix B	Indian Navy
• Erieye AEW&C on SAAB 2000	Pakistan
• Hawkeye 2000 on P 3C	Pakistan
• KJ-2000 with ESA radar on A-50 (Mainstay)	China
• KJ-200 Balanced Bean system on Y-8F 600	China

Chinese AWACS

A study of the AEW development process discloses very little about the performance of sensors that are likely to be used by the Chinese KJ -2000 (AWACS). Four such systems are being developed on the IL-76MD, which would have a triangular electronically steered phased array (ESA) antenna enclosed in a static radome; the ESA radar is being indigenously developed by the Nanjing Research Institute of Electronic Technology unit. It is also reported that the Chinese system is based on a combination of the IL-76 and Argus AEW mission suite (BAE system avionics). *Jane's* has reported that China seems to have acquired an unspecified number of Argus systems to be fitted on the IL-76. Although a Chinese delegation is reported to have visited the UK for discussions on the procurement of the Argus system, the information needs to be treated with caution.[18] Some Internet sources claim that Chinese AWACS would have capabilities similar to the Russian A-50. *Jane's* has also reported that the Chinese Argus-based AEW&C capability was being developed alongside possible acquisition of up to three Russian A-50Eh AEW& C aircraft.[19] In addition to the KJ-2000, the second AEW&C platform is being developed on a modified airframe of the Y-8 aircraft, which is designated as the Y8-F-600. The platform has been extensively modified with improved avionics and engines for better performance. This platform would be fitted with an electronically steered phased

18. "Airborne Early Warning, IL-76MD AEW Variants," in Martin Streetly, ed., *Jane's Electronic Mission Aircraft*, Issue 14, December 2004, pp. 45-46.
19. Ibid., p.46

array radar, similar to the Swedish Ericsson PS-890 Erieye.[20] This system is widely known as "Balanced Beam" project mainly because of the shape and mounting of antenna in the form of a triangular beam mounted on top of the fuselage along with the fuselage reference line (FRL). The information available in the public domain is inclined to compare the system with the Erieye, even though it is not clear if it is based on similar technology. The Erieye system has the capability to detect targets in 360° and expected to have detection ranges in excess of 350 km.[21]

Pakistan's Acquisitions

Pakistan's multi-pronged approach to acquire AEW&C systems has been addressed in the beginning of the paper. The first system that is likely to be delivered and operational in Pakistan is the SAAB 2000 turboprop, along with the Erieye early warning (AEW&C) system. The SAAB 2000 Erieye combines a modern turboprop aircraft with an advanced technology sensor. The turboprop SAAB 2000, with a cruise speed of over 665 km/h (360kt), is one of the fastest turboprop aircraft. The combination of near jet speeds, higher rate of climb and descent, and 180° turn in less than 30 seconds enhances its survivability. The Ericsson PS-890 is an S-band pulse doppler, active phased array surveillance radar which incorporates 200 solid state modules. The range of the S-band (3.1 to 3.3 GHz) side looking radar is 300 km. The 900 kg dorsal antenna is housed in a 9-metre-long box radome mounted atop fuselage. From its standard operational altitude of 6,000 metres (20,000 ft), the radar has a maximum range of 450 km.[22] Though many other sources claim that the system has coverage of 360°, the information in the public domain gives an impression that the look angle on each side is optimised for 120° coverage on both sides and there is a limitation of a partial blind zone or reduced pickup zone of 45° to 60° in the frontal and rear quarters.[23]

The Erieye airborne warning and control system also includes a command

20. "Y-8 'Balanced Beam' (KJ-200)," *Airborne Early Warning Aircraft* , downloaded from www.sinodefence.com/airforce/specialaircraft on January 1, 2007.
21. Ibid.
22. n.5.
23. Ibid.

and control system with five operator work stations; the system also includes an electronic warfare (EW) suite, electronic support measures, identification friend or foe (IFF), communication and data link and a self-protection system. It is claimed that the operational efficiency of the system is so high that a small force of three aircraft is sufficient to sustain two airborne platforms round-the-clock for a limited period or one airborne patrol with one aircraft on continuous ground alert for more than 30 days.[24] The Erieye system is also operating on Embraer 145 or P-99 aircraft with the Brazilian Air Force and Hellenic Air Force of Greece.

Pakistan has also finalised a deal with the US Department of Defence (DoD) for the sale of three excess P-3 aircraft with the Hawkeye 2000 AEW suite and associated equipment at a total cost of $855 million.[25] Variants of the Hawkeye are being flown by the Israeli, Egyptian, Japanese, Singapore and Taiwan Air Forces and the French Navy. Pakistan will acquire the Hawkeye 2000 AEW&C suite on refurbished and modified P-3 aircraft with range and endurance. The latest variant of the E-2C (Hawkeye 2000) with its new mission computer, improved radar displays and cooperative engagement capability (CEC)[26] is a system of hardware and software that allows the sharing of radar data on air targets among ships. Radar data from individual ships of a battle group is transmitted to other ships in the group via a line-of-sight, data distribution system (DDS).[27] The CEC capability will mean better coordination between the Hawkeye and other platforms (ships, fighter aircraft, etc.), achieving unprecedented performance.

The Hawkeye has already been operating from the P3-C in the US Navy and Australian Air Force. The AN/APS-145 radar is the key element of the Hawkeye. The APS-145 offers enhanced performance over land and sea when searching in over the horizon mode and at the land, sea and OTH interface. It is reported that the APS-145 is able to track aircraft over land, regardless of terrain and target

24. Ibid.
25. n.1.
26. "United States Navy Fact File, E-2 Hawkeye Early Warning and Control Aircraft," downloaded from http://www.navy.mil/navydata/fact.asp on January 22, 2007.
27. FY 1998 Annual Report by Director, Operational Test & Evaluation on Cooperative Engagement Capability downloaded from www.fas.org February 8, 2007.

density. The environmental management system (EMS) automatically modifies its signal processing and tracking algorithms to suit the changing search environment. The radar is capable of detecting ground vehicles in less density environment and over the sea it detects moving and stationary surface and aerial targets. An enhanced high speed processor is incorporated into the mission computer, which maintains in excess of 20,000 tracks for scan-to-scan correlation.[28] The radar is capable of detecting targets within a three-million-cubic-mile surveillance envelope while simultaneously monitoring maritime traffic. The Hawkeye 2000 is expected to automatically track more than 600 targets, and control more than 40 airborne intercepts.[29] Enhanced main display units provide operators with improved visual representation. The Hawkeye has only three operators, "a radar operator, an air control operator and a combat information center operator. The three system operators work independently in all operational roles."[30] Therefore, the capability to control 40 intercepts simultaneously needs to be addressed with caution and needs further studies about the type and extent of intercepts controlled by a total of three operators. The ASW variant of the P-3 Orion can accommodate a maximum of 21 crew, including flight crew. Therefore, it would be safe to assume that the AEW version would accommodate a larger number of display systems and controlling crew. A pictorial cut-out of the P-3C with the Hawkeye's UHF radar is placed at **Appendix B**, showing the additional space for intercept tactical controllers.

Acquisition and Development by India

In addition to acquiring the Phalcon AW&CS on board the IL-76 airframe, India is working on developing another indigenous AEW system as of 2005. According to former Defence Minister Pranab Mukherjee, completion of development activities and commencement of user trials should occur in 2012. As of 2005, the aerial platform had not been chosen although the Brazilian Embraer was considered a contender.[31]

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28. n.18.
29. Specification of E-2C Hawkeye 2000 downloaded, from www.fas.org on January 22, 2007.
30. Fact Sheet E-2C Hawkeye downloaded from http://www.northropgrumman.com /e2c_hawkeye.html
31. "Airborne Surveillance Platform" http://www.globalsecurity.org/military/world/india/asp.htm

The Phalcon AEW&C aircraft is based on four sensors: phased array radar, phased array IFF, ESM/ELINT and CSM/COMINT. The AEW&C phased array radar replaces the conventional rotating radome radar. It is mounted on a stationary dome providing 360° degree coverage. The electronically steered beam supports tracking high manoeuvring targets. The radar operates in three modes: normal surveillance mode, long range mode, and surface mode. In the long range mode, the detection ranges are greater than 400 km. The radar is capable of detecting the airborne targets between 50 metres to 15 km. It can track 100 targets simultaneously and track 500 targets in TWS mode. Four simultaneous interceptions are possible from one operator workstation (OWS) and a maximum of 16 intercepts could be controlled simultaneously. The IFF system employs solid-state phased array technology to perform interrogation, decoding, target detection and tracking and IFF data is automatically correlated with the primary phased array radar. The ESM/ELINT system receives, analyses and locates radar signals, covering 360°. It combines high sensitivity with high probability of intercept, and achieves excellent accuracy in bearing measurement. The PHALCON's CSM/COMINT receives in UHF, VHF and HF bands, rapidly searching for airborne, shipborne or ground communications signals of interest.

At this juncture, not much is known about the progress of indigenous efforts by the DRDO. The Scientific Advisor to the Defence Minister Dr M. Natarajan, informed during the third Subroto Mukherjee Seminar on December 31, 2006, that the AEW&C will be based upon phased array radar technology with 240° sector coverage and detection ranges greater than 200 km. The platform would also integrate C band SATCOM link, radio relay (RR) and V/UHF links. The system is likely to be developed over a period of the next 4-5 years.

The Indian Navy has been using the E-108M Oko (Eye) AEW and surface surveillance radar on board the Kamov (Ka-31) helicopters. The radar is folded and stowed beneath the aircraft fuselage. The surveillance radar operates in the S-band (2-4 GHz) and scans mechanically in azimuth and electronically in selevation. [32] It is optimised for detection of low flying aerial targets in the heavy land or sea clutter environment. It has 360° coverage with six RPM. Radar can

32. "KAMOV Ka-31 Helix -B AEW Helicopter" downloaded from www.bharat-rakshak.com on January 22, 2007

simultaneously track 40 airborne or surface threats and detect fighter aircraft from a range of 110- 115 km, depending upon the radar cross-section.[33] The radar information is transmitted via an encoded radio data-link channel to a shipborne or shore-based command post. The data link range is 150 km.

IMPLICATIONS FOR INDIA

The two striking implications of China and Pakistan acquiring AEW&C systems are: firstly, the acquisition of force multipliers of the magnitude of AEW would erode whatever little numerical and qualitative superiority the IAF has over the PAF; secondly, it demonstrates Pakistan's growing insecurity in this region and over the Indian Ocean. Pakistan is developing offensive and defensive capabilities of its comparatively smaller air force through force multipliers. The acquisition of AWACS should not be seen in isolation – the entire gamut of weaponry in the form of F-16, UAVs, air-to-air missiles (AMRAAM), guided bomb units, laser guided bombs, JDAMS, anti-shipping missiles and other combat aircraft from China should be considered in totality to assess the implications for India. "Thus, even a small strike force of F-16 supported and controlled by AWACS and other electronic warfare systems would pose a significant potential to neutralise the adversary's AD radars, surface-to-air missiles (SAM) and anti-aircraft artillery."[34]

Pakistan is well aware of the IAF's modernisation plan and its emphasis on space-based capabilities, information technology, networking of forces and development of information, surveillance and reconnaissance (ISR) capabilities. While India's threat perception and defence requirements may be more strategic and continental in nature, Pakistan, in its attempt to attain parity with India, projects every move of the Indian armed forces as anti-Pakistan; hence, the military modernisation plan is seen in a limited context. To negate the capabilities of the IAF and Indian Navy through their modernisation plan, Pakistan seeks advanced high end technology and long range surveillance systems for greater early warning and attack capability.

The Pakistan Air Force would receive a quantum jump in the fields of

33. n.18.
34. Jasjit Singh, n.3, p. 63.

reconnaissance and surveillance during peace-time and during operations.The six Erieye systems with the Pakistan Air Force are likely to be flown along India's western borders and coastline. The ELINT and COMINT equipment on board these aircraft will monitor all radar and radio transmissions on the Indian side up to a range of 400 km or more. The IAF's electronic-ORBAT and deployment of forces would become totally transparent to the PAF. This problem becomes more significant, because during peace-time, Pakistani aircraft could fly 40-50 km from the international border, thus, observing and monitoring the IAF's operational and training activities up to a depth of 300 km from the international border. This would help Pakistan draw a complete picture of the strengths and weaknesses of Indian air defence and strike capabilities.[35]

The Pakistan Air Force would receive a quantum jump in the fields of reconnaissance and surveillance during peace-time and during operations.

The IAF would be forced to withdraw its operations to the rear bases, restrict its radar and radio transmissions, and still, a large part of the IAF's flying activity, operational exercises, tactics and radio transmissions would be monitored by Pakistan. In this case, the Indian Air Force would eventually be forced to move its fighter aircraft to rear bases in the central and eastern states, which in any case the IAF should consider as a long-term measure of survivability. Availability of AAR and air battle management by AWACS calls for dispersed deployment in depth. Therefore, the launch bases should be kept in depth to provide better air defence and survivability. This would entail long - term planning, capital expenditure on development of airfields and shifting of infrastructure which has been built and developed over 30 to 40 years. A long-term plan for shifting in a phased manner will need to be seriously actioned.

Pakistan's acquisition plan for AWACS is to obtain the systems from different sources and diversified sensors to meet different requirements of surveillance and intelligence operations over land and sea. It is also clearly visible that Pakistan does not want its long-term plans to suffer from sanctions or denials in

35. Jasjit Singh, Ibid., p. 66.

the future, considering the fluctuations in geo-strategic / geo-economic interests. For India, therefore, it implies that it must live with the reality of Pakistani AEW&C and plan its strategy to fight the next battle of air dominance over Pakistani territory in conditions of AWACS symmetry.

It is expected that by 2015, the aircraft carrier *Vikramaditya* (*ex-Gorshkov*) and Indian air defence ships are likely to be operational. The aircraft carrier with MiG-29, naval light combat aircraft (LCA) and naval helicopters along with IAF maritime Jaguars, SU-30 MKI, aerial refuellers and AWACS would form a formidable force. To counter this force with long range early warning and to acquire the capability to neutralise the aircraft carrier, Pakistan is acquiring, a large number of P-3C Orions, Hawkeye, Augusta submarines and anti-shipping missile like the Harpoon and Exocet.

Another important implication of China-Pakistan strategic cooperation in development of AWACS is the familiarity of the Chinese aviation engineers with the capabilities and limitations of the IL-76 as a platform and information on the Phalcon AEW system. Israel may have backed out from the deal to supply the Phalcon AEW system, but in the process of evaluation and negotiation of the deal, People's Liberation Army Air Force (PLAAF) personnel must have studied the Phalcon system in detail. This intimate knowledge of the system could be utilised to develop a counter-strategy for Indian AWACS and exploit the weaknesses of the Phalcon. The Indian Air Force and specially AWACS operators will do well to know the weaknesses of their system and consider that Pakistan is aware of them. On the other hand, Pakistan may assist China by supplying critical inputs on sensor technology from the Swedish Erieye or Hawkeye 2000 sensors.

AWACS busting has always drawn significant attention. Some believe AWACS busting by fighter aircraft is a viable proposition without considering the detection ranges of AWACS at low altitudes, early warning available, fighter air defences and ability of AWACS to retreat in the presence of threat. Also, one has to keep in mind that systems like the E-3C, Phalcon and A-50 have ESM platforms which can detect radar and radio transmissions from ranges larger than that of radar; such radar and radio transmissions could be analysed to identify an emanating threat.

A radar warning of 250 km is adequate to scramble or divert airborne fighters to engage the threat. As the threat closes in, AWACS would continue to retreat while guiding own fighters or it may hand over the interception to the aerostat or ground -based system in the case of a medium level approach. The advent of the surface-to-air Chinese FT-2000 anti-radiation missile has further bolstered the case for engagement of AWACS. Though the possibility of AWACS engagement by these systems cannot be totally ignored, the probability is low due to:

- None of these systems has been tested for its efficacy.
- The FT-2000 has a range of 100-120 km –that would mean that the AWACS should be flying within that range for it to successfully engage it.
- It is a passive radar homing missile – what would be the impact of switching off the radar or activation of electronic counter-measures (ECM)?

Lastly, the Pakistani AWACS would mean detailed joint planning with the army and navy to work out all possible contingencies theatrewise, starting from J&K going down to the Indian Ocean and island territories. Availability and utilisation of assets among the three Services, planning and prioritisation of theatrewise operations and contingency plans must be worked out. The Indian Air Force would have to plan its battle of air dominance fully aware of the risks involved in preemption and initiative. The aggressive and unconventional approach would be crucial to achieve the surprise factor. That brings us to air operations in AWACS symmetry.

AIR OPERATIONS IN AWACS SYMMETRY

The potential of AWACS and its capabilities provide the decisive edge in air warfare. AWACS asymmetry allows the transformation of a small force into a winning force.[36] But the bigger question is: what would be the effect on its efficacy if the opposing air force also has the same capability? The air operations under the umbrella of AWACS symmetry may not have similar success rates as were seen in the air battles of the Middle East.

In the situation of AWACS symmetry, a detailed study of the capabilities and limitations of the systems would help analyse what should be our

36. Ajai Singh, n.13.

The potential of AWACS and its capabilities provide the decisive edge in the air warfare.

operational strategy. Both the Erieye and Hawkeye systems have certain limitations as compared to the Phalcon AWACS. The Erieye system has a limited radar cover in the frontal and rear cone of the aircraft. Reliable radar detection is in the cone of 150°-160° on both sides of the aircraft. The detection range against a fighter class of aircraft is limited to 330 km as compare to 400 plus of the Phalcon. Though it is claimed that the Hawkeye-2000 affords enhanced performance over land, its control capability, endurance, limited number of operator work stations (OWS) impose considerable limitations. It, therefore, remains best suited for maritime surveillance. The SAAB 200 is also constrained by a restricted number of OWS and operators on board.

Also, other aspects of performance like blind zones, communication ranges, radar accuracy, resolutions and data handling systems also affect the control capability; therefore, it becomes extremely important to know the precise performance limitations and exploit them at the earliest to achieve the element of surprise.

In the case of AWACS symmetry, the performance of the radar platform would remain the same – only the methods of its utilisation in time and space, initiative, innovative tactics and aggressive approach would help gain advantage in the beginning of the air battle. Therefore, the approach of the politico-military leadership would have to be aggressive and preemptive. "There will have to be a shift in the thinking from air space denial to air space control as means of achieving one's aim. The battle for dominance on both sides will be fought in the air...., the side which has superior tactics and training would emerge victorious and be in a position to control operations in other dimensions as well."[37] In the air

"There will have to be a shift in the thinking from air space denial to air space control as means of achieving one's aim. The battle for dominance on both sides will be fought in the air...."

37. Ajai Singh, Ibid.

battle, the one who detects, aims and shoots first, would seize the initiative. Tactical control of fighter sweeps and free escorts in the enemy's air space would become more critical. An aggressive approach would help achieve air dominance, for example, positioning own multi-role air superiority fighter (MRASF) equipped with BVR air-to-air missiles in enemy territory and engaging hostile aircraft as soon as they get airborne. Some of these aspects were practised and tested in the IAF exercise Gagan Shakti in October 2006.

India needs to consider fast track progress for development and deployment of space-based capabilities to create a sort of asymmetry and maximise the advantage of all assets. Meanwhile, sensor integration and fusion of data is already being progressed, for example, integration of AWACS with the integrated air command and control system (IACCS) through its ground exploitation system (GES). IACCS integrates with ground-based/aerostat radars, UAVs, communication links (HF, V/UHF, and SATCOM) and the entire gamut could provide a fused data link to fighters on the operational data link (ODL). We need to create a seamless synergistic net-centric environment to integrate command and control centres, weapon platforms, ISR data targetting information and data links and precision weapons to create an asymmetry to counter the AWACS symmetry.

CONCLUSION

In the overall context, one has to consider that the machine performs as well as the man behind it. Intent, knowledge, capability and training would ultimately help one side gain an edge over the other. In modern air warfare, AWACS emerges as a most potent force multiplier which could easily tilt the balance in favour of an AWACS operator. Strategically and operationally, AWACS provides a decisive edge to air operations, and air defence operations, in particular. It provides the quantum jump in detection and control capability. The most outstanding feature of this platform is the reach and flexibility that it provides. As an air surveillance, command and control platform, it could be operated anywhere in the area of interest. Training, tactics and operational exercises are the best way to master the employment of AWACS in different

scenarios. Training should include not only the capabilities of AWACS and the methods of its exploitation, but also address the issues pertaining to mental attitudes, innovative approaches and in-depth study of the enemy's capabilities and limitations in a situation of AWACS symmetry. The battle for air space control and air dominance would have to be swift, concentrated and the most critical aspect of our wars in the future. As has been proved in the past, an initiative and aggressive approach in the air battle will provide the decisive edge and prove to be a governing factor in the result of war.

Acquisition of AEW by Pakistan is definitely a security concern, but at present, it seems that the best way to deal with it is to plan and prepare. There is no need to for the Indian Air Force to be overly concerned. It is yet to be seen as to how long it would take for these deals to materialise. The recent news of the US Congress introducing a Bill to restrict military aid to Pakistan, subject to the US president certifying that Pakistan is doing enough to control the Taliban, could mean delays/cancellation or nothing at all. In the overall context, the IAF is better off as far as aircraft, weapon systems, training and professionalism are concerned. But the crux of the matter would be proving it once again, if the situation comes to that.

APPENDIX A

Comparative Performance of AEW & C Systems

Phalcon	IL-76 Erieye	SAAB Erieye	Emb-145 Hawkeye	P-3C on IL-76	KJ-2000 Hawkeye	E-2C
Flight Crew	Five	Two	Two	Five	Five	Two
Msn Crew	10 /11	5 to 6	5 to 8	11 or more	>10	Three
Max Range,	6,100 km	1,300 km	2,460 km	3,746 km	-----"----	2,775 km
Service, Ceiling	34,000 ft	25,400 ft	37,000 ft	28,700 ft	34,000 ft	37,000 ft 11,275 metres
Flight Endurance	7 hrs	5 - 7 hrs	08 hrs	12 hrs	7 hrs	6 h 15 min
Patrol Speed	600 km/h	296 km/h	450 km/h	610 km	600 km/h	480 km/h
Max Speed	800 km/h	600 km/h	833 km/h	760 km/h	800 km/h	602 km/h
Sensors	L Band ESA Radar	S Band Phased array PD radar	S Band Phased array PD radar	AN/ APS145 UHF PD radar	ESA radar	AN/ APS145 UHF PD radar
Antenna	Fixed Trian-gular in radome	Fixed, dual sided, electronic scanning	Fixed, dual sided, electronic scanning	Rotating, in Circular radome	Fixed Triang-ular in radome	Rotating, in Circular radome
Detection Range	450 km	350 km	350 km	> 500 km	Not kn-own	> 500 km
Tgt Tracking	100 targets	40 targets	40 targets	>600 targets	Not kn-own	>600 targets
OWS*	Eleven	Five	Five	Three	Not known	Three
Inter-ceptions	16	10-12	10-12	40	Not known	40

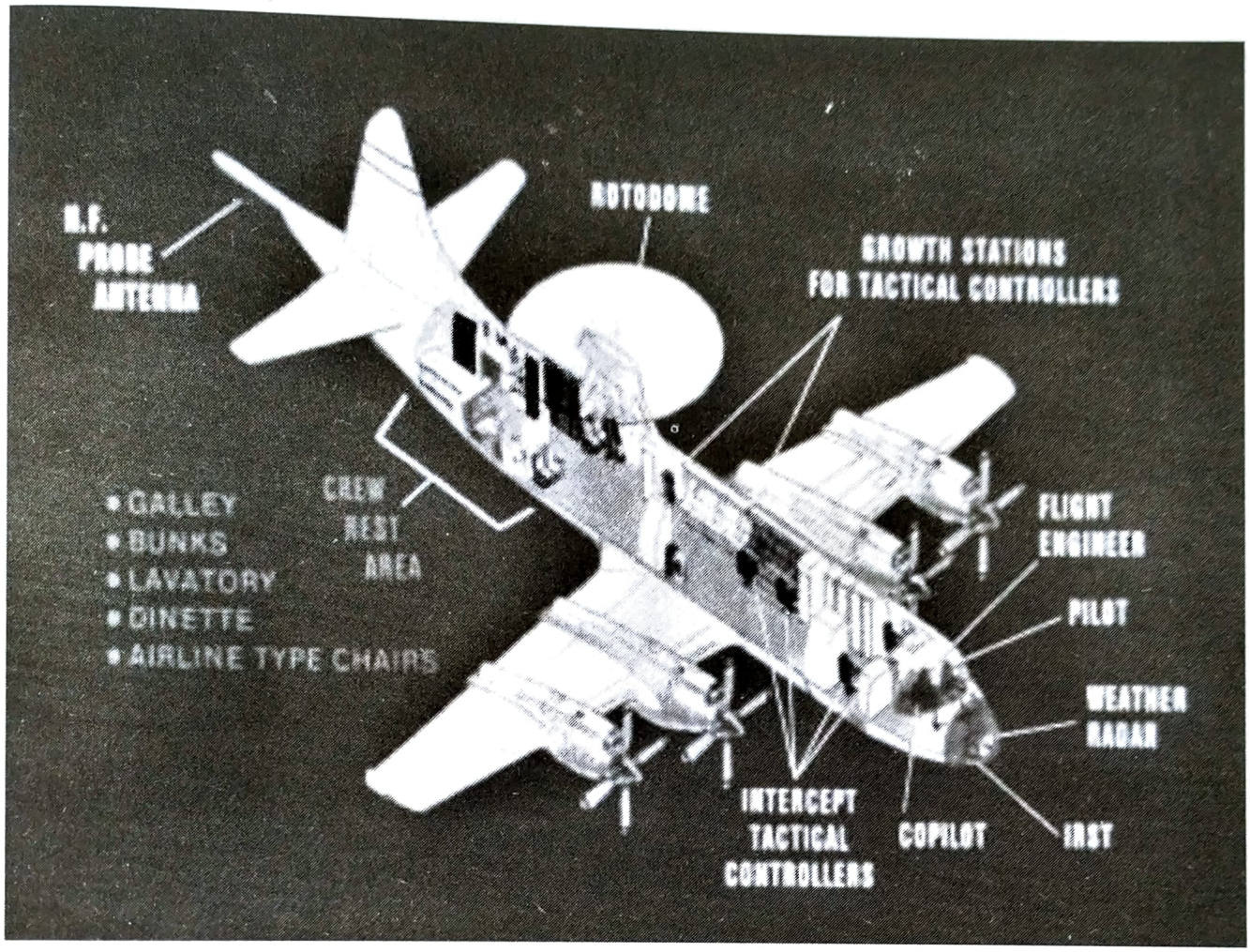
The platform data has been collected from various articles, journals and Internet sites:
Martin Streetly, ed., *Jane's Electronic Mission Aircraft*, Issue 14, December 2004, pp. 45-46 .
"Fact Sheet E-2C Hawkeye," downloaded from http://www.northropgrumman.com /e2c_hawkeye.html
"Airborne Surveillance Platform," http://www.globalsecurity.org/military/world/india/asp.htm
"Sweden Finalises SAAB 2000 AEW&C Contract with Pakistan," downloaded on December 27, 2006, from www.defenceindustrydaily.com

"Y-8 'Balanced Beam' (KJ-200) *Airborne Early Warning Aircraft*," downloaded from www.sinodefence.com/airforce/specialaircraft on January 1, 2007.
"United States Navy Fact File, E-2 *Hawkeye Early Warning and Control Aircraft*," Downloaded from http://www.navy.mil/navydata/fact.asp on January 22, 2007.
Specification of E-2C Hawkeye 2000 downloaded, from www.fas.org on January 22, 2007.
Martin Streetly, "Electronic Eyes on Wings and Rotors," *Jane's International Defence Review*, vol.38, November 2005.

* Operator Work Stations

APPENDIX B

P-3c With Hawkeye UHF Radar



The Hawkeye's UHF radar has been integrated with both the Lockheed P-3 and C-130 airframes, providing a mid-range system with substantially better range and endurance performance than the E-2C. These derivative systems exploit the additional airframe volume available and use larger and newer computer and display technology, in comparison with the cramped E-2C airframe. Downloaded from www.ausairpower.net/aew-aesa.html on 23 Jan 2007