Centre for Land Warfare Studies (CLAWS)

Joint Seminar

On

Night Vision India: 2013

"Seeing Through the Fog of War"

CLAWS and Indian Military Review (IMR) Joint Seminar on Night Vision India: 2013 "Seeing through the Fog of War" was held on 16 and 17 Jan 2013 at The Air Force Auditorium, New Delhi. Prior to the seminar, a book written by Lt Gen RK Nanavatty (Retd), "Internal Armed Conflict in India - Forging a Joint Civil-Military Approach" was released by Lt Gen SK Sinha, PVSM, (Retd), former Governor Assam and Jammu & Kashmir.

The seminar was conducted in four sessions as under: -

(a) **Session** 1. Combat by Night

(b) **Session 2**. Emerging Technologies for Night Vision

(c) **Session 3.** Night Air Combat and Support Operations

(d) **Session 4.** Countering the Threat

The seminar was attended by serving officers of the Armed Forces, civil and police services, veterans, and personnel from corporate sector, media and think tanks.

INAUGURAL SESSION

Welcome Address: Maj Gen Dhruv C Katoch, SM, VSM, (Retd), Director, CLAWS

It is a pleasure to welcome the audience and eminent speakers to the seminar on Night Vision Technology. We are privileged to announce the release of Lt Gen Nanavatty's book "Internal Armed Conflict in India - Forging a Joint Civil-Military Approach". The

book is a comprehensive study of internal armed conflict in India and the paramount need of forming a joint civil-military doctrine for conflict resolution. This book would be a useful guide to the military as also to others dealing with internal conflict and is recommended to be introduced for study across military training institutions in India.

The issue of night vision devices (NVDs) is a very contemporary and relevant issue. The ability to detect, identify and engage targets at night would be crucial to Indian Armed Forces as well as Central Armed Police Forces. In earlier times hostilities used to cease at last light precisely because of lack of ability to continue war fighting by night. The first use of NVDs was in World War II. However, the real revolution in NVDs came about the 1980s and its impact on war outcome was first demonstrated in Gulf War I. The need of the hour is for the public and private sector to step up to the challenge and provide our security forces the wherewithal to counter the threats both foreign and domestic.

Key Note Address: Lt Gen Philip Campose, VSM, DG Perspective Planning & President Executive Council of CLAWS

Battlefield transparency under all types of conditions will be the hallmark of 21st century military operations. The two wars in Iraq and the ongoing Afghanistan operations have acted as test beds for modern technologies particularly NVDs, which will be an enabler of success in future. The military forces that own the night have a decisive edge vis-a-vis the adversary. The twin obstacles of weather and visibility which play havoc with military operations can be overcome to a great extent by the application of night vision equipment. The possibility of conventional war can't be ruled out but in the near to medium term the threat from domestic sources to internal environment would be pervasive. There will be no front, flanks and rears in such scenarios.

NVDs are force multipliers and are widely used in counter insurgency and border surveillance operations. The legacy systems already in place are heavy and inefficient. Indian Army is in the process of equipping its soldiers with third generation NVDs to match different weapon platforms. To accommodate these new devices there has to be a change in doctrines, organisational structure and training methods. Foliage

penetration is the next technology on horizon. There is an urgent need to indigenise the night vision technology and Public-Private Partnership (PPP) will be crucial in this regard.

Industry Perspective: Mr. Bimal Sareen, Chairman Defence Committee, PHD Chamber of Commerce and Industry

Currently, the domestic private industry is mainly a subcontractor and ancillary provider of products to the defence forces. India has a great advantage as it can acquire the latest state of art technology for defence modernisation programmes overcoming the progressive upgrade inertia of existing legacy systems in most cases. Some of the important parameters which can help the industry to deliver quality NVDs for defence forces are:-

a) Technology specification
b) Operational use
c) Mobility requirements
d) Clarity and resolution
e) Weight, cost and power performance

India's strategic production policy is evolving under constraints of technology, resources and in some cases policy. There is lack of trust and collaboration between public-private research and development (R&D) model. There is a need to overcome the prevalent confrontational attitude. Impetus needs to be given to process based mass manufacturing and here the private industry can contribute in a big way. At present the private sector is responsible for supplying raw materials, semi-finished assemblies and maintenance workshops. 25 per cent of demand is provided for by the nearly 6000 Small and Medium Enterprises (SMEs).

The Defence Production Policy (DPP) - 2011 is responsible for creating conducive environment for private sector to participate in defence. The offsets clause is a sub part of DPP 2011 which enhances indigenisation through Transfer of Technology (ToT). All the participants including the government, military and industry need to recognise the imperativeness of a collaborative model.

The DPP has defined project based production model with “Make” category for indigenisation of defence requirements. There is huge opportunity for private sector as the demand from the Indian Armed Forces is huge both in terms of quantity and quality. Some of the recommendations are as follows:

a) Set up a National Technology Collaboration Programme to ascertain nature and volumes of demand and business.
b) Variety of generations specification through which plan outlay of modernisation can be provided.
c) Actively develop secondary sources in house.
d) Intellectual Property (IP) needs to be defined so as to make room for commercial use of the same.

Session I: Combat by Night

F-INSAS Preparing the Soldier: Lt Gen JS Bajwa, UYSM, SM, DG Infantry

The future battlefield will be lethal, violent and intense. The sub conventional environment will also be on the same lines. The nature of warfare will be of the order of 24 hours in a day with no letup in tempo of operations. Our adversaries are arming themselves to the teeth and India needs to have the technological edge so as to deter and defeat the enemy in engagement. All infantry battalions are required to be equipped with night vision capability as per the war establishment plan. Indian Army is wary about the threat perceptions and is taking a serious look at the quantity and quality of equipment held.

The operational environment of a future infantry soldier would be to hold ground and capture enemy territory in conventional scenarios and pursue the enemy relentlessly in the sub conventional domain. There is a deficiency in performing the tasks by infantry at night to comparable levels in the day time. The most important characteristic of conventional scenario is battle field transparency under all time and weather conditions. Crucial tasks such as identification friend and foe, target acquisition and target

neutralisation by accurate fire, aided by NVDs, is a capability that the infantry is hard pressed for.

Infantry forms the largest part of Low Intensity Conflict (LIC) domain and counter insurgency. Insurgents are petrified of NVDs as their ability to operate at night is highly restricted to actions such as infiltration. The ability of infantry to operate with impunity at night will deny action of freedom to the insurgents. Actions such as area domination and surgical elimination of terrorists can also be aided by night vision capacity with minimal collateral damage.

Apart from night sights, other areas which can be explored are smell and sound detection at night. The system should be compact and man portable. The Army is looking at a mix of passive night sights and thermal imagers (TIs). There is a need of reducing blooming effect by application of auto-gating. The unattended ground sensors (UGS) are also limited in their ability as they are not able to differentiate between man and animal at extended ranges. Another source of concern is the power backup facility for the NVDs which is highly constrained as of now. FICCS is the heart of F-INSAS. There has to be a healthy balance between L1 and T1 procedures in future procurements so as to obtain the desired quantity and quality from the vendor.

Surveillance and Target Acquisition: Maj Gen Vinod Vashisht, GOC 41 Artillery Division

Accurate and devastating firepower would be paramount in any future engagement as the room for maneuver has become limited with the advent of nuclear weapons in India’s neighbourhood. The primary task of artillery can be summarised as Seek-Locate-Destroy. The processes involved in seek & locate are sensor tasking, information flow, data synthesis and intelligence extraction. For target acquisition to be effective the information flow should be timely and accurate for the commander on ground to make the right operational decision. The two gulf wars and the war in Afghanistan have been studied all around the world and the lessons learnt from the experiences are:-

a) Technology drives doctrine to a greater extent than ever before

b) Technology alone on its own can't win wars

There is an urgent need to build capacity and enhance training regimes to absorb modern technologies by our security forces. The wherewithal to train on simulators complimented by live exercises on a periodic basis in real operational scenarios is the way forward to produce a world class fighting force. Some of the issues faced by the artillery are:-

a) Over-reliance on overseas vendors and manufacturers.
b) Long revisit periods for equipment.
c) Limited downlink capability particularly due to constrained bandwidth at theater level.
d) Coordinate accuracy of target seek and locate.
e) Inter-service jointness especially for intelligence and targeting

Some of the recommendations to remedy the current state of affairs are modern communication links, needs based sensors including NVDs for different weapon platforms, live feeds, National Geographical Information Systems (GIS), map information based collation and enhanced crew efficiency through training. Currently, there is inadequacy in the numbers of NVDs and the quality of resolution of optical imagery is also not up to the mark. There is an urgent requirement of a dedicated defence satellite for bandwidth and other critical functions of coordinate identification. NVDs can also help in decreasing the sensor to shooter cycle particularly during night and times of reduced visibility.

Thermal Imaging Technology in use by Military Products & Systems: Mr. Meir Giber, Director Marketing & Sales, CONTROP Precision Technologies Ltd, Israel

CONTROP Precision Technologies Ltd is a solution provider and product manufacturer for Israeli Ministry of Defence (MoD). CONTROP specialises in the production of panoramic scanning devices, gyro-stabilised EO/IR payloads, Cameras/CCTVs, Thermal Imagers (TIs) and Image Intensifiers (IIs). In the TI range the product range is of three types namely:-

a) Short Wavelength IR- Long Distance Communication
b) Medium Wavelength IR- Homing missiles
c) Long Wavelength IR- used in Forward Looking Infrared (FLIR)

The latest in IR technology includes the FLIR solutions of mainly two types, CAT un-cooled FLIR and Fox cooled FLIR. Their light weight IR cameras can be installed on even small tactical Unmanned Aerial Vehicles (tac-UAVs). These products also come with a special feature called Continuous Zoom Lens (CZL) which helps in stabilising the picture on zooming in and out as well on shaky and mobile platforms. Longer ranges for target acquisition are made possible through wide Field of View (FoV) and CZL technologies present in the majority of CONTROP's product range. CONTROP also has nearly 26 different types of airborne payloads for surveillance and reconnaissance. The company was also involved in the upgrade of cameras for Mi-17 helicopters.

CONTROP's solutions have been used to integrate the ground forces with Headquarters (HQ) via satellite and air assets for a highly networked environment. The EO/IR solutions have features of high rate of stabilisation including zenith and nadir, low weights and CZL and different FOVs features. EO/IR for land systems can be used for border security, scanning and observations and long range identification. All the products have a user friendly and comfortable man-machine interface. CONTROP has its mobile EO/IR system in place for the Border Security Force (BSF) mobile surveillance vehicle platform.

Discussion Session I

The discussion round helped in exchange of ideas between the audience and the speaker panel. The points discussed were:-

- Current TI systems have very limited identification capability.
- High altitude platforms, fog and foliage penetration and fusion technology development progress.
- Current TI solutions cannot see through real obstacles and movement is the main characteristic which is identifiable by current technologies.

- L1 vs. T1 procurement models. L1 model may be cheap up front but can provide out dated technologies which are more costly over their life cycle.
- Healthy mix of range and TI sensors which are weapon platform centric for the security forces.
- Fusion technology, Hybrid systems and laser gated illumination are the future of NVDs.
- Indigenisation of NVD technology through increased private sector participation.
- Sort out issues of power backup and batteries for NVDs which are standard products in the market.

Session II: Emerging Technologies for Night Vision

Night Vision Projects: Looking into the Future – Lt Col MK Singh (Retd), Additional General Manager (Army), BEL Regional office, Delhi

Bharat Electronics Ltd. (BEL) is a Defence Public Sector Unit (DPSU) that was established in 1954. BEL is the only organisation that deals with night vision enablement in India along with DRDO. The core competence of BEL is defence electronics that includes radars, communications, C4I2 systems, electro-optics, servo loop systems, electronic warfare, avionics and maritime systems. BEL is located across the country in nine major cities. 88 percent of BEL's customer is defence and 12 percent comprise of civil including Central Armed Police Forces.

The activity of BEL over the spectral band covers from 0.4μ to 12μ. These are the visible, near invisible, medium invisible and the long invisible spectral band. As far as night enablement are concerned, BEL is the only company in India which addresses the entire spectrum of night enablement that includes II, uncooled TI and cooled TI both in the 3μ to 5μ and 8μ to 12μ wavelength in the Indian scenario. BEL does this under the guidance of DRDO through Transfer of Technology arrangements and in-house development. BEL also has integrated sights with LFRs and also developed indigenous Laser Target Designators (LTDs). As far as manufacturing of Night Vision Devices in

India are concerned, it is being manufactured in four factories with capability to expand further depending upon the demands and needs of the customer.

In terms of deliveries, BEL's performance in II based NVDs, BEL has delivered 25,916 devices and is in the process of delivering 30,634 more NVDs which are II based to the Indian Army. BEL has taken baby steps as far as uncooled TI sights are concerned which are also totally indigenously developed. BEL has also delivered around sixty weapon sights for snipers, INSAS and hand held devices. As far as cooled TI sights are concerned, under license manufactured through ToT, BEL has manufactured a total of 7,593, of which 554 indigenous TI camera/devices are being delivered and a quantity of 10,000 based on indigenous TI sights whether it is DRDO based or BEL's in-house development is the future projection.

Covering II based NVDs, what is manufactured at Belop "Multi Alkali (under production) where the typical figure of merit is 1400 where BEL provides the tube with normal and autogated power supply. What is scheduled is "Multi Alkali (scheduled)" which provides minimum figures of merit of 1600 and a typical 1700 with autogated tubes. One can see that what BEL is manufacturing at Belop is comparable to Omni VI and Omni VII which have figure of merit of 1600 and 1792 respectively.

What is permitted to export to India is 1250 as the maximum figure of merit. Devices with 1400 figure of merit fitted with non-autogated power supply can be exported to India but under induced monitoring. However, even though, the Photocathode response of Gen 3 is higher than XD-4, due to Ion Barrier Film on MCP, the Gen 3 tube which is exportable to India has lower Signal to Noise Ratio than XD-4 tube which is manufactured at Belop.

What BEL and DRDO are doing for the future is trying to come up a fusion technology by fusing II and TI based NVDs which will not only enable better night sight but also enable sharing among soldiers. However, the challenge on areas such as power, size and weight remains. The fusion of both technologies would merge the strengths of image intensification which will be clear, sharp green-tinted picture with an advantage of

infra-red which in turn will enable to see practically under any environmental conditions resulting in enhanced NVD.

Advanced Technologies of Image Intensifiers Industry over the Last Decade – Mr. Mark Blats, Business Development Technical Director, Harder Digital

Harder Digital is a Germany based industry that deals mainly in image intensifier tubes and products mainly for the military market. Gen 3 Image Intensifier Tubes was developed thirty to forty-five years ago. However, Harder Digital started manufacturing Gen 3 image intensifier tubes only a decade ago. Gen 3 image intensifier tubes can be divided into four main parts:

1. GaAs Wafers
2. Photo-Cathode activation process
3. Ion-Barrier Film and decontamination process
4. Generation III compatible Image Intensifiers MCPs

All these four parameters have certain influence on the quality of Gen 3 tube. As far as GaAs Wafers is concerned, today's industry can cover any quantity and any sort of quality in any production line. One can see the increase in the use of GaAs wafers in the production of high quality goods over the years. As such, Harder Digital is also adopting this technology to produce high quality specialised products. Other elements in the use of this technology are that it can result in highly uniform products with repeatability quality. The availability of test methodology and equipment also results in the quality of productivity, which in turn affects the quality of the products. In this case image intensifier tubes.

This only shows that various companies in this particular industry are investing a substantial amount of capital in trying to enhance the capability of Photo-Cathode activation from 1000μ to 3500μ.

The Ion-Barrier Film and decontamination processing is a very important aspect in enhancing Gen 3 tubes because of the fact that it plays a very major role that affects the signal to noise ratio of the tube. Initially the influence of Ion-Barrier on the tube was

about 30 percent. In the present times, the Ion-Barrier could be brought down to as low as 15 percent. It is important to note here the lesser the influence of Ion-Barrier on the tube, the better it is in terms of signal to noise ratio.

Harder digital has decided not to make own facility for Wafers as it is readily available in the open market and manufacturing GaAs Wafers is extremely costly; such huge investment for medium sized company such as Harder Digital is just not possible. On the other hand, manufacturing of MCPs is important because the development of MCPs is done primarily for image intensifiers and MCP is a critical element that company like Harder Digital must have. The developments of MCPs are carried out with Gen 3 tube compatibility in mind and for extending life of the device.

Harder Digital has entered into alliance with Tata Strategic Electronic Division and have signed a Memorandum of Understanding with the following objectives:

- Delivery of Gen 3 High FOM Image Intensifier Tubes for India MoD in large volume.
- ToT for Gen III High FOM Image Intensifier Tubes handling and measurements including delivery of State-of-the-art Testing and Inspection equipment, local assembly, repair and full maintenance line along with full transfer of technology for manufacturing of Image Intensifier Tubes.

Industry Perspective: Mr. Eric Garris, Lead Engineer Research & Development, Exelis

The working of NVDs is described as follows:

Monocular lens focuses the few photons available in darkness onto an intensifier tube, which is under vacuum. Inside, a photocathode converts photons to electrons. A voltage accelerates the electrons to the micro channel plate only a few thousandths of an inch away. The plates multiply the electrons, and a second voltage accelerates them to the phosphor screen and then again it converts electrons into photons that reach the eye-piece.

Micro channel plate has millions of tiny, slanted channels. Electrons enter and bounce off channel walls. Each collision produces two to three more electrons, multiplying the initial number many times. A film prevents positive ions created by some collision from streaming back to the photocathode, which would degrade it. A voltage across the plate moves electrons through the micro channels.

Photocathode layers, only a few microns thick are struck by photons. Their energy kicks out electrons. Gallium arsenide responds strongly to the predominantly red and near infrared frequencies of light radiated by the night sky.

In retrospect, generation 0 of image intensifier began production in the 1950s. It typically used an S-1 photocathode with peak response in the blue-green region (with a photosensitivity of 60 μA/Im), electrostatic inversion, and electron acceleration to achieve gain. Consequently, Gen 0 tubes are characterised by the presence of geometric distortion and the need for active infrared illumination.

Generation I of Image Intensifier began production in the 1960s. It typically uses an S-20 photocathode (with photosensitivity of 180-200 μA/Im), electrostatic inversion, and electron acceleration to achieve gain. Gen I is characterised by geometric distortion, performance at low light levels, and blooming.

Generation II of Image Intensifier began in the 1970s. Usually an S-25 (extended red) photocathode (with photocathode of 240+ μA/Im and a microchannel plate to achieve gain). Gen II tubes provide satisfactory performance at low light levels and exhibit low distortion.

Generation III of Image intensifier began in the 1980s. It uses gallium arsenide for the photocathode and a micro channel plate for gain. Gen III tube Produces more than 800 μA/Im in the 450 to 950 nanometer (near-infrared) region of the spectrum. Gen III provides very good to excellent low-light-level performance, and long tube life.

Some of the major advantages of Gen III Image Intensifiers are:

- Reliability – There are key design features that enable a long, high-performance operational capability. On the contrary, Gen II tube's performance degrades faster than widely published when evaluated at Gen III standards.
- Environmental Stability – Gen III Image intensifiers have the capability to survive much higher storage temperatures with a more stable tube housing material.
- Luminous Gain – Higher for better low light performance.

i-Aware is a state of art night vision goggle technology enhancing the situational awareness of the soldier, marine, and special operative by providing import/export capability for information and imagery with proven Gen III image intensification.

i-Aware is relevant in the present times because the future battle requires more utility from a night vision goggle than just seeing in the dark. The network-centric, digital battlefield offers rich situational awareness information to enhance small unit operations. The soldier is a source of information via their night vision goggle imagery. Information import and export to soldiers during small unit operations at night maintains light security discipline and maximize weapon readiness. Finally, Exelis has listened to the soldier's needs and has provided a solution with i-Aware products.

Remarks by the Chairperson, Lt Gen Aditya Singh PVSM, AVSM (Retd), former GOC-in-C Southern Command**

In the discourse of Night Vision Devices (NVD), the discussions are not to be confined to individual level as NVDs are a part of the overall system. When one dwells on technology and NVDs, one cannot but look in retrospect of how far technology has advanced from the then analogue devices to the more contemporary ones where one can record and play around with the content. However, digitalisation and how it can be made a part of the system needs to be analysed. There were major advances as regards to NVDs but in the context of India, there is a failure on the part of the establishment to procure such advance devices due to various processes in acquiring such devices for India's armed forces. Therefore, by the time such equipment is procured there would be another more advanced version. As such, as regards to such technologically sensitive devices such as NVDs, time-line is of prime importance.

Another important aspect in the discourse of NVDs is that user is a very essential aspect, as the user will drive the process. However, in order for the user to drive the process, he must at least understand the challenges so that those challenges drive the scientist and the technologist to a solution and address the various issues such as size, power requirements, weight, resolution both for the detectors, the sensors, optics, signal to noise ratio, clarity among other parameters. These NVDs are also to be able to operate autonomously where they can digitally detect and record as humans are subject to strain, fatigue and exhaustion.

The chair also noted that the aspect of situational awareness is as important and a part of the system which will not only help in seeing what is around but also recording of the events as a part of the evidence to be produced at a later stage. There is also a need of striking a balance between weapon system and the device itself. However, the speaker urges the people who are entrusted with process of procurement to be aware of the technology, which is at vogue.

Discussion:

Mr. Garris was challenged on his statement on the lifetime durability of XR5. He responded by saying that the running and re-runs of the data of the said device under test conditions of US Military-spec proves his argument. He was also challenged to prove his presentation on the diminishing life cycle of the Gen II device over Gen III device. On this also, Mr. Garris responded by saying that his arguments were based on test conditions conducted under US military specifications.

The discussion also included queries about Gen 3 device’s figure of merit and what range of figure of merit can India import with monitoring and without monitoring. It was stated that India could import devices up to 1250 figure of merit without monitoring while devices with figure of merit 1400 and above can be imported with induced monitoring. It was also stated that devices with a merit figure of 1700 were for the US military but could be imported to India with induced monitoring. There were also queries about visible difference in performance of devices with lower figure of merit with a much higher

numeric. It was stated that the difference is not visible with the naked eye; however, the difference could be identified after processing and was in the range of 10 per cent.

Session III: Night Air Combat and Support Operations

Opening Remarks: Brig Gurmeet Kanwal, (Retd)

Night vision devices enable gaining of moral ascendancy in battle. The saying that “he who owns the night owns the battlefield” is true. The example of bin Laden’s killing was cited. The Revolution in Military Affairs (RMA) came home when a US operator guided an SUV in Yemen killing 3 terrorists and their leader.

Night Air Operations: AVM Manmohan Bahadur, VM, ACIDS (PP and FS)

The first aerial bombing was by Italy in 1911 during the Italo-Turkish War. Recently it was carried out in Libya. The Chicago Tribune had stated that bombing by air is historical. The examples were given of Korean and Vietnamese wars, RMA in 1980s Libya 2011, and modern advancements affecting aviation. Ground strafing occurred in night for the first time in California 1937. Target was lit. Defensive counter-air techniques involved searchlights and fire, and were used throughout the decade. Night interception was made possible by the F-67. A combination of flares was adopted to illuminate the target but bombs at high altitude got illuminated as well.

Developments in night-fighting capabilities were made during the period of 1941-52, i.e. of World War II and the Korean War. A passage was quoted to support the efforts and observations made in the USA regarding air combat at night which stated that night combat made warfare costly in terms of damage inflicted. The same, however, was not observed in the Korean War. It was not accurate and effective. Night attacks required to be within the control range of ground radars which was necessary to make it accurate and effective. In the Korean War night attacks acquired a supporting role but were not totally effective. During World War II battlefield air strikes had been non-existent, but in the Korean War were assisted with the help of radars. 25 per cent of attacks were made at night but could only harass the enemy.

The trend continued during the Vietnam War as well but with improvements, in terms of the ground-mapping radar. Other equipment remained ineffective. North Vietnamese moved equipment and conducted repairs during the night. Videos were shown demonstrating the RMA of 1980s in terms of precision weapons and night capability as witnessed in the attacks on Tripoli and Benghazi in Libya in 1986. Enhanced NVGs can see through smoke, IR sensors and in absence of light. There are synthetic vision systems developed for transport aircraft and UAVs. The digital databank is not restricted by the available view as it can construct a digital version of the entire available battlefield.

In Libya in 2011, 26000 sorties were made, of which 400 were by helicopters. SAR pods, GMTI aspects and ISR using satellite imaging sent back imagery in real time. However, face-to-face debriefs remained important. UN operations require NV capability as in inescapable requirement as insurgents are scared of air attacks and are particularly petrified of attacking helicopters. NV provides great asymmetry but requires intensive training, and is able to utilize a greater part of the spectrum and hybrid synthetic technology.

Army Aviation: Supporting Night Operations: Maj Gen PK Bharali, VSM, ADG Army Aviation

There are differences between fighting and supporting. Main equipment of Army Aviation is helicopters and supporting operations by them are part of combined arms operations. Helicopters are integral components of a combined arms team. No infrastructure is required for them and they can be used anywhere. Useful technical characteristics include slow speed to go along with ground forces, overcoming of obstacles of terrain by being in air and extreme mobility during ground operations. Additions of guns, rockets, missiles and bombs convert helicopters into air-borne attack platforms. They can also be used for surveillance only. If the commander is placed inside then they can be employed as an aerial command post.

Army helicopters are used for transport and as part of massing of forces and fire by the commander through the use of attack helicopters and gunships. They fit in the time and

space management by the commander. Main support is provided by helicopters to the basic unit of the army-the section. They can be multiplied in numbers to fulfill the requirements of a larger force. Sorties are made from a height or from a forward helipad. Very little infrastructure is required for them and helicopters can be maintained there.

Helicopters are used in conventional or 4th generation warfare against non-state actors at section/platoon/company level. For night operations, systems (sensors) are required for operational actions like take-off, navigation, reaching the area of operation, manoeuvre and engagement of the enemy, coming back and going for another mission. Sensors make the electronic data available to the pilot in the terms he can understand. Other requirements for night operations are systems necessitating flight safety, improved survivability, IR suppressors and jammers.

System architecture includes AFCS, TAWS, and FLIR; Human- Machine Interface (HMI), and NV goggles. Lighting is required inside the pilot's cabin to obtain image clarity. Other systems needed are search, spot, lip, and finger lights and brightness memory. The helicopter can fulfill special user requirements through light weight, optimal performance, simplicity and cost. It was highlighted that "Army Aviation is all about soldiering in the Air".

Mechanised Forces in Night Operations: Brigadier AP Dere, DDG (Equipment)

Previously 300-400 m of sight was available at night-time by NVDs. Now night fighting capabilities require the building and smooth integration of technology. Important issues related to these are the availability and use of cooled technology, gunner and commander sights for tanks, night-enabling image intensifiers and thermal sights.

Thermal sights can be cooled or uncooled and are judged in terms of their parts, materials, bands at which they operate and the working environment for which they are required. Requisite materials for achieving the above have been employed by companies in USA, France and India. In India however more improvements are needed and most importantly it has to be judged what is exactly required.

Current AFVs in sights should be seen in terms of mission reliability, capacity building and procurement of critical technology. Panoramic sights are required for the commander integrated with the gunner. The driver of the tank also needs limited-range sights. Critical technology at optimum level is needed but one should be careful of critical benchmarks, and issues of ventures, imports and medium and long term requirements. Indigenous Research and Development is also to be looked at as well as in terms of where India stands. R and D in India with regard to uncooled technology also have to be seen.

Challenges include the availability of critical technology as it is not easy. Also, issues regarding procurement are tied along the fact that the process is frightfully long and by the time the procurement is cleared and obtained, the technology becomes obsolete. The requirements of systems and technology have to be seen in terms of their being successfully integrated with the existing systems or infrastructure. They should be capable of technical absorption that is being imported. Private industrial involvement has to be judged in terms of what it can provide regarding the requisite technology. Important questions related to these that need to be addressed are whether serious integration of the technology obtained is possible with the existing equipment in India, and whether we are capable of maintaining it.

Imperatives to be addressed are the procurement of current technology with future upgrades, and the scope for the same in joint ventures with foreign vendors, offsets that are optimised to obtain current technology, transfer of technology including software, protocols, and codes and replication of OEM-mandated production protocols. Allied aspects are the operational, training and human resource aspects.

Procurement Issues: Lt Gen Vinay Sharma, PVSM, SM, VSM (Retd), former MGO

The budget comprises of the capital and revenue budgets, of which the capital one is more “glamorous”. The MGO deals with the inventory management of the army. This involves the procurement of indigenous and foreign equipment, import-export, maintenance, repairs and availability of spares. The aim of the MGO is to sustain the

army in war and peace at all times, i.e. to maintain the operational readiness of the army from the equipment point of view.

The procurement policy for the army focuses on obtaining equipment from a variety of sources, one of which was the erstwhile USSR. A lot of inventory is employed over a diverse terrain and operational areas. Capital acquisition occurs through the capital route and under the capital head comes that equipment that is to be introduced in the army. The Ministries of Defence and Finance continue to state that revenue budget should be reduced but it is not possible because of the need for constant maintenance of spares. Therefore, a mismatch in policy exists between the Army and the Defence Ministry.

Ideally, the percentage of the state-of-the-art equipment should be 30 per cent but at present the army has only 15 per cent. A 'womb to tomb' system of equipment management is followed. No procurements can be generic, and bottom-line requirements should be laid for design and development agencies.

There should be greater investments in R and D. The perspective on RoI (Return on Investment) cannot be the same as it is viewed in the civil sector. There is a need to synergise earlier systems and the issues of in-service exploitation and maintenance, as the rigmarole of trying to get spares as wear and tear appears presents itself. The question of Transfer of Technology (ToT) also has to be addressed in all its aspects.

Discussion Session III

- The use of effective lasers for light illumination, so far only thermal imaging has worked and other NVDs have been rejected by the troops on the ground. The future involves a greater use of FLIR and NVG.
- Procurement policies in the Air Force and the Army. There is a need to streamline procedures for making SQRs. Procurement has a major effect on operational preparedness.
- The development of ATM and induction of Rudra into Army Aviation and of pilots into attack helicopter units. DRDO had begun the Nag ATM project in 2003 but gave up in 2009. Now working on Helina project for helicopters and hopefully

would complete it by 2015. A lot has been done on the selection of pilots for attack helicopters. Presently selection process carried out in other countries is also being looked at.

- Process of procurement in the Air Force. New system created in 2008 in Air HQ. A full cell devoted to acquisition process created in the Deputy Air Chief's branch.

Session IV: Countering the Threat

This session gave an overview of the existing challenges which face the security forces guarding our land borders as also camouflage and concealment measures which can be taken to reduce the impact of hostile night vision devices. The need to enable our forces with respect to night vision capability and measures to achieve indigenous capability was also discussed.

Enhancing Border Surveillance: Mr JB Sangwan, DIG (Training), HQ BSF.

India with its fifteen thousand kilometers of land borders faces multifarious challenges in border management. The land borders with Pakistan and Bangladesh are guarded by the BSF and this accounts for 45 per cent of the total land borders of the country. It is thus imperative that the Central Armed Police Forces are provided the means to effectively guard our borders. The challenges being faced on the borders are as under: -

- Infiltration attempts (supported by fire) from across the western border, especially in Jammu and Punjab.
- Planting of IEDs and sabotage activities along the western border.
- Increased activities of fundamentalist & militant groups in border areas.
- Smuggling of narcotics, arms and explosives.
- Exfiltration of Bangladesh nationals in to India.
- Presence of Indian insurgent groups in Bangladesh.
- Movement of terrorists using Bangladeshi territory for transit.
- Illegal migration/human trafficking.
- Smuggling of cattle.

- Outstanding boundary issues.

Present border management involves deployment of a large number of people. These troops need to be equipped with a modern night vision devices in adequate numbers to enhance capability. Most devices in current were procured 20 to 30 years ago and are technologically obsolescent and not user friendly.

Border out posts contribute to the surveillance and domination by virtue of their location in the border areas and physical presence of force personnel. Observation posts are located in the large gaps between border outposts and are manned in shifts, generally in pairs. Earlier, the posts were 10 to 15 km apart away but now they are sited closer to cater to increased infiltration attempts being made by terrorists from Pakistan. Patrolling is being carried out by means of horse, camel, vehicle, motorcycle, boat, cycle and on foot. “Naka” is a small body of troops, which is deputed at assigned positions close to the border to keep vigil at night and to take preventive actions with the use of fire arms in self defence. They have no effective night vision devices.

Currently the force uses monocular and binocular devices (25 to 30 years old). These are ineffective in pitch-dark conditions and are not user friendly. Though hand held thermal imagers enjoy a good reputation amongst the troops but it is costly equipment with a limited life, inadequate in number and is also ineffective in foggy weather. Lorros is effective for medium and long-range observation but a single man cannot handle and operate the system. Similarly, BFSR also requires a technical hand to operate. HHTIs also have a prolonged repair cycle which lasts for almost a year as repair facilities are located in the Southern portion of the country. Establishment of surveillance grid in the Jammu region, which has a monitoring system, has however reduced infiltration to a considerable extent. Some recommendations are as under: -

- TIs should be made more users friendly.
- PNVDs should be lightweight, have a long power backup and be robust.
- Cycle of maintenance should be reduced.
- Indigenous manufacture should lead to cost reduction.

- PNVDs should have a recording system for effective monitoring at the ground level.

Camouflage and Concealment against Night Vision Capable Platforms: Maj Gen Rakesh Bassi, SM, Director General of Combat Engineers, Engineer-in-Chief's Branch

From earlier times when observation and surveillance was centred on the visible spectrum, technology now enables tremendous night vision capability. However, the cat and mouse game between sensors and counter measures is never ending which in turn has enhanced the process of evolution of devices from sniper devices used in World War II to forward looking infrared of the present era. The Iraqi invasion of Kuwait and US efforts in Afghanistan have substantiated beyond doubt that the possession of night vision devices can act as a force multiplier.

The detection and identification technology of TIR, NIR, UV, VIS and RADAR, has given rise to 2nd and 3rd generation equipment being used for low cost and high resolution power. All objects emit infrared energy and image identification technique is based on function of temperature. It can sense temperatures ranging from -20 to 2000 degree Celsius, which in turn helps in eliciting IR signatures of military equipment. It gives the thermal image of the object (black and white in nature). Most critical targets display a contrast due to difference in temperature which leads to its detection. In the case of radars, target signatures obtained by these are more complex. Infra-red details are more dynamic in nature and change with the environment and the movement of objects. Several mechanisms come into play to finally yield the image of the equipment. For instance, the aircraft has radiation from solar insulation from outside, skin, top of the aircraft, reflection of the sky and base of the aircraft receiving heat from the ground. These together form the IR signature of the aircraft.

Counter Measures against Night Vision Devices:

In the visible spectrum, techniques used are to blend with the surroundings and use natural camouflage. In infrared spectrum, procedure is to reduce emissivity and reflectance to hide or distort the signature. For thermal spectrum, techniques used pertain to screening to diminish heat radiation, creation of thermal signatures compatible with the environment and use of liquid nitrogen. It is impossible to cover the entire electromagnetic spectrum because of the economic and functional non-viability. Use of camouflage devices and other measures does not eliminate chances of detection but only reduces it. It is upon the user to decide a spectral range in which a particular camouflage would prove effective.

Camouflage Equipment and Measures

- Synthetic Camouflage and Multi Spectral Camouflage nets
- Infrared Reflectant and multi spectral camouflage paints
- Low Emissive Coating
- Personal Camouflage Ghille AND Mobile Camouflage System
- Sniper, Ponchos and personal Screens
- Smoke

Future techniques

a) Use of nanotechnology - US army experts have introduced microscopic, electromagnetic molecules in paints, which can detect corrosion in vehicles. Therefore, the user can choose effective paints for concealment

b) Meta material- It produces an illusion of invisibility by refracting light in a negative angle.

c) E- camouflage- It allows the tank to disappear in the background. It merges the tank and background into one.

Light weight cam system-It is a net in areas which are large and have no head cover like vast grasslands. These are radar transparent.

e) Plasma stealth technology-It offers protection against radar and thermal detection techniques. It leads to the formation of plasma clouds consisting of highly charged particles around the equipment and helps in concealment.

In conclusion, modern techniques in night vision have to provide a multi spectral approach. Technology aside, it also requires the discipline and imagination of the user.

Enhancing capability to counter threats: Mr. Rahul Chaudhry, CEO Tata Power Strategic Electronics Division

TATA power has a reputation of being involved in R&D regarding defence production. They have had more than four decades of partnership with MoD, Armed Forces, DPSU & DRDO for development and supply of state-of-art systems. They have offered integrated design to production capability of specific domain expertise in the areas of Air Defence, Electronic Warfare, Command & Control, Tank & Gun Ballistics and Service Control & Drive electronics for platform positioning & tracking.

They have been behind the development of Samyukta Electronic warfare system and APJ Abdul Kalam had assigned the task of providing control complex for the nuclear submarine to TATA. They also leverage core technologies of foreign partners to realise

products of Indian armed forces. Breaking the denial regime around the night vision device in India, Tata Power has confirmed the readiness of Gen 3 II tubes with FOM: 1700 and are only waiting for an open tender. Tender specifications should be made keeping in mind the time frame; any tenders passed today will lead to the induction of NVDs only in 3 to 4 years. It is imperative to highlight the limitation of Gen 2 NVDs in time to upgrade our systems (Gen 2 NVDs will work for 27 days in a month and 8 months in a year and will not work in the jungles of North East India). Our neighbouring countries have already advanced towards Gen 3 NVDs. Worldwide trend for NV tenders show that advanced armies have already moved towards Gen 3, FOM: 1600 technology. Therefore, at this instance, for India, cost should not become a strategic condition, the 30 per cent increase in price of the Gen 3 II tubes will be compensated by its superior capability in starlight/overcast/monsoon conditions over a 15-year life cycle.

Recommendations:

End Use monitoring system is a sovereign issue between India and the US Government. The should be no need to reveal the location of our armed forces equipped with night vision devices to US.

As per the DPP policy only OEMs to be allowed to respond to NVD tenders.

Discussion Session IV:

(a) The kind of sensors and counter measures has to be determined by battle-field requirements; therefore cost effectiveness loses its significance

(b) Defence preparedness cannot be compromised for the sake of ideals.

(c)The denial regime around the night vision devices needs rethinking.

(d) Tata Power SED urged to break the monopoly and being given chance to go ahead with the production of Gen 3 tubes, the technical aspect(night vision devices).

Concluding Remarks of the Chairperson: Maj Gen Dhruv C Katoch, SM, VSM, (Retd), Director, CLAWS

There needs to be a greater degree of involvement of Indian industries in Defence production. The fact that we have large borders and quantity of equipment we require is large indicates that the cost is going to be high. However, a lack defence preparedness may cost the nation far more in terms of people infiltrating from all corners and wreaking havoc in this country. Long lead time taken to repair equipment needs urgent attention. Similarly, question of power back up is also a major issue and needs to be dealt with in the most efficient manner. Protective camouflage and concealment technologies need to be used based on critical vulnerabilities.

Valedictory Address: Lt Gen Narendar Singh, AVSM, SM, VSM, DCOAS (P&S)

Enhancement of night vision devices is a very contemporary issue and a great deal needs to be done in this regard. Ever changing nature of war, for example, irregular forms of warfare, proxy wars, and sub conventional warfare has necessitated a relook at war fighting techniques, organisation structure, and equipment resulting in a paradigm shift in our response. India has to innovate new strategies in the wake of new threats. Across the conflict spectrum, the revolution in military affairs has affected the way in which sensor technologies, computing system, satellites and communication systems function and allow an omniscient view of battlefield thus challenging the fog of war. We need to equip our forces after reviewing their requirements. There is a need to procure the latest equipment in a progressive manner to make the troops more self-reliant. No cost is as high as the security of the nation.