CENTRE FOR JOINT WARFARE STUDIES

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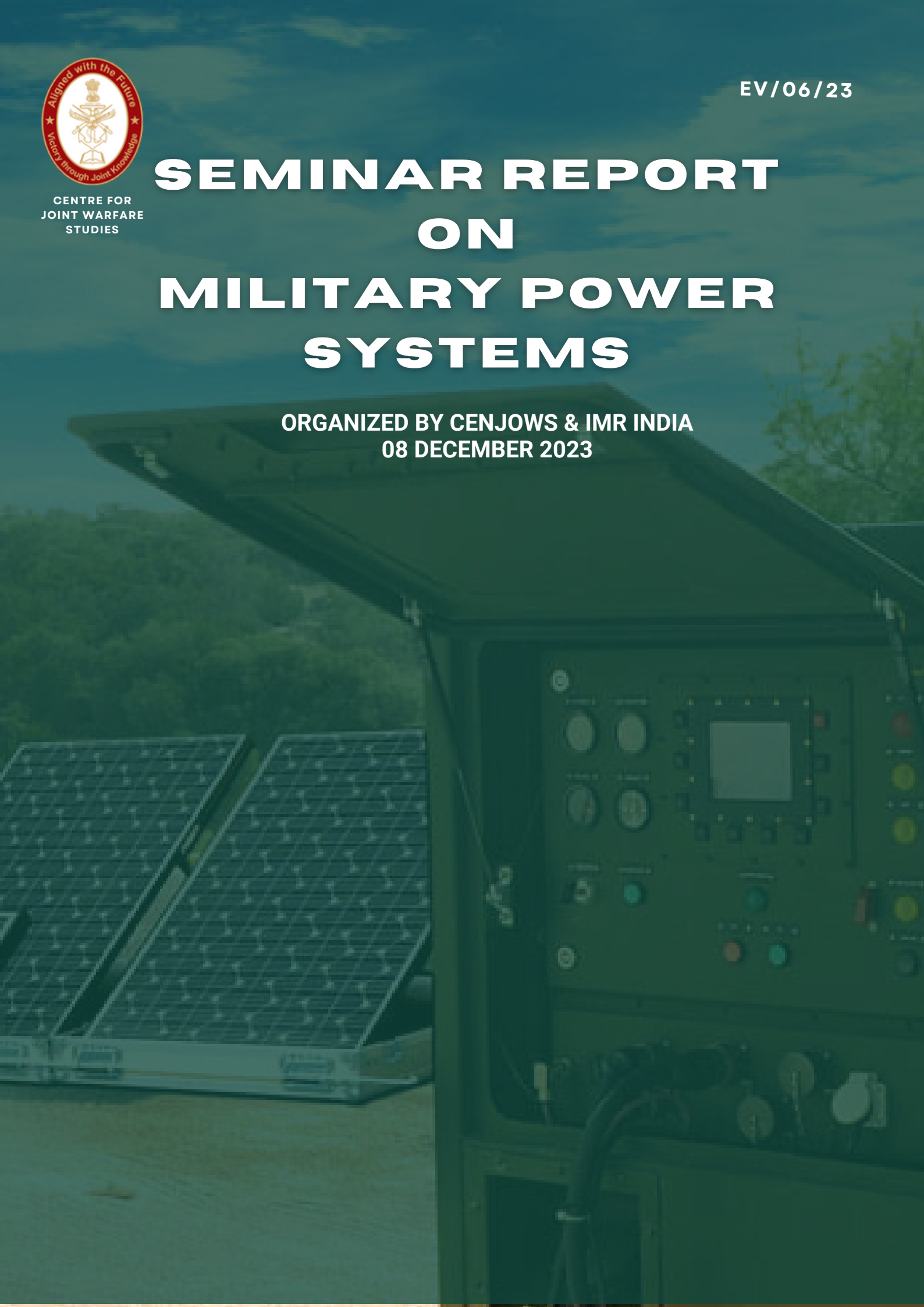
SEMINAR REPORT ON MILITARY POWER SYSTEMS

ORGANIZED BY CENJOWS & IMR INDIA
08 DECEMBER 2023



SEMINAR REPORT

MILITARY POWER SYSTEMS

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The Centre for Joint Warfare Studies (CENJOWS), in collaboration with Indian Military Review (IMR), hosted a conference on "MILITARY POWER SYSTEMS" on December 8, 2023. The event was conducted in New Delhi's Manekshaw Centre. Prominent panelists in the conference comprised senior serving members from tri-services, representatives from DRDO, and industry representatives. The seminar offered an environment for the industry to interact with the armed forces to understand their Power System reqirement and obtain information about their standards so that they model their expertise while flourishing. The session also informed the audience about technical advancements achieved by the industry and DRDO, and the design bureaus under the respective service wings in the field of power systems in addition to the limitations they address. The seminar was conducted in four sessions.

SESSION 1: INAUGRAL SESSION

Lt Gen Sunil Srivastava, AVSM, VSM (Retd), Director CENJOWS**, felicitated the speakers, panelists, attendees, serving and former military members in his welcoming comments. He expanded on the seminar's subject and remarked that the deliverables are not visible as far as military power systems are concerned. In case of propulsive power, the dialogues within parties are going on regarding the GE 414 engine for the advanced medium combat aircraft. For developing and designing helicopter engines, light tanks, we are partnering to develop the core of the engines. Coming to the indigenous unmanned platforms, indigenous gas turbine diesel engines, air independent propulsion systems for surface platforms of the Indian Navy, he alluded that the work is under progress. He advocated on the feasibility of electric propulsion as a parallel technology for propulsion. Even for aircraft carriers like the Queen Elizabeth Class, he referred to the Britishers switching to electric focus propulsions, Americans having moved to aircraft launch electric systems for destroyers like the Zumwalt class. There are electromagnetic rail guns for directed energy weapons on ships. For supercapacitors and batteries, he referred to flexible batteries being put along with the aircrafts. Research and development is coursing through, with experimentations being carried out with entirely EVT oil electric systems, for a smaller and lighter categories. In the case of our dams, the R&D is taking forward an approach of a hybrid design. For lethality, survivability, mobility, power is an essential requirement especially, keeping in mind the kind of varied environmental conditions like super high altitudes and warm areas of the deserts, in which we operate.Hence the conditions are varied in which we have to employ our systems, thus the requirements for power systems are likely to be extreme.The direction in which everybody is moving towards lies in swap C2 size, weight, cost and cooling, and futuristic trends would pertain

towards interchangeablility and interoperability. The variability and the volume of these power systems, comes in with their own peculiar power source. At present, we need to harmonize and find solutions to leverage advanced materials, technology in delivering smart power solutions. The military requirements currently includes power scavenging, power energy harvesting, wireless and beam base charging. There is also a requirement for wave based propulsion for the unmanned systems.

Vice Adm Sandeep Naithani, AVSM, VSM, Chief of Materiel, Naval HQ, delivered the inaugural address stating that the Indian Navy has made various sub-domains of military power where they are seeking broad ideas of collaborations within the industry. Our military power systems at present are technologically advanced and serve as the backbone of all major systems onboard, like weapons, sensors, communications and machine control systems. From forward operating bases to the naval vessels, the efficiency and effectiveness of our military operations hinge upon the strength and adaptability of the state of the art power generators and the security systems. The Indian Navy has shown an unparalleled growth in power generation capillaries, wherein the capacitiesin developing domestic R&D ecosystem for lithium and technology for naval platforms, the ships have varied from a few 100 kilowatts to generating many megawatts.To put things in perspective, he gave the casestudy of INS Vikrant that generates 24 megawatts of electric power which is sufficient to fulfill the energy needs of the street lighting of Chennai. Power generation in the Indian Navy, includes steam engines, diesel engines, gas turbines, batteries and also nuclear technology. Apart from the management of power being generated onboard, shipsare now planning to switch from the manual to fully automated systems. However, the Navy have not been able to fully develop a completely unmanned support systems, like the merchant ships, with respect to the reliability of the automated systems. This is also an area where the Indian Navy would like industry partners to augment efforts toward developing intelligent power management systems, which should be fully automated. In a quest for keeping pace with contemporary technologies, intelligent power switching devices, automatic transfer switches have already been inducted in the Navy for mission critical equipment. Another key technology being pursued by the Navy in the domain of military power systems is the inertial energy storage system for IESS. A practical use for this technology would be the availability of backup for critical machine systems like the scaling gear onboard ships. Availability of space is of great concern for ships and submarines. Therefore, the Navy has engaged with technology startups working in the field of rotating machinery and development of an axial flux motor. Batteries are also another important part of the Indian naval inventory and are critical during Summers. Therefore Navy is planning to get into lithium batteries which are smaller in size and are more energy efficient. Another issue which is important is the timely testing, tuning and repair through a robust and effective maintenance infrastructure. For this, the Navy has set up a unit, which is called electrical

trials and maintenance authority, or ETMA, based in Mumbai. The satellite units of Vizag, Kochi and Calcutta,are responsible for setting up standards and the specification of all naval electrical equipments. He concluded by mentioning that automatic power management systems still remains an area for grave concern for the Indian Navy.

Lt Gen Sanjay Verma - Keynote Address. The keynote address was given by Lt Gen Sanjay Verma, PVSM, AVSM, VSM** (Retd), Consultant DRDO and Former DG WE. The speaker began by expressing appreciation for Aatmanirbharta (self-reliance) and emphasized the need to move beyond fossil fuels in both the commercial and military sectors. Referring discussions at the COP 20 Summit in Dubai, he highlighted the imperative to reduce dependency on fossil fuels, citing recent positive developments, including the progress of solar and wind power in Gujarat and the geothermal potential in Puga Valley. These advancements were deemed crucial for addressing challenges in the military system, such as safety, long storage capacity, and operation in diverse terrains. Continuing, the speaker emphasized that technological development hinges on discovering new materials and power systems, stressing the importance of keeping pace with better and advanced materials. The need for an intelligent power management system was underscored, and the inclusion of supercapacitors in military systems to meet pulse power and continuous power requirements was discussed. Supercapacitor, that is another area which is going to ignite the storage capacity and the reduction of conventional electrical energy. Concluding the talk, the speaker highlighted the proactive approach of the Indian Army and defense forces in dealing with these challenges, citing examples such as the militarization of electrical modules and successful aircraft testing. This demonstrated the commitment to advancing technology and addressing the evolving needs of the military infrastructure.

Col KV Kuber (Retd), Director Defence and Aerospace, E&Y. The industry perspective was given by Col K V Kuber. The speaker initiated the discussion by highlighting the heavy dependence of military operations on power systems, citing the Israel-Ukraine war as an example. Global developments, including China's sterling engine and its adoption by farmers in Punjab, were discussed, along with insights into U.S.-based Interhoc engines working on hybrid fuel. He stressed on the need to see how we can master that type of technology while China has actually introduced it into space as they have been building a long range hybrid electric vehicle, vertical takeoff and landing demonstrated the technology for the future of military operations. Citing one of the prime examples, he alluded to the growth of the telecom industry that led to a lot of investments in renewable energy. To accommodate 5G and 6G for a seamlessly integrated battlefield, advanced testing of some of these power systems as the future of the communication technologies should be given importance. The liberalization of the power market and digitalization of the power sector were emphasized. The integration of renewable energy and innovative

battery solutions, particularly in scaling up, was a key point. The speaker delved into considerations for both the commercial market and military systems, underscoring the need to capitalize on capable energy and support private companies through strategic funding. The discussion expanded to small modular reactors, presenting them as transformative for power systems. Cybersecurity concerns were raised, and the speaker touched upon PRL, MRL, and TRL levels, highlighting foreign collaborations with DRDO. Concluding, the speaker emphasized on Aatmanirbharta at the fundamental level, focusing on material, power, and chemistry, asserting the indispensable role of power systems for India's advancement.

SESSION 2: POWER PACKS AND STORAGE SYSTEMS FOR LAND SYSTEMS AND COMMS

Session 2 was chaired by **Brig PS Sidhu, Brig Tac C, Signals Directorate**, Army **HQ**. The chairperson started the session with his introductory remarks highlighting that how the armed forces are been driven by technology and its importance in the modern warfare by drawing reference from the Russia-Ukraine War and Israel-Hamas conflict. The chair higlighted that the technology supremacy cannot be underestimated and there is a requirement of developing the power packs and storage systems for land sysytems and communication sysytem. He mentioned about the groundbreaking inventions that have started to take place concerning lithium-ion batteries. These lithium batteries are rechargeable and have high-density solutions. He also highlighted that presently although the Indian Army is exploring these batteries, they are also considering solid lithium-ion batteries to ensure maximum safety for the soldiers. He highlighted that how the US has learnt from its mistakes in Afghanistan and switched to solar panels as a source of power to enhance its military power systems. He concluded that power systems in the future demand solutions to the existing challenges and facilitate the need for efficient and effective power management for soldiers and battle management systems.

The 1st speaker **Brig JS Sidhu, Brig (T&WS)** from the **Army Design** Bureau covered the challenges in meeting power requirement for Land Forces.Brig JS Sidhu started by presenting a brief overview of India’s Operational Environment characterized by diverse terrain. He highlighted the need for effective power solutions keeping in mind the operational environment in which the land forces are operating. He cited varied power requirements, power storage equipment, weight, survivability, logistics burden, budgetary constraints and environmental concerns as challenges to power and energy sources for the Indian Army. Additionally, he flagged how Robotics Systems require essential high-performing batteries and UAVs face the dual problem of endurance v/s payload take-off, indicating the need for motors. Brig Sidhu detailed out the requirements for soldier wearables, weapons, surveillance, communication equipment, communication centres,

UAVs and munitions, rockets and missiles and flagged the need to develop indigenous capabilities referring to China's success in BLDC motors for aerial platforms. He also mentioned the MoU between the Army Design Bureau and the National Thermal Power Cooperation (NTPC) for the implementation of Green Hydrogen Projects. Presently the Army Design Bureau is exploring in the fields of wind energy development, fossil fuel management, decentralized and off-grid solutions, and national solar missions. In his concluding remarks, he mentioned that the demand for power and energy sources will likely increase exponentially with the need for future-ready efficient systems and reduced logistical penalties and financial burden.

The 2nd speaker **Devakanta Pahad Singh Scientist "G" Defence Institute of Bio Energy Research** from **DRDO** covered the topic alternative technologies for energy storage in high altitude and low temperatures area. The need to segregate into fixed, transportable and mobile systems within military is essential as these require different approaches and specific solutions. Operational energy is limited and expeditionary energy capability is very little in comparison. Hence for military operating in adversary area or occupying those areas, the military needs to be prepared for these kind of requirements. The speaker highlighted the present capability gap to include limited energy installation availabity, limited operational energy and limited expeditionary energy capability. The speaker highlighted the Hybrid Power Syetem developed and instaled in the forward high altitude area to overcome the power storage challenges. The speaker concluded that futuristic trends show the need for pulse power can be embedded with liquid metal battery and nickel hydrogen battery which is already being used in space at present but the main constraint remains cost because of the precious metals that are used as catalyst.

The 3rd speaker **Col Praveen Nair, CWE Utilities** from MES covered the power requirement in the field area. In his presentation, the speaker highlighted a significant agreement involving 25 MW with Khabra plants scheduled for September 2024, underscoring a commitment to advancing green energy production. He stressed the imperative for the Indian Army and defence forces to leverage evolving technologies for enhanced accuracy and reduced manpower. The focal point of the presentation was the establishment of a reliable, robust energy management system in forward areas, characterized by portability and off-grid capabilities, with a parallel focus on minimizing carbon footprints. Addressing the current energy landscape, he highlighted the country current 400 GW power production and our ambitious goal to achieve 800 GW by 2040. He also highlighted the concerns of the escalating reliance on the fossil fuels which is presently attributing to 40% of greenhouse gas emissions to the energy sector. The speaker delved into the intricacies of the existing power supply system in military stations, categorizing them into HQ camps, fwd/Base Camps, and fwd areas. Emphasis was placed on the net-zero concept, with recognition of drawbacks in the current system such as high

electricity costs, carbon emissions, air load challenges, space constraints, and limited sun availability. The speaker advocated for futuristic hybrid power systems, citing advantages like pollution-free, sustainable energy, ensuring a cleaner, more efficient energy future.

The 4th speaker **Col Anshul Verma, Col Induction & Operations, Signal Directorate, Army HQ** covered the topic on power requiremnets for communications sysytems in diverse terrain and conditions. Col Anshul Verma brought out the user perspective and highlighted how the new 'State of the Art Data Centres' have huge power requirements and therefore there is an urgent need to address the power requiremnet and power storage for these data centres to future sustanence. He flagged the challenges of communication in isolated and high-altitude terrains where batteries are the primary source, especially in forward areas. Additionally, he highlighted diversity, weight, form-factor, charge time, peak current, maintenance and safety as key challenges for power systems currently being faced by soldiers in high-altitude areas. He drew inferences from the recent decision by the European Union to have uniform batteries and advocated that a similar mechanism tobe applied in India's context for solving challenges to military power systems. In his concluding remarks, Col Verma listed the robust expansion of the military and defence sector, growing military spending, increasing popularity of lithium-ion batteries and the need for lightweight and portable military equipment as future key market-shaping factors.

The 5th speaker **Col Umesh Varma (Retd) from Multisphere Power Solutions** covered the topic on mission critical power conversion solution serving the Defence and aerospace markets. The speaker provided an industrial perspective on mission-critical power conversion solutions tailored for the defense and aerospace markets. Delving into military power systems, he highlighted the significance of power generation and converters in various applications such as mid-high systems, aircraft, radar, communication points, and electrical systems within battle areas. Emphasizing their extensive inventory, he mentioned supplying over 6000 units and 425 product types to different customers annually, with a global operational team of more than 400 individuals. The speaker underscored the essential role of power conversion, stressing the importance of understanding the functionality of power supplies. Noteworthy was the mention of their manufacturing unit in Gurgaon and insights into the design intricacies of magnetics, showcasing a comprehensive approach to addressing the power needs of defense and aerospace technologies.

The 6th speaker **Dr Mandira Majumderfrom Godi India** covered the topic on advanced Li-on batteries applicable in military applications. The speaker discussed the Godi industry, focusing on the varied applications of batteries in Military Power Systems (MPS), particularly highlighting the LFP-based Li-ion battery. Addressing the warranty concerns

associated with Li-ion (LFP), speaker highlighted the Godi Li-ion (LFP) as a solution. Highlighting the characteristics of Godi batteries, which are NMC-based Li-ion, she emphasized their value proposition. The speaker acknowledged the role of supercapacitors in complementing the drawbacks of lithium-ion batteries, emphasizing that they cannot entirely replace them. Providing an overview of supercapacitor applications, she elaborated on how Godi contributes to MPS. The key takeaways included from factor versatility, excellent performance, supercapacitors, and wide-temperature electrolytes. The speaker concluded by asserting that the adaptability, reliability, and efficiency of NMC and LFP batteries, combined with supercapacitors and innovative electrolytes, contribute to a more robust and technologically advanced military infrastructure, shaping the future of military powering systems.

SESSION 3: POWER SUPPLY FOR AERIAL AND MARITIME SYSTEMS

The chair of the third session, **Air Cmde SK Satpathy, VSM, Air Cmde Ground Electronic & Engineering Sp, Air HQ** opened the session by stating that despite the relevance of the subject, there's so much overlap in the power systems. The session was intended to focus the aerial and maritime viewpoints on what the Indian Navy and Airforce are seeking and how the niche capabilities within power systems can meet their needs.

The 1st speaker **Cdr Saurabh S Sharma, Cdr(Submarine Design Group) from the Naval** HQ highlighted the issue of integrated platform management systems onboard for surface combatants in real time data accessibility, multiple MMIS operated by a centralized server, and the power supply sources that need to be synchronized automatically. The speaker briefed that presently the Indian Navy is operating different types of underwater combatants like conventional, non-conventional and the strategic nuclear submarines which are very peculiar in nature in terms of operational capabilities. All these needs to be reliable and should be able to sustain for a longer period of time without any requirement of maintenance or repair. The underwater combatants unlike surface combatants have stringent operational requirementsin terms of reliability, maximum mean time between failure and repair, long-term supportability, obsolescence management and stringent environmental aspects. These are the conditions with which the platform operates in and the equipment which is fitted on the platform is supposed to withstand these environmental aspects. Under the influence of external vibrations, the equipment is supposed to be operable optimally. The propeller itself is the main source of the vibration for an underwater platform. Even with the sizing and powering requirements is the resonance frequency; hence the equipment is supposed to be proved for this particular frequency for vibration test. The military grade power supplies of both AC

sources and DC sources are usually specified in this particular format. The variations, both prolonged and short term variations of voltage and frequency, are required to be adhered to. The speaker highlighted about the generators that they are the primary source of power for a conventional submarines and an emergency source of power for a nuclear submarines. Given that these diesel generators are different from land based generators, because they have to operate under heavy back pressure requirements the Navy would be requiring both online and offline protection devices for these generators. Coming up to AIP, which is primarily fuel cell based, the Navy is interested in 3 types of fuel cells with respect to the efficiency, life sizing of the plant and the reactant quantity required as flash. The issue is not just the fuel cell construction, but the storage of the reactants also. Coming onto equipment, static converters are required to be adhering to military standards and flash. The requirement for the Navy is a very high mean time between failures and very high efficiency of over 95%. The UPS technology has grown by leaps and bounds worldwide, and the Indian Navy requires the best specific equipment like main motor generators, static bidirectional converters making it dual or triple redundant.

The 2nd speaker **Shri KS Azhil Thirumaran, Sc F, ADE, DRDO** covered the specific power requirements for UAV used in defense or related services. Within the UAVs, there are primary power sources and secondary power sources. The primary power source being the alternator, is coupled to the engine while the secondary power source is the battery is are being used in large. For using a power management unit for the continuous power, terminal junctions are being set up as an essential system. Some systems may require power continuously, while some are required on a requirement basis. Hence, it has been designed with an overcurrent protection, so that the essential loads are connected, with a configuration inside to provide power from the source to the load. Special power supplies are required for UAVs as they need to be highly reliable, extremely efficient and also noise free. Those powers of sources are quite different from battery based power systems. As the endurance is growing more, there are currently niche developments happening within the areas of UAV power supplies.

The 3rdspeaker **Shri Logananthan S, Research Centre Imarat, Hyderabad, DRDO** brought out issues related to supply chain, chemical industry, manufacturing as well as material science spaces. A potential niche area of R&D is being explored with the intention to replace lithium ion cells due to the scarcity of lithium. Within batteries, there are two forms of cells - one is a wet cell with a leak brown system like lead acid battery and the other is the dry cell which is leak proof. The challenges are how to increase the ionic conductivity of the solid state electrolyte, to be designated as a solid state battery. There are certain standards which have evolved for lithium ion batteries whereby quality checks are carried out for physical, mechanical, thermal and electrochemical properties, to carefully derive the results for diffusivity, ionic transport and the separator breakdown. In

terms of application, certain parameters like specific energy requirement, the specific power requirement and the payload in terms of kilograms are looked into. Typically, the specific power and the specific energy also depends on certain parameters to be used in the cell components like the average cell voltage that depends upon the type of anode and cathode, and the second thing is the bulk density of the material which decides the porosity of the the powdered material or the sintered material.

The 4thspeaker **Dr Suman Roy Choudhury, Scientist H, Naval Materials Research Laboratory (NMRL), DRDO** focused his discussion mostly on multi-use vehicles with the primary motivation to tell the user what are the type of options that are available and to assist the developers on how to approach the problem. He also commended Indian Navy's support and cooperation while reiterating on mechanism through which basic work requirements with better maturity along the same QR can be modified to allow faster introduction of many products, whether by DRDO, whether by DRDO and industry, or whether by industry themselves.Underwater radiated noise is very predominant, so the concrete technologies are generally marine traction batteries like lithium and etcetera fuel cell powertrains and flow batteries. In terms of efficiency, the powertrain options more or less remain the same. However the problem is the fuel needs to bleed out underwater where the pressure is high. **NMRL** research interests also include borohydride, which is reactive as a fuel component with a low operational cost. This is a system which the most of the navies are using for the AIP primarily, standardized by the Germans. So it depends on how engineering of the system is being done. For liquified oxygen, it determines the space, almost occupying 50% of space, Hydrogen determines careful engineering. The weight formation can be detected and also the diesel generator noise is well detectable. Instead, if AIP is used, it will keep the submarine underwater for several weeks depending upon the power it is consuming.The NMRL is currently working on flow batteries with hydrogen bromine to achieve a speed demand that can be used for underwater loitering ammunition variants. This can be maneuvered even at an extremely slow speed. In case it needs to hit a moving platform, it can also move at very high speed, almost 5 to 6 times of the average power.

The 5th speaker **Air Cmde SK Satpathy, VSM, Air Cmde Ground Elec & Engg Sp, Air HQ** delved into the areas how the Air Force looks at the power supply systems. There are constraints in the Air Force certification process for the power supply systems. The industry needs to gear up to provide reliable power supplies in the air. Ground systems are common for the tri-services in terms of power supply systems, demands and challenges. The power supply in the Air Force has transitioned from bulb-based systems to certain transistors, sophisticated electronic equipment for tolerance and fluctuations. Earlier systems and hardwares are getting more integrated into software based systems. Systems are becoming more sensitive with smaller power interruptions.The Air Force

requires very critical power supply, ruggedness, durability, and reliability while being dependent on standards which are not clearly defined by the Indian standards. In the Air Force, a critical requirement of an airfield lighting system is required for reliability of the landing as well as all the operational activities.

SESSION 4: POWER SUPPLY FOR AERIAL AND MARITIME SYSTEMS

The chair of the fourth session, **Maj Gen AK Channan, AVSM, VSM (Retd), Former Head Army Design Bureau** opened the session by stating that power systems as a particular theme needs to be deliberated more by the armed forces. He stressed that power requirement has evolved from precision, information management, operation of the DH, logistics, extreme habitation, the requirements deployed are varied and niche with the challenges becoming extremely pointed. The power systems developed for the military can offset the huge cost and deflation over a larger market.

The session was intended to focus on the future trends and requirements by the military.

The 1st speaker **Dr. Ajay K. Arora, GM (Fuels), IndianOil (R&D Centre)** highlighted that existing fuel can assist in fuel efficiency on specific missions, further leveraging the nation in achieving the net zero target.Future trends towards energy contribution is reducing, but the oil percentage will remain stagnant. Hence, in years to come oil will play an important role due to an increasing energy demand.Buyer fuels will have a considerable contribution in future but oil will have considerable strain in energy mix. In India there is a transition of energy, hence the challenge for the alternate fuel should be scalable, sustainable and low cost.

The 2nd speaker **Shri Maneesh Dewangan, Scientist F, DRDO** brought out that with the USA, Russia and China aggressively pursuing the race, other countries are also joining in, like UK, France, and Germany. Presently, India has got two programs, one is HCV, another being SCM with an established IT program. Power requirements for hypersonic vehicles are different from conventional missiles. Under the Vishnu program, India has started its long duration hypersonic cruise missile development to meet the current and futuristic warfare scenarios with the objective of flight demonstration of scramjet engine using a land launch system.The air-breathing scramjet engines have higher mach numbers compared to rockets. The weapon design should largely be enhanced with solid booster assisted takeoff along with ram/scram cruise powered vehicles.The thermoelectric generator is a very niche concept with thermocouple as the basic element. A group of thermocouples make the thermopile, which is electrically connected in series and

thermally connected with parallel. So the basic requirement of the thermoelectric generator is that we convert the temperature difference into the electrical voltage.

The 3rdspeaker **Ms. Rishika Singh, Visiting Associate Fellow,** CAPS focused her discussion on the global scenario for nuclear energy, which will continue to play an essential role in the carbon pre-integrated energy systems for the future. Reliability on key power production for advanced, efficient technologies will drive deep carbonization across industrial sectors, paving the way for nuclear alternatives.The key characteristics defining the development and deployment of nuclear power reactors highlight the critical difference between reactor generation. A reactor's key characteristics are cost effectiveness, safety, security, non proliferation with stability, a commercialized road map and a stable fuel cycle.SMRs employ multiple novel technological approaches that are passive safety features. That factory built modules with SMRs can simply be assembled at site and requires a lot less manpower as compared to conventional nuclear power plants.Prominent features of SMRS are meant for a broad variety of applications, such as providing baseload electricity generation process, heat application, sea water leaves, salination and hydrogen production, which is gaining relevance in industrial, municipal and institutional actors in both developed countries and developing economies as well.Alternative sources of energy are nature dependent, hence small reactors have the potential to solve this issue of vulnerability to grid outages. Since these small reactors could easily support bases, they can also be designed to provide critical services in surrounding towns during long term outages.

Lt Gen Sunil Srivastava, AVSM, VSM (Retd), Director CENJOWS** summarised the key takeaways of the seminar where he highlighted fuel cell technology and other issues when it's scaled up, is going to mature that, globally in the commercial sector. He also pointed out that within the military, not much is discussed on how we are going to leverage 5G and 6G power requirements at present for military use. Another clear perspective that emerged from the discussion, he drew conclusions that the need for standards and interchangeability is required for every gadget that is being purchased. Few years we have seen the military budget and the purchasing powers being leveraged for procurements, but the processes vary in their own disparate systems with their own kind of power supplies. Given that every OEM wants to have an advantage, to sustain their businesses for the next 10-15 years, these are the dimensions that require standardization. He further pointed out the requirement of a vision portal where clearly lists out thousands of items are displayed with specific DPS use, which can assist in developing solutions by the commercial industry, private industry. Even for power systems, acceleration of our solutions by digital simulation, modeling training and innovation with open architecture solutions is the key because the technology for power systems changes pretty fast and our military acquisition cycles are very long. With

induction within the military, their exploitation cycles are longer even with disruptive technology so he pushed for an argument towards smart acquisition which promotes innovative solutions.

Maj Gen Ravi Arora, Chief Editor, Indian Military Review, ended the seminar with a vote of thanks to the Director CENJOWS for having personally selected the speakers and prepared the program for the event, all the sponsors for their efforts and the delegates from the industry players, branches of DRDO and service wings of the armed forces dealing with systems engineering, maintenance, design and operations, making the event a success.