

हर काम देश के नाम



स्वावलंबन  
SWAYLAMBAN 5.0  
स्वदेशीकरण योजना  
INDIGENISATION PLAN



DIRECTORATE OF INDIGENISATION  
NAVAL HEADQUARTERS  
MINISTRY OF DEFENCE

## PREFACE

1. The 4<sup>th</sup> edition of *IN's Swavlamban* document *Swavlamban 4.0* was released by the Hon'ble Raksha Mantri on 25 November 25 to provide the Indian industry with clearly defined indigenisation requirements of Indian Navy and encourage the Indian industry and academia to participate in the Navy's indigenisation efforts.
2. Self-reliance in defence is not merely a policy goal - it is a national imperative. It demands a culture of indigenisation, innovation, a commitment to excellence and a belief that India can lead not just in manufacturing but also in shaping the future of maritime technology. As the Indian Navy continues to evolve into a force that is agile, resilient, and future-ready, reliance on indigenous innovation has become a strategic imperative.
3. *Swavlamban 5.0* is more than a document - it is a declaration of intent. It outlines Indian Navy's vision to deepen collaboration with Indian industry, academia, start-ups and to co-develop solutions that are tailored to Naval operational realities. This edition reflects Indian Navy's sharpened focus on autonomy, survivability and superiority across all domains of naval warfare. It is a strategic articulation of how Indian Navy intends to harness the full spectrum of Indian capability - from deep-tech start-ups to established industry leaders and academic institutions.
4. The release of *Swavlamban 5.0* document is intended to contribute towards nurturing a defence ecosystem that is responsive to the needs of Indian Navy and aligned with its long-term vision. *Swavlamban 5.0* is a guideline document to the reader to understand this blueprint for transformation and serves as a reference for the Navy's indigenisation roadmap. The Indian Navy welcomes all innovators to contribute to this journey - not just with products, but with ideas that redefine what is possible. All stakeholders are invited to engage with this vision of Indian Navy, not just as contributors, but as co-creators of India's maritime destiny.



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## MESSAGE

1. India's maritime strategy is fast adapting to a paradigm where technological superiority and national autonomy are strongly intertwined. As a cornerstone of national security, the Indian Navy must possess not only advanced platforms, but also the indigenous capability to design, develop, sustain, and enhance the technologies that underpin maritime power.
2. India's maritime future will be shaped not merely by the platforms we operate, but by the ideas we nurture and the technologies we create. In an increasingly complex security environment, the ability to develop indigenous capabilities and ensure technological autonomy has become both a strategic imperative and an achievable ambition.
3. *Swavlamban 5.0*, the fifth edition of this vision document, articulates the Indian Navy's evolving technology requirements and provides a roadmap for the Indian industry, academia, start-ups, MSMEs, and research institutions to align their research and innovation efforts to future operational needs. It seeks to create and sustain a collaborative ecosystem that transforms indigenous ideas into technologies and capabilities that are resilient, scalable, and future-ready.
4. More than a statement of intent, *Swavlamban 5.0* is a bridge between the Navy's aspirations and the nation's innovation potential. It reinforces the belief that self-reliance is a continuous discipline – one that must permeate the defence ecosystem from concept and research to production and combat capability. Through this endeavour, the Indian Navy remains committed to building a technologically empowered and strategically autonomous maritime force that will win India's battles at sea and protect our national maritime interests effectively, always and at all times.

Jai Hind. Sam No Varunah.

(Krishna Swaminathan)  
Admiral  
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20 Oct 26



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## MESSAGE

1. The character of maritime operations is being reshaped by disruptive technologies and an increasingly complex security environment. In this evolving landscape, technological superiority backed by sovereign ecosystem is the core determinant of operational dominance. Accordingly, the Indian Navy's pursuit of *Atmanirbharta* is anchored in building indigenous capabilities that are contemporary, adaptable and decisive.
2. *Swavlamban* document is a resolute manifestation of this vision. It serves as a definitive bridge connecting the Navy with India's innovators-industry leaders, start-ups, MSMEs, academia and research institutes. By clearly articulating our capability priorities and emerging technology requirements, with each edition, the aim has been to empower our partners to align their efforts with critical operational needs and challenges of tomorrow.
3. In this context, *Swavlamban 5.0* is our shared blueprint to further nurture the indigenous innovation ecosystem through co-development, strategic collaboration and a collective "**Dare to Innovate**" mindset in the country.
4. I am sanguine that this document would help transform indigenous concepts into formidable maritime capabilities, ensuring the Indian Navy remains a combat-ready force safeguarding India's maritime horizons.



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### COM MESSAGE

1. True strategic autonomy rests on absolute technological self-reliance. As featured in this forthcoming edition of the Swavlamban document, we mark a decisive milestone in our ongoing mission to transform the Indian Navy into a technologically superior and formidable force.
2. Total indigenisation is no longer just an objective, it is an operational imperative. This publication serves as a comprehensive blueprint, detailing our evolving requirements for critical platforms, advanced weaponry, marine propulsion, specialized software and state-of-art sensors. By systematically eliminating foreign dependencies, we ensure uncompromised supply chains and absolute sovereignty over the readiness of our assets.
3. Achieving this vision requires a collective national efforts. Within these pages, we invite India's dynamic industries, visionary MSMEs, pioneering startups and academic institutions to collaborate directly with us. This edition of Swavlamban provides the clarity and confidence for our domestic ecosystem to heavily invest in indigenous research, development and advanced manufacturing.
4. Together, let us harness native ingenuity to engineer world-class maritime solutions, secure our oceanic frontiers and script a defining chapter in India's defence indigenisation journey.

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# **PART – I**

## **INTRODUCTION**

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## CHAPTER 1

### INTRODUCTION TO INDIAN NAVAL INDIGENISATION PLAN

1. The release of first 'Swavlamban' document in August 2022 and its revised version 'Swavlamban 2.0' in October 2023 by Hon'ble RM were the outreach efforts by Indian Navy, which have enabled and encouraged the Indian industry and academia to participate in the Navy's indigenisation efforts.
2. With the renewed thrust towards 'Atmanirbharta' and increased interest of industry, MSMEs and academia in the indigenisation program of *IN*, 'Swavlamban 4.0' document has been updated to 'Swavlamban 5.0' and aims to be a comprehensive reference document for all indigenisation requirements of the *IN* by listing out all the equipment/ systems/ subsystems which can be taken up for indigenisation in the coming years.
3. The *IN* has acquired adequate expertise in the hull design and construction of various types of warships. In the field of propulsion systems (barring Marine Gas Turbines and Propulsion Diesel Engines) and related auxiliaries, support services like air conditioning, refrigeration, etc., production capabilities are available today in the country. We are also reasonably self-sufficient in power generation and distribution systems, communication systems, combat management systems, sonars and electronic warfare systems
4. Indigenous development in weapons and their control elements, sensors, radars, fire control systems, unmanned Systems, etc. however, needs to be pursued with vigor. Although we possess design capabilities and to some extent the production base, considerable performance enhancements are required in the field of underwater weapons and sensors, multi-function radars, IT-based systems, etc., as their critical subsystems and components are still being imported.
5. The role of the indigenous industry in defence manufacturing sector cannot be over emphasised. The entire industrial might of the country, whether it is the erstwhile Ordnance Factories, Public Sector Units (PSUs), Defence Public Sector Units (DPSUs), large private industries or Micro,

Small and Medium Enterprises (MSMEs), need to partner to achieve the goal of self-reliance of the *IN*. They should become the stakeholders of the plan and provide not only the much-needed technical knowhow and share their vast manufacturing experience, but also bring the *IN*'s concepts and proposed capability to fruition in the form of world class defence hardware that would serve the needs of the *IN*.

6. Part I of the document briefly elucidates the indigenisation strategy of *IN*, various methodologies and schemes available for indigenisation under GoI/MoD and broad requirements of indigenisation in shipbuilding and indigenisation achieved so far. Part II-V of the document highlight the indigenisation requirements of *IN* under various categories whereas Part VI deals with the future technologies with defence applications relevant to *IN* where industry participation is solicited. In the appendices, the exact indigenisation requirements under various categories are listed out, along with the point of contact for further discussion/information.

7. **Categorisation of Ship's Equipment.** The ship-building materials, equipment and systems onboard an *IN* warship can be classified under the following three categories: -

7.1. **Float.** This category encompasses all materials, equipment and systems associated with the hull structures and fittings including deck machinery.

7.2. **Move.** Equipment under this category encompasses propulsion system, power generation diesel/ gas/ steam turbine engines, alternators, associated control systems (Integrated Platform Management System/ Automatic Power Management System), auxiliary equipment/ systems viz. pumps, chilled water & refrigeration plants, compressors, switchboards, communication equipment, firefighting systems etc.

7.3. **Fight.** Equipment under this category encompasses all types of ship-borne weapons & sensors, armament that directly contributes to the combat capability of the platform and special operations by MARCOs.

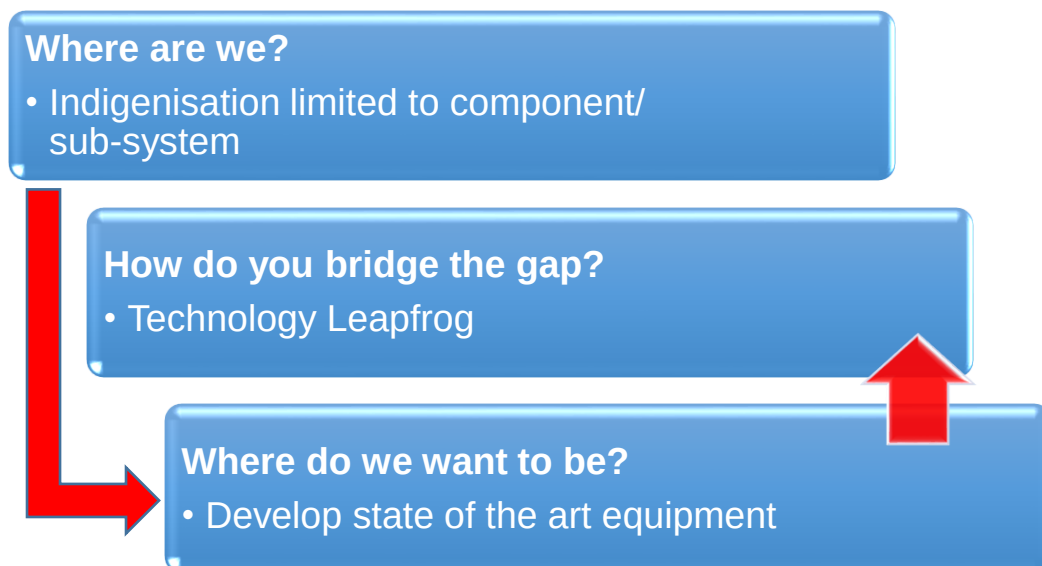
8. **Indigenisation Strategy.** Indigenisation is undertaken at three distinct levels of complexity viz., systems, subsystems and spares level. These are elaborated below: -

8.1. **System Level.** This level includes system as a whole and is primarily based on Naval Staff Qualitative Requirements (NSQR). Due to requirement of *ab-initio* development and inherent complexity, 'systems' have typically been developed by DRDO till date. However, in the recent past, efforts to develop some complex systems through industry partners have been successful.

8.2. **Subsystem Level.** At the second level are the subsystems which form part of individual systems. Subsystems are indigenised based on specifications generated by *IN*. Indigenisation at this level can be undertaken either through a combination of DRDO and industry or by industry alone, depending on the complexity of the technology involved.

8.3. **Spares Level.** The third and very important aspect of indigenisation is sustenance of inventory through regular replenishment of spares. These are the low technology, fast moving items which can be indigenised directly by the industry.

9. An indigenisation strategy has been formulated accordingly to bridge the gap between the desired and the existing capability.



10. Till the recently, indigenisation was focused on import substitution through reverse engineering and was limited to components/ subsystem. This method, though helpful in management of existing inventory, ensured that the *IN* remained saddled with decades old technology. The revised indigenisation strategy is, therefore, focused on technology development in gap areas in addition to requirement-based indigenisation.

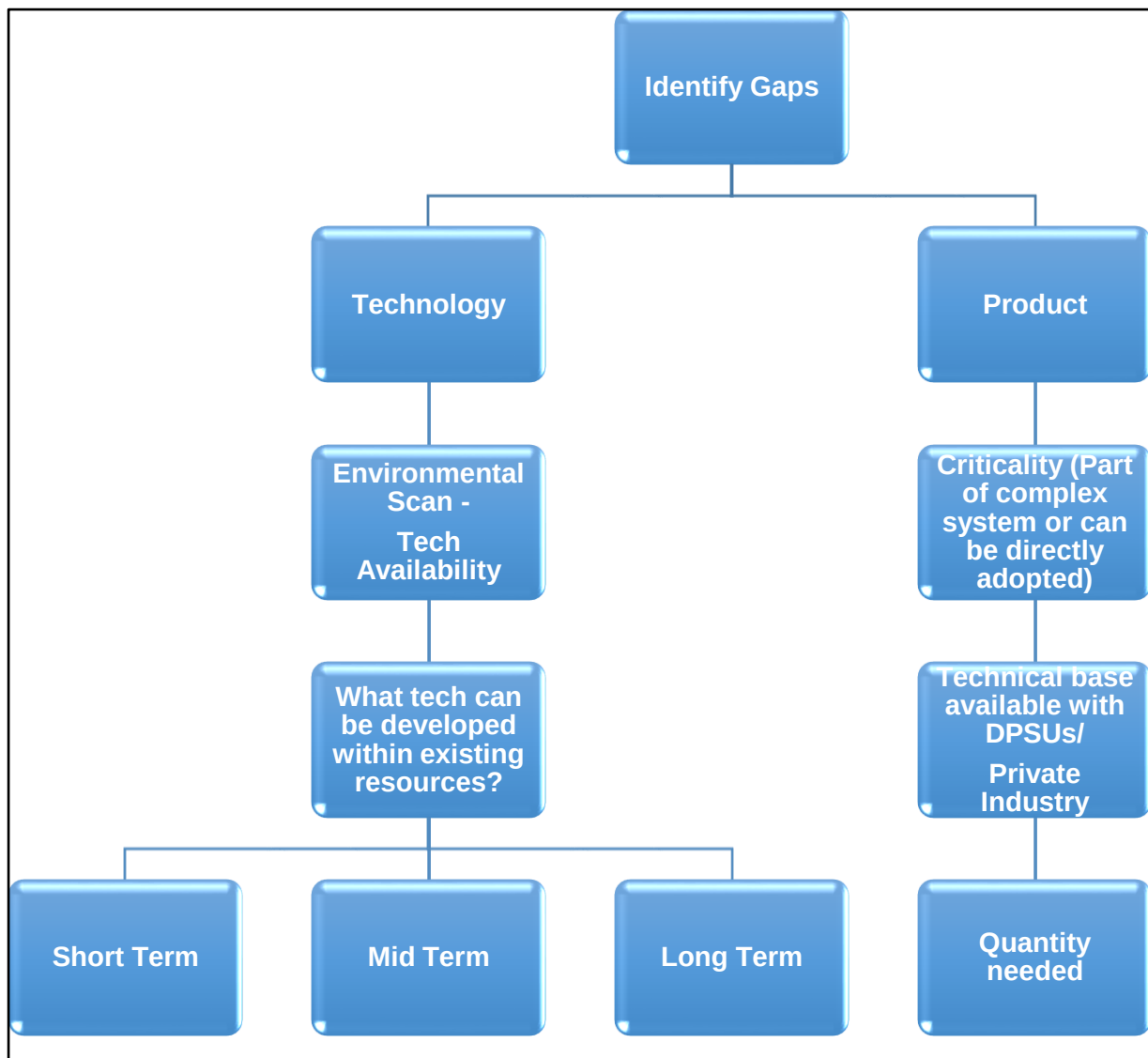


**Figure 1: Indigenisation Strategy of Indian Navy**

11. Technology development focusses on the knowledge areas. For each technology area, environmental scan is conducted and technology base available within the country is identified. In order to optimise the development timeline, technologies for which feasibility exists are classified into three categories depending upon level of technology and timeframes for indigenisation. Technologies for which sufficient order quantity are

available and technology easily accessible are reserved for industry. Where higher level of technology is required, help of academia is sought and technologies which are futuristic in nature or not feasible for development due to cost considerations vis-à-vis numbers involved, are reserved for DRDO.

12. Product development is aimed at indigenisation of a specific product. Development of products is the preferred mode of indigenisation in situations where urgent import substitution is required.

13. **Agencies Involved in Indigenisation.** Though all professional directorates are involved in indigenisation of equipment/systems/spares to certain extent, the indigenisation in the *IN* is undertaken primarily by three agencies: -

13.1. Directorate of Indigenisation for ship systems.

13.2. Directorate of Air Projects and Plans for aviation systems.

13.3. Directorate of Armament Production and Indigenisation for armament and ammunition.

14. **Items Being Imported for Shipbuilding.** The major items used in the ship-building program that are still being imported and need to be indigenised are tabulated below: -

14.1. **Float Category.**

| Ser No. | Type of Equipment                                                                            |
|---------|----------------------------------------------------------------------------------------------|
| 1       | Underwater Electrodes (for Ship repair)                                                      |
| 2       | Underwater NDT (for Ship repair)                                                             |
| 3       | High Grade Composites for Fabrication of items such as Doors, Hatches, Ventilation flap etc. |
| 4       | High Grade Carbon Fiber Reinforced Plastic (CFRP) Composites for Mast & Super Structure      |

#### 14.2. Move Category.

| Ser No. | Type of Equipment                                               |
|---------|-----------------------------------------------------------------|
| 1       | Gas Turbines                                                    |
| 2       | Main Propulsion Diesel Engines                                  |
| 3       | Complex Marine Gearboxes                                        |
| 4       | Shafting                                                        |
| 5       | Propellers – Both Fixed & Controllable Pitch                    |
| 6       | CFC Free Fire Fighting Systems for Magazines & Machinery Spaces |
| 7       | Arrestor Wires for Flight Operations on Aircraft Carriers       |
| 8       | Aircraft Lifts                                                  |

#### 14.3. Fight Category.

| Ser No. | Type of Equipment                                                                                  |
|---------|----------------------------------------------------------------------------------------------------|
| 1       | Surface to Air Missile                                                                             |
| 2       | Surface Surveillance Radar [Buy & Make (Indian) in progress]                                       |
| 3       | Air Early Warning Radar [Buy & Make (Indian) in progress]                                          |
| 4       | Satellite Communication System (SATCOM)                                                            |
| 5       | Aviation Control Suites                                                                            |
| 6       | Fire Control Systems                                                                               |
| 7       | Integrated Mast & Control System for Submarines                                                    |
| 8       | Mine Hunting and Diver Detection Sonars                                                            |
| 9       | Light and Heavy Weight Torpedoes                                                                   |
| 10      | Towed Array Sonars                                                                                 |
| 11      | Unmanned Aerial Vehicles for Surveillance and Delivery of Ordnance/ Autonomous Underwater Vehicles |
| 12      | Global Positioning Systems, Inertial Navigation Systems                                            |
| 13      | Super Rapid Gun Mounts (SRGMs)                                                                     |

### Methodology/ Indigenisation Routes

15. The procedure followed for indigenisation of stores/systems is as per chapter 10 of DPM-2025 (through Indian industries) or chapter IV of

DAP-20 (through DRDO). Funds are expended from Minor Heads 110(p), 110(q) or 110(f) based on extent of production/ R&D activities involved. Additionally, projects are also taken up with Indian Industry through 'Make' category, culminating in procurement under Capital route. Indigenisation projects are progressed under following routes: -

**15.1. Revenue Scheme.** This route is exercised through funds allotted to NHQ under Minor Heads 110(p) – Indigenous Development and 110(q) – Research & Development.

**15.2. Make Schemes.** Make schemes are sub-divided into three categories; Make-I, Make-II & Make III and are elaborated in succeeding Para 17.

**15.3. Technology Development Fund (TDF) Scheme.** The Technology Development Fund (TDF) operated by DRDO was introduced in union budget 2014-15. This scheme aims at funding the development of defence & dual use technologies. The funding is for public/ private industry especially MSMEs; and only Indian vendors including Association of Persons are eligible for this scheme. Each project is capped at ₹ 50 Cr with a development period of two to four years. Further details can be found at <https://tdf.drdo.gov.in>.

**15.4. iDEX.** The iDEX (Innovations for Defence Excellence) initiative was launched by the Hon'ble PM in April 2018 with the aim to achieve self-reliance and foster innovation and technology development in defence and aerospace by engaging industries including MSMEs, start-ups, individual innovators, R&D institutes and academia. Various categories viz., Defence Indian Start-up Challenge (DISC), Open Challenge (OC) and Acing Development of Innovative Technologies with iDEX (ADITI) are available under iDEX. Problem Statements are launched by the SHQs under ADITI & DISC while suo-moto proposals from the environment taken up for examination through OC. The max grants for OC & DISC are ₹ 1.5 Cr while ADITI projects can be funded upto ₹ 25 Cr. Further details can be found at <https://idex.gov.in>.

**15.5. DRDO Projects.** The indigenisation of Naval Armament stores is also progressed through DRDO. DGNAI is the co-chair of the *IN-DRDO Synergy - Armament Combat & Engineering (ACE)* Cluster.

## **Indigenisation Methodology at Indigenisation Units**

16. Following methodology would be followed for indigenisation: -

**16.1. Development Procedures.** The procedure followed for indigenisation of stores are as per chapter 10 of DPM-2025 (through Indian industries) or chapter IV of DAP-20.

**16.2. No Cost-No Commitment (NCNC) Basis.** The Production Agencies (PAs) are at times engaged for development of stores on NCNC basis. In such cases, the Indigenisation Cells will generate Paper Particulars (PPs) in association with the Production Agencies (PAs). The store will be declared developed and bulk production may be initiated based on satisfactory trials and approval of NHQ.

**16.3. Indigenisation through DRDO/ Academia.** Stores shall be taken up for indigenisation through DRDO/ academia wherever feasible, post discussion with respective Development Agencies (DAs) in Development cum Production Partner (DcPP) mode.

**16.4. Sample Based Indigenisation.** In view of large number of stores required to be indigenised and constraints on resources for generation of drawings/ paper particulars, samples will be issued to DAs for indigenisation. The DAs shall be responsible for generation of drawings and identification of material, etc. based on the sample provided under the supervision of concerned Indigenisation Unit. The RFP would be formulated accordingly.

## **Indigenisation through 'Make' Procedure**

17. The 'Make in India' initiative of the Government of India, aims to promote the manufacturing sector and increase the contribution of manufacturing output to 25% of GDP. Defence sector is prominent among

the 25 sectors of industry covered under the 'Make in India' initiative. The provision of 'Make' category of capital acquisition is a vital pillar for realising the vision behind the 'Make in India' initiative. Hence it is imperative that the 'Make' procedure should be structured to provide the necessary leverage to make adequate investments, build the required capabilities and match up to the contemporary and futuristic requirements of the Indian Armed Forces. Further details can be found at <https://www.makeinindia.com>.

18. The 'Make' procedure addresses the multiple objectives of self-reliance, wider participation of Indian industry, impetus for MSME sector, sound implementation, transparent execution and timely induction of equipment into *IN*. Acquisitions covered under the 'Make' category refer to equipment/ system/ sub-system/ assembly/ sub-assembly, major components, or upgrades thereof, to be designed, developed and manufactured by an Indian vendor, as per procedure and norms detailed in chapter III of DAP-2020.

19. Only Indian vendors as defined in chapter-III of DAP 2020, are eligible for participation under 'Make' program of acquisition. successful development under this scheme would result in acquisition, from successful Development Agency (DA), through the 'Buy (Indian-IDDM)' category with indigenous design and development and a minimum of 50% Indigenous Content (IC) or under 'Buy (Indian)' category with minimum of 60% IC by inviting commercial bid and thereafter following the procedures detailed in chapter II of DAP 2020.

20. The sub-category under 'Make' category are further sub-divided into the following: -

**20.1. Make-I (Government Funded).** Projects under 'Make-I' sub-category will involve Government funding up to 70% of prototype development cost or maximum ₹ 250 Cr per DA released in a phased manner and based on the progress of the scheme, as per terms agreed between MoD and the vendor (*iaw* chapter-III of DAP 2020).

**20.2. Projects under Make-II and Make-III (Industry Funded).** Projects under Make-II and Make-III would encompass equipment/ system/ platform or their upgrades or their sub-systems/ sub-

assembly/assemblies/ components/ materials/ ammunition/ software, primarily for import substitution. Under Make-II and Make-III, no government funding is provided for prototype development but there is an assurance of orders on successful development and trials of the prototype. Projects, with procurement not exceeding ₹ 100 Cr/year based on delivery schedule at the time of seeking AoN will be earmarked for MSMEs. However, if at least two MSMEs do not express interest for a 'Make' program earmarked for them, the same shall be opened up for all.

**20.2.1. Make-II.** This sub-category essentially pertains to products involving indigenous design, development and manufacturing to enable Indian industry leap-frog to advanced or complex technology, cases where Indian companies either hold the IPR, including where it has been acquired from the foreign companies, or have the ownership of the design of the main system/equipment, will be deemed to be indigenously designed and developed. Successful development under Make-I and Make-II would result in acquisition, from successful DA(s), through the 'Buy (Indian-IDDM)' category of DAP a minimum of 50% IC on cost basis of base contract price.

**20.2.2. Make-III.** This sub-category is applicable to ammunition/ equipment/ system/ assemblies, etc. which although would not be designed/ developed indigenously, but can be manufactured in India as import substitution for product support of weapon systems/ equipment held in the inventory of the Services. Indian firms may manufacture these either in collaboration or with ToT from foreign OEMs. Under this category, an Indian vendor can enter into a JV with OEM. Schemes under Make-III will be procured under the Buy (Indian) category with a minimum of 60% IC on cost basis of base contract price. However, vendors eligible in Buy (Indian-IDDM) are also permitted to participate under Buy (Indian) category with indigenous design and min. of 50% IC on cost basis of base contract price.

**21. Development and Procurement Process under 'Make-II' and 'Make III' Category.** The development & procurement process under Make-II and Make-III sub-category would broadly involve the following activities: -

21.1. Advance Planning & Consultations, and Feasibility Study.

21.2. Formulation of Preliminary Staff Qualitative Requirements (PSQRs).

21.3. Constitution of Project Facilitation Team (PFT).

21.4. Categorisation and Accord of Acceptance of Necessity (AoN).

21.5. Issue of Expression of Interest (Eoi).

21.6. Evaluation of Eoi responses.

21.7. Award of Project Sanction Order (PSO).

21.8. Design and Development of Prototype.

21.9. Conversion of PSQRs into SQRs/ NSQRs.

21.10. Solicitation of Commercial Offer.

21.11. Single Stage Composite Trials/ User Trials by SHQ.

21.12. Staff Evaluation.

21.13. Commercial negotiations by Contract Negotiation Committee (CNC).

21.14. Award of Contract.

**22. Defence Acquisition Procedure (DAP) 2020.** It aims to further 'Self Reliance' of the country in the defence sector and implement 'Ease of Doing Business' with emphasis on Simplification, Delegation, Reduced

Timelines and making the process as Industry friendly as possible. Make in India initiative of the Government of India focuses on increasing participation of Indian vendors including MSMEs, and therefore “Make” procedure has been further refined in DAP 2020 to make it more objective and time bound with focus on Indian industry specially MSMEs. The visionary FDI policy statement of enhancing FDI in defence will enable in making ‘Manufacture in India’ a lucrative option for foreign equipment manufacturers (<https://www.mod.gov.in/dod/en/defence-procurement-proc--dap>).

23. **Srijan Defence Portal.** Pursuant to *Atmanirbhar Bharat*, MoD/DDP launched an Indigenisation Portal on 14 Aug 20, named ‘[srijandefence.gov.in](https://srijandefence.gov.in)’ as an opportunity for Make in India for Defence to give information on items that can be taken up for indigenisation by the Indian industry. On this portal, DPSUs and SHQs display details of their items which have been imported or being imported, which the Indian industry can design, develop and manufacture as per their capability or through joint venture with OEMs. Presently, about 1850 items of *IN* have been uploaded in the portal. Major items uploaded on the portal which are still pending for indigenisation are listed at **Appendix M**.

24. The Navy as a customer, and the industry as a supplier need to have a clear understanding of the requirements and the plan for induction and indigenisation. Keeping this aspect in focus, the Indigenisation requirements of the *IN* have been collated under one head based on current requirements with respect to new induction ships and submarines and life cycle support imperatives of the existing *IN* inventory.

## CHAPTER 2

### INDIGENISATION ACHIEVED

#### Background

1. The equipment and machinery fitted onboard ships in the three categories of 'float', 'move' and 'fight' have been indigenised to the extent possible. The analysis of these categories indicates that while sufficient self-reliance has been achieved in the first category and reasonably in second category, there is a significant shortfall in the third category of 'fight'.

#### Major Systems Indigenised

2. The major equipment and systems developed indigenously by *IN* as part of various ships building program are as follows: -

##### 2.1. Float.

| Ser No. | Equipment/ Material                                       | Indigenising Organisation |
|---------|-----------------------------------------------------------|---------------------------|
| 1       | Hull Construction Materials                               | DRDO / SAIL/ Industry     |
| 2       | Hangar Doors and Shutters                                 | Industry                  |
| 3       | Anchor Capstans / Windlass                                | Shipyards/ Industry       |
| 4       | Davits and Boats/ Rigid Hull Inflatable Boats (RHIBs)     | Industry                  |
| 5       | General Service Life Jackets/ Hazardous Duty Life Jackets | Industry                  |
| 6       | Silicon Rubber Seals                                      | Industry                  |
| 7       | HTS                                                       | Industry                  |
| 8       | NGHHTS                                                    | Industry                  |
| 9       | Paints                                                    | DRDO/ Industry            |
| 10      | STP                                                       | Industry                  |
| 11      | ATUs/HEs                                                  | Industry                  |

## 2.2. Move.

| Ser No. | Equipment/ Material                                  | Indigenising Organisation                            |
|---------|------------------------------------------------------|------------------------------------------------------|
| 1       | Steam Turbine                                        | M/s BHEL                                             |
| 2       | Boilers                                              | Naval Dockyard, Mumbai, M/s Thermax                  |
| 3       | RO Plants                                            | M/s Rochem,<br>M/s Technoprocess                     |
| 4       | Pumps                                                | M/s Best & Crompton,<br>M/s Alekton,<br>M/s BE Pumps |
| 5       | HP Air and AC Compressors                            | M/s ELGI Compressors,<br>M/s ACCEL                   |
| 6       | AC and Ref Plants                                    | M/s Voltas, M/s KPCL, M/s ACCEL                      |
| 7       | Stabiliser System                                    | M/s Veljan Hydrair,<br>M/s L&T                       |
| 8       | Gas Turbine Generator (GTG) Control System           | M/s BEL                                              |
| 9       | Gas Turbine (GT) /GTG Starting Rectifier             | M/s Precision Power                                  |
| 10      | Steering Gear                                        | M/s Veljan Hydrair                                   |
| 11      | Motors and Power Generation & Distribution Equipment | M/s Narhari Motors,<br>M/s Marine Electricals        |
| 12      | Submarine Batteries                                  | M/s Exide, M/s HBL                                   |
| 13      | Inertial Navigation System                           | DRDO/ RCI                                            |
| 14      | Switchboard and APMS                                 | M/s GE Ltd                                           |
| 15      | ATS (Auto Transfer Switch)                           | M/s Marine Electricals                               |
| 16      | HSR (Helo Starting Rectifier)                        | M/s Static Transformer                               |
| 17      | Echo Sounder for Submarines                          | M/s Keltron                                          |

### 2.3. Fight.

| Ser No. | Equipment/ Material                                                                                              | Indigenising Org                   |
|---------|------------------------------------------------------------------------------------------------------------------|------------------------------------|
| 1       | Electro Optical Director for GMs - SOP                                                                           | M/s BEL                            |
| 2       | Electronic Warfare Systems                                                                                       | M/s BEL                            |
| 3       | Electro Optical Director for GMs - EON                                                                           | M/s BEL                            |
| 4       | Gun Fire Control System – Lynx U2                                                                                | M/s BEL                            |
| 5       | Anti-Submarine Warfare Fire Control System (ASW FCS)                                                             | M/s BEL                            |
| 6       | Supersonic Missile System                                                                                        | M/s BAPL                           |
| 7       | AK630 and Super Rapid Gun Mount                                                                                  | OFBs/ M/s BHEL                     |
| 8       | Torpedo Tube Launchers                                                                                           | M/s L&T, M/s MDS                   |
| 9       | Combat Management System                                                                                         | WESEE, M/s BEL                     |
| 10      | Data Link & Net Centric Operation (NCO) Equipment                                                                | M/s BEL                            |
| 11      | Weapon Systems Integration                                                                                       | WESEE, IN                          |
| 12      | Composite Sonar Dome                                                                                             | DRDO                               |
| 13      | Helo Traversing System                                                                                           | M/s L&T, M/s GRSE                  |
| 14      | Chaff Launchers                                                                                                  | M/s OFB/ MTPF                      |
| 15      | CCS/ VCS                                                                                                         | M/s BEL                            |
| 16      | HF/ VLF Receivers                                                                                                | M/s BEL                            |
| 17      | HF Transmitters                                                                                                  | M/s BEL, M/s HAL                   |
| 18      | V/UHF sets                                                                                                       | M/s BEL & M/s ECIL                 |
| 19      | Main Broadcast/ Sound Reproduction Equipment                                                                     | M/s Phi Audicom, M/s Linea Engg    |
| 20      | Rocket Launcher                                                                                                  | M/s L&T                            |
| 21      | Torpedoes                                                                                                        | M/s BDL/NSTL                       |
| 22      | Mines                                                                                                            | M/s ARPPL/ NSTL                    |
| 23      | ILMEN-GUVK (system for transfer alignment of Ship borne Gyro parameters to Kamov helicopters) for 1135.6 Ships). | M/s Whirlybird Electronics Pvt Ltd |

| Ser No. | Equipment/ Material                                                | Indigenising Org                       |
|---------|--------------------------------------------------------------------|----------------------------------------|
| 24      | Helo Deck Communication System (HDCS).                             | M/s L&T                                |
| 25      | Integrated SATCOM Multifunction Antenna (ISMS) for SSK Submarines. | M/s Navstar                            |
| 26      | Sonar USHUS /USHUS II/ TUSHAR                                      | M/s BEL                                |
| 27      | Indigenous Cavitation Meter                                        | M/s BEL                                |
| 28      | Sonar HUMSA and Variants                                           | M/s BEL                                |
| 29      | IAC MOD C                                                          | M/s BEL                                |
| 30      | ATDS Mareech                                                       | M/s BEL                                |
| 31      | IADS                                                               | M/s MDS                                |
| 32      | Torpedo Batteries                                                  | M/s HEB, M/s HBL                       |
| 33      | 30mm Ammunition                                                    | M/s EEL                                |
| 34      | Submarine Flare Launcher Basket                                    | M/s Vijay Engineers                    |
| 35      | 30mm AO-18 Gun Cluster                                             | M/s AWEIL (GSF)                        |
| 36      | Scoop Bulk Head for Torpedo                                        | M/s Sri Vamshee Industrial products    |
| 37      | Medium Range Microwave Obscurant Chaff                             | DRDO/ Defence Laboratory Jodhpur (DLJ) |
| 38      | PF shell for 30mm ammunition                                       | DRDO/ ARDE                             |
| 39      | HEDA Ammunition for 76mm Gun                                       | M/s MIL (OFK)                          |
| 40      | Chaff Payloads                                                     | DRDO/ DLJ                              |

### 3. Other Equipment & Systems Developed.

3.1. Retractable stabiliser systems.

3.2. Digital GTG control system.

3.3. Gas Turbine (GT)/ Gas Turbine Generator (GTG) starting rectifier.

3.4. Deck hydraulic systems.

3.5. Steering gear systems.

3.6. Stern windlass.

3.7. Fin stabiliser.

3.8. DC insulation measuring unit.

3.9. Extraction trolley and cross piece for missiles.

3.10. **Indigenisation by IUs.** Indigenisation of a large number of marine engineering and electrical/ electronic components viz. valves, compensators, pumps, shafts sleeves, coolers, air reducers, blowers, impellers, heat exchangers, instrumentation, PCBs, etc. have been undertaken/ completed by IUs.

4. **Oceanology & Meteorology.** With an endeavor to contribute towards strengthening the spirit of *Atmanirbharta*, Directorate of Naval Oceanology & Meteorology (DNOM) has steered projects which will provide Met & Oceanology support to aid the decision makers in planning evolutions. The details of the projects are mentioned below: -

4.1. INDRA is a mobile application developed as an *IN/* DNOM initiative in partnership with BISAG-N, Gandhinagar towards indigenisation and migration from similar COTS applications. The application was launched by the Chief of the Naval Staff on 06 Jun 24 and amalgamates *IN* Met capabilities in the indigenously developed mobile application. The app has been launched for Tri Services and ICG use by Hon'ble Raksha Mantri at JCC (Lucknow) on 05 Sep 24.

4.2. The app is DCyA-certified and comprises of several new features like NAVAREA VIII warnings, tsunami & earthquake alerts, location-based adverse weather warnings, tidal data, ocean state forecast and etc.

4.3. Training on usage of the app and user management has been provided to *IA*, *IAF* and *ICG*. All service personnel can download the app on their Android and Apple mobile phones via Google Play and iOS App store respectively.

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## **PART – II**

### **SHIP SYSTEMS**

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## CHAPTER 3

### MARINE ENGINEERING

1. Over the past few years there has been considerable success in indigenising major systems like steering gear, stabiliser systems, reduction gear (lower power range), and deck machinery etc. as replacement for imported ship fits, as well as for major ship/ submarine building program for Navy. It has infused confidence and will lead to further boost the I/N-Industry partnership in future projects. Almost all major equipment and systems such as propulsion plants, prime-movers for power generation, air conditioning and refrigeration plants employed on board ships are specifically designed for marine application or are adapted (marinised) from successful commercial models.
2. Warship equipment are designed to inherently meet the following requirements: -
  - 2.1. Assured performance in the presence of six degrees of ship motion, significant of which are roll and pitch.
  - 2.2. Ability to withstand shock loads.
  - 2.3. Appropriate material and metallurgical composition to withstand corrosion and erosion.
  - 2.4. Assured performance when submerged/ partially submerged and subjected to harsh marine environment.
  - 2.5. Wide temperature variation in machinery spaces.
  - 2.6. Attenuation of airborne and structure borne noise by appropriate vibration mountings and acoustic enclosures.
  - 2.7. Modularity in design to assure high level of maintainability in heavily congested machinery spaces.

2.8. Reliable operation in the presence of high levels of humidity, with high Mean Time Between Failure (MTBF).

2.9. Minimum maintenance requirements with high Mean Time Between Overhauls (MTBO).

3. Marine Engineering equipment can be broadly classified into following categories: -

3.1. Main propulsion equipment (gas turbines/ diesel engines/ nuclear/ steam/ electric propulsion).

3.2. Prime movers for power generation equipment.

3.3. Auxiliary equipment (pumps, chilled water & refrigeration plants, steering gear and stabilisers, HP & LP air compressors, hydraulics & other ship systems).

3.4. Machinery control systems/ equipment.

3.5. Miscellaneous equipment (lifts, firefighting systems).

### **Main Propulsion Equipment**

4. The main propulsion plant of a warship should have the following essential characteristics: -

4.1. Capability of high maximum speed as well as low speeds for loitering and patrolling.

4.2. Good endurance and fuel efficiency over a wide operating range.

4.3. High availability and maintainability (high MTBF).

4.4. Reversing capability.

4.5. High power to weight ratio.

4.6. Compact and modular construction.

4.7. Low noise.

5. *IN* currently employs the three conventional propulsion plants i.e. steam boilers & turbines, diesel engines and gas turbines. Sufficient developments have been made in respect to steam propulsion plants and smaller diesel engines. Indigenously manufactured steam turbines of M/s BHEL and main propulsion diesels of Kirloskar Oil Engines Limited and Cummins India Ltd. are already in use onboard ships. Nuclear propulsion and integrated electric propulsion are also envisaged for future ships & submarines.

6. **Gas Turbines.** Presently all gas turbines fitted in *IN* platforms are of foreign origin. Therefore, there is an urgent need to develop indigenous gas turbines. Indigenisation initiatives taken in this regard include induction of General Electric LM 2500 gas turbine on the basis of its licensed Assembly, inspection & testing in India with progressive increase in indigenisation. Development of a fully indigenous Kaveri marine gas turbine [marine derivative of Light Combat Aircraft (LCA) gas turbine] is also being pursued at GTRE, Bangalore.

7. **Diesel Engines.** The primary requirement for the diesel engines is to have low noise levels and high availability/ reliability. Although a great degree of self-reliance in lower power range has been achieved, the high-power diesel engines built to Naval specifications are largely imported or assembled in India. Indigenous manufacturing/ development of high-power diesel engines to Naval specifications will greatly reduce our dependence on imports. In addition, the following specific requirements also exist:-

7.1. **Motor Boat Engines.** The Survey Motor Boats (SMB) and the Rigid Inflatable Boats (RIBs) including ones that one used for Special Operations, are powered by diesel engines in the power range of 100-250 HP. These engines are to be lightweight and rugged in design with high MTBO/ MTBF. The SMBs are operated at sea for 8 to 10 hours continuously.

**7.2. Non-Magnetic Engines.** The minesweeping vessels are fitted with non-magnetic 250 HP engines. Due to the specific role of the ships, it is essential that engines onboard these ships are to be built with non-magnetic characteristics. Presently, no indigenous industry is manufacturing non-magnetic engines.

**8. Reduction Gear.** For efficient power transmission to the propeller, marine gearboxes should possess the following essential features:-

8.1. Higher hardness of pinion and gear materials with attendant higher gear tooth loadings.

8.2. High efficiency and reliability.

8.3. Long life.

8.4. Low noise levels.

8.5. High MTBO and MTBF.

9. Gearbox generated noise is a major factor in the overall under water noise signature of ship. Presently some gearboxes of ships are being manufactured in India by M/s Elecon, under joint venture with M/s Renk, Germany and M/s Walchand Industries in collaboration with DCNS/ Naval Group, France. There is a requirement of gearboxes with greater indigenous content in the range of 1-50 MW for the newer platforms.

**10. Shafting/ Controllable Pitch Propellers (CPP).** Some headway has been made in indigenous development of Fixed Pitch Propeller (FPP) shafting systems with foreign collaboration; however the critical components such as propeller, stern tube bushes, 'A' bracket bushes, plummer block bearings are still being imported. The import content in case of Controllable Pitch Propeller (CPP) and based shafting systems is much higher. There is a need to indigenously develop CPP shafting systems with greater indigenous content for future projects.

11. **Propulsion System Integration.** The propulsion system comprises power plant, reduction gear, shafting, propulsion system auxiliaries and control system. These major elements are to be sized and suitably coupled/ integrated to ensure optimum performance of the entire system under various operating profiles of the ship. Presently, expertise for this critical task of system integration is not available within the country and therefore, *IN* is dependent on foreign sources. With a large number of ships being inducted under the indigenous ships building programmes, there is a need for Indian industry to acquire adequate expertise and in-house competence in propulsion system machinery selection, design and integration.

12. **Air Independent Propulsion (AIP) Solutions for Submarines.** *IN*-DRDO is developing AIP solution for powering submarines as it offers considerable tactical flexibility. Operational considerations like low noise, shallow water capability, size and manoeuvrability issues have garnered Navy's interest in non-nuclear AIP solutions. Indigenous competence in this field is at a very nascent stage and is required to be built up. The industry partners viz. IOCL, M/s L&T, M/s MDL etc., are being engaged for the same.

### **Prime Movers for Generators**

13. Diesel Engines, Steam Turbines and Gas Turbine prime movers are presently used onboard *IN* ships for power generation. Diesel Engines in the medium power range (50 – 1500 kW) and Steam Turbines (500 – 1000 kW) are used for power generation.

14. Indigenous development/ licensed production of Diesel Engine and Gas Turbine prime movers in the higher power range (1 to 3 MW) will enable import substitution and also provide prompt and reliable product support for the Navy.

### **Machinery Controls & Instrumentation**

15. **Machinery Control Systems.** To ensure substantial indigenisation in the design of all machinery control systems and to ensure standardisation, these systems have been evolved around open architecture standards. This has enabled indigenous availability of core hardware as well as software of machinery controls on all new construction

ships. For existing ships, conversion to indigenous equivalent designs has also been planned in a phased manner. M/s L&T has taken up indigenisation on this front.

16. There exists a need to initiate indigenisation of equipment and its spares for ships procured from foreign countries, viz., Vikramaditya, Talwar class, etc. However to begin with, indigenisation of spares/ components of critical equipment/ systems need to be initiated, so that indigenous replacements of equipment/ parts are available during the ship's first Medium Refit (MR).

17. Boiler tubes, refractory items, certain steam auxiliaries and MD pumps fitted onboard western origin ships like 'G' class and 'B' class have been successfully indigenised in the past.

18. Further, indigenisation of certain items related to engineering equipment/ systems has already been initiated for INS Vikramaditya. The present status is indicated below:-

18.1. Identification of indigenous equivalents/ sources for Russian origin and Customer Nominated Equipment (CNE) and Petroleum Oils and Lubricants (POLs).

18.2. Identification of indigenous equivalents/ sources for 18 chemicals and consumables.

18.3. Development of 16 types of mechanical seals specific to the ship by Ms General Seals, Mumbai has also been initiated.

18.4. Identification of equivalents for Russian origin bearings viz ball, roller, single row etc. through M/s Bharat Trading Corporation, Mumbai has been initiated.

**19. Indigenous Development of 0.6 MW Water Jet Propulsion System (WJPS) under TDF.** An indigenous Water Jet Propulsion System (WJPS) of 0.6 MW capacity has been developed by M/s L&T under DRDO TDF scheme. The prototypes are at advanced stages of trials on an *IN* platform.

20. **Composite HP Air Bottle under TDF.** Development of composite air bottles (400 Bar, 210 L) is being progressed under TDF. The contract was concluded with M/s Amalgamated, Nashik in Aug 21 for development of five bottles of 250 L/ 400 bar to meet HP air requirements. The deliverables include the following: -

| Pressure | Bottle Nos/Ltrs | Application                              |
|----------|-----------------|------------------------------------------|
| 500 bars | Ten/ 300        | Hydrogen Storage - Fuel cell (for NMRL)  |
| 400 bars | Five/ 250       | HP air storage onboard Aircraft Carriers |

21. **NBCD Equipment.** Development of fixed FF system for machinery compartments is being progressed by DRDO/ Centre for Fire Explosives and Environment Safety (CFEES). The production of this system may also be progressed by industry in partnership with the developing agency.

### Indigenisation Requirements

22. The list of critical equipment for which spare parts/ components that could be taken up for indigenisation are as follows:-

#### 22.1. Turbo Driven Steam Auxiliaries.

Turbo-drive of AC plants.

#### 22.2. Feed Water Pumps.

22.2.1. LPSG feed pump.

22.2.2. Condensate feed pump.

22.2.3. Pump for boiler chemical treatment.

22.2.4. Hand pump for boiler dosing.

22.2.5. Proportioning pump for boiler dosing.

22.2.6. Condensate feed pump for TA.

22.3. Lub oil and fresh water/ feed water heat exchangers which are fitted in various equipment/ systems.

22.4. **Fuel Pumps.**

22.4.1. Fuel transfer pumps.

22.4.2. Stripping pumps.

22.4.3. Manual pumps for Aviation Carrier Turbine Fuel (AVCAT).

22.5. **Lub Oil Pumps.**

22.5.1. Transfer pumps

22.5.2. Hand pumps

22.6. **Sea Water Pumps.**

Fire pumps.

22.7. **Fresh Water Pumps.**

Pumps for de-mineralised water system.

22.8. **Bilge system Pumps.**

22.8.1. Portable pumps.

22.9. **Hydraulic Pumps.**

22.9.1. Transfer pumps.

22.9.2. Manual pump.

22.9.3. Variable discharge pumps.

22.9.4. Hydraulic pumps for aircraft arresting gear and lifts.

22.10. Shafting components viz. plummer bearings, thrust pads etc.

22.11. Lub oil coolers, condensers and evaporators of motor driven ac plants and turbo driven ac plant.

22.12. Components of boiler and turbine aggregate control systems.

22.13. Filters of lube oil system.

22.14. Boiler mounting for K(B)(G)-3(D) boilers and 1500 kW turbo generator.

22.15. Specialised SV mounts.

### **Significant Indigenous Projects**

23. A list of requirements for indigenisation of marine engineering equipment and systems is placed at **Appendix A**.

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## CHAPTER 4

### SUBMARINE EQUIPMENT AND SYSTEMS

1. Private industry has partnered with the *IN* towards indigenous development of equipment, systems and components for submarines including the strategic platforms. Successful development of many such equipment/ systems for the critical platforms has given the Navy adequate confidence in the Indian industry for development of technologically complex systems. This has further led to change in approach by the Navy to involve Industry for the support of the existing platforms for which most of the equipment was being imported till very recently.

#### **Existing Submarine/ Equipment**

2. Some examples of indigenisation which have been progressed in the recent past include:-

2.1. Hydraulic oil accumulators.

2.2. Fuel flow meters.

2.3. System filters.

2.4. Pumps.

2.5. Cables.

2.6. Batteries.

2.7. Heat Exchangers.

2.8. Instrumentation components viz. transducers and parameter indication devices.

2.9. Diesel engine monitoring system.

2.10. Anechoic tiles, Submarine Acoustic Coating (SAC) and other type's coatings such as vibro-damping coatings and silencers.

3. Equipment/ systems envisaged for fitment on indigenous underwater platforms are as listed below:-

3.1. High density valve regulated lead acid batteries for submarines.

3.2. Compact high capacity turbines.

3.3. Main motor generators.

3.4. Propulsion motors.

3.5. Non hull penetrating submarines masts.

3.6. Optics for submarine masts.

3.7. Integrated sonars.

3.8. Control and monitoring systems based on Versa Module Europa (VME) / Programmable Logic Controllers (PLCs) with fibre optic backbone.

3.9. Inner and outer exhaust flap assemblies.

3.10. Wet deck shelters for special operations missions.

4. Major technologies relevant to underwater platforms which may be taken up for development are enumerated below:-

4.1. Phosphoric acid fuel cell technology for Air Independent Propulsion system.

4.2. **Acoustic Signature Management.** The following equipment/ systems need to be developed towards acoustic signature management onboard submarines:-

4.2.1. Raft Mounting System for propulsion system and auxiliaries.

4.2.2. Tuned mass dampers & pneumatic shock mounts for <200 kg equipment.

4.2.3. Enhanced shelf life rubber shock mounts.

### **Project -75/ 75(I) Submarines**

5. The construction of submarines under the Scorpene project was undertaken by Mazagon Dock Limited (MDL) under ToT from DCNS/Naval Group, France. Further, P 75(I) submarine project is being planned through the 'Strategic Partnership' route. This offers an excellent opportunity for indigenous development of equipment and systems as per the provisions of the contracts. Few of the equipment and systems proposed to be indigenised are as follows:-

5.1. Steering gear.

5.2. Shafting.

5.3. Reduction gear.

5.4. AC plants.

5.5. Ref plant.

5.6. Compressors.

5.7. Pumps.

5.8. De-Mineralised (DM) water plant.

5.9. Accumulators.

5.10. Various types of filters.

5.11. System valves.

5.12. Electrical equipment viz. motors, power distribution centers etc.

### **Indigenisation Requirements**

6. List of requirement for indigenisation of equipment/ systems for submarines is placed at **Appendix B**.

## CHAPTER 5

### AIRCRAFT HANDLING EQUIPMENT

1. With the induction of 2<sup>nd</sup> aircraft carrier, industry support is being sought for the development and maintenance of various handling and support equipment onboard this ship. Large number of equipment for handling aircrafts/ arms/ ammunition onboard ships is required by Navy. Some of the equipment used onboard and being imported presently which need to be indigenised are enumerated below:-

- 1.1. Ship-based hoisting and lifting equipment (aircraft/ vehicle lifts and cranes).
- 1.2. Automatic aircraft landing system (microwave/ electronic ACLS) for indigenous fixed wing Aircraft.
- 1.3. Carrier-based fixed wing aircraft arrester wire recovery system.
- 1.4. Aircraft Catapult Launch System.
- 1.5. Flight deck & hangar fixed fire fighting system.
- 1.6. Aircraft traversing system.

#### **Indigenisation Requirements**

2. A list of requirement for indigenisation of Aircraft Handling Equipment is placed at **Appendix C**.

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## CHAPTER 6

### DIVING, SPECIAL OPERATIONS AND HYDROGRAPHIC EQUIPMENT

1. Special operations and diving equipment, by virtue of the unique requirement, inherently need to be based on high end technology. However, these equipment are required in limited quantity and also have a limited shelf life. Considering these aspects, the following equipment have been identified for indigenous development and production:-

1.1. Thermal night vision devices with advanced optics and user defined sizes based on application for wear by humans, weapon mounted sight etc.

1.2. **Communication Systems.** Communication is the backbone of any Special Operation and every team should have a reliable and rugged communication system. Following need to be developed indigenously:-

1.2.1. Software Defined Radios.

1.2.2. Satellite communication sets.

1.2.3. Remotely deployable command and control system.

1.3. **Specialised Crafts for Special Operations and Diving Operations.** Discreet induction of Special Forces in Area of Operations is paramount for a successful mission. Specialised crafts are, therefore, an indispensable part of the planning process. Indigenisation in this field would be a great capability enhancer for special operations in the *IN*.

1.4. **Diving Sets.** Air diving sets and closed circuits oxygen diving sets with full face masks/ mouth piece for diving operations up to various depth and capable of stand-alone as well as surface demand modes.

1.5. Manned-Portable UAV with following capabilities: -

1.5.1. Ordnance delivery.

1.5.2. Day/ night aerial surveillance of enemy targets.

1.5.3. Relay of information between deployed teams and command post.

1.5.4. Capability of being launched and recovered from a mobile platform e.g., RIB, rubber dinghy and surface vehicle.

1.5.5. Underwater diver lamps, complying to weight/ buoyancy restrictions, diving certifications and light intensity requirements for efficient diving operations.

## **Hydrographic Equipment**

2. Hydrographic equipment are specialised systems which are required for mapping coastal areas, deep oceans and collecting environmental/ physical parameters at sea. The data is used for making navigational charts, ENCs, products and publications used by international shipping and wide range of users in maritime domain, and therefore, the data collected by hydrographic equipment is required to comply with quality standards promulgated by International Hydrographic Organisation (IHO). Following equipment have been identified for indigenous development and production: -

2.1. Long endurance survey grade drones with capability to land/ take off from ship's helicopter deck.

2.2. Autonomous survey craft along with launch & recovery system for development from ship equipped with multi-beam echo-sounder for surveying coastal waters.

2.3. Water level meter for remote observation of tidal data.

2.4. Sound-velocity profilers and Conductivity-Temperature-Depth probe.

## 2.5. Current meters for measuring currents in coastal waters.

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**PART – III**

**NAVAL ARMAMENT,  
WEAPONS AND SENSORS**

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## CHAPTER 7

### ARMAMENT, WEAPONS AND SENSORS

1. **Background.** At independence, India's defence-industrial production was mainly coming from the Ordnance Factories. The *IN* in the early 80s embarked on indigenisation of fast moving components. Of late, naval armament stores are being indigenised through *ab-initio* design and reverse engineering using in-house expertise.

2. **Categorisation of Naval Armament Stores.** Naval armament stores can broadly be categorised into the following:-

2.1 Missiles (Air-to-Air, Air to Surface, Surface to Air, Surface to Surface and shoulder launched).

2.2 Torpedoes (air, ship and submarine launched).

2.3 Mines.

2.4 Bombs and mortars.

2.5 Depth charges.

2.6 Underwater rockets and launchers.

2.7 Guns and ammunitions.

2.8 Small Arms and ammunitions.

2.9 Countermeasures (decoys and deceivers) and launchers.

2.10 Pyrotechnics stores.

2.11 Demolition charges.

2.12 Special Arms and ammunition for MARCOS.

### 2.13 Power Cartridges.

3. **Indigenisation in *IN*.** Indigenisation of ship borne weapons/armament is very challenging and complex in nature. The indigenisation efforts of *IN* in the field of armament technology is spearheaded by DGNAI. The seamless synergy amongst various stake holders has culminated in successful indigenisation of a variety of critical naval armament, paving the way for meeting the operational requirements of seagoing platforms through indigenous means.

4. Indigenisation of armament for Kavach chaff system (launcher & rockets), AK 100 and AK 630 ammunitions, 40/60 modified ammunition, 76/62 SRGM ammunition sub-assemblies, 140mm rocket, RGB-12 and RGB-60 rockets has been undertaken in association with (erstwhile) OFB. In addition, a number of explosives for RZ-61 & P-series missiles, propellant for Torpedo Impulse Cartridge, re-filling of warheads of missile, torpedo, depth charge, bomb, etc. have been developed. However, despite all this, we have achieved only limited indigenisation. Items like insensitive munitions, torpedo scoop bulkhead, 30 mm AO-18 cluster, alternate source of 30mm ammunition, 30mm proximity shell, 76mm HEDA shell, chaff payload, Microwave Obscurant Chaff (MOC) etc. have been developed recently.

5. A multipronged approach for development of shipborne weapons/armaments is being adopted; one to harness the R&D potential at DRDO and the other through expertise of private industry. Thus there is much scope for improvement in these areas.

### Underwater Systems

6. Underwater systems mainly consist of torpedoes, decoys, rockets and underwater mines. Over the years, there has been considerable indigenisation in terms of primary and secondary batteries of torpedoes, torpedo launchers and ASW rockets launchers, explosive filling of depth charges etc.

7. Presently *IN* holds a large number of imported torpedoes of eastern & western origin. There is a huge opportunity for the private industries to

contribute to indigenous development of the following sub-systems of torpedoes: -

**7.1. Homing System.** It is a vital component of the torpedo. The homing system mainly consists of a transmission & receiving circuit, transducer, amplifier for the amplification of incoming signals, logic unit for data processing. Presently the entire homing systems of the torpedoes are of foreign origin. There is an urgent need to indigenously develop the homing systems.

**7.2. Warhead and Exploders.** Though sufficient expertise for refurbishment of warheads has been achieved through OFs for some torpedoes, there exists a larger opportunity with private industries for indigenous development of warheads and exploders of torpedoes. There is a need to indigenously develop the payload, casing, fuze and Safety & Arming Device (SAD)/ exploders.

**7.3. Exercise Head.** The purpose of the exercise head is to record various signals within the torpedo during practice firings. It comprises various sub units viz; recording, surfacing, locating and recovery aids. Sufficient expertise has been achieved in development of surfacing aids such as rubber floats through private industries. However, there exists a need for indigenous development of recorders, actuators, compressed air bottles, electro explosive devices, smoke markers, noise makers etc.

**7.4. Propulsion System.** Batteries are used to propel the torpedo. The propulsion batteries are either primary or secondary type. Primary batteries are single shot battery whereas secondary batteries are of rechargeable nature. The batteries which are used in the *IN* are usually of AgO-Zn or sea water-activated (Mg-AgCl). In light of recent advancement of Li-Ion battery technology worldwide, there is a requirement to indigenously develop heavy duty batteries to achieve better endurance of the torpedo. Indigenous manufacture/ development of high-power batteries to naval specifications in the higher power rating will greatly reduce our dependence on imports.

**7.5. Control System.** The control system of the torpedo regulates the course, depth and roll of the torpedo. Currently, all control systems of the torpedoes in *IN* inventory are of foreign origin. Indigenous development of course gyro mechanisms, servo actuators for rudders etc is required.

**7.6. After Body and Tail Unit.** The after body of the torpedo mainly consists of propeller shaft, propellers, sealing mechanism rubber 'O' rings etc. Sufficient scope exists for indigenisation of a large variety of these sealing mechanisms; and 'O' rings could be taken up for development by Indian manufacturers.

8. *IN* has indigenised underwater rockets, depth charges, limpet mines, processor-based ground mines, which are primarily used in combat against dived submarines and incoming torpedoes.

9. Other underwater naval armament like anti-torpedo countermeasure systems are being imported. Indigenous development/ licensed production of anti-torpedo countermeasures will enable import substitution and also provide prompt and reliable product support for the Navy.

**10. Indigenisation Envisaged.** The list of equipment for which spare parts/ components could be taken up for indigenisation are as follows: -

10.1. Homing heads of torpedoes of eastern and western origin countries.

10.2. Warheads and exploders.

10.3. Exercise heads and its components.

10.4. Rubber floats and recovery aids of torpedoes.

10.5. Elastomers used as sealants in propulsion systems and propellers.

10.6. Anti-torpedo countermeasures.

## Ordnance/ Gun Systems

11. The ordnance/ gun systems held in the *IN* inventory are predominantly of eastern origin, inducted and procured from OEMs. The private industry has partnered with the *IN* in indigenisation of sub-assemblies of these vital gun systems. A large number of firms have been associated with the development of various gun systems and sub-systems for *IN*. Successful development of these systems has given the Navy confidence in the Indian industry and displayed that such complex technologies can be evolved with concerted participation of the various lead stakeholders.

12. There has been requirement of fast moving consumables of gun systems in the past and the requirement is envisaged to grow significantly in the upcoming years with the induction of a large number of ships. The platforms need to be equipped with safe, reliable and ready to combat gun systems.

13. **Indigenisation Envisaged.** The list of equipment for which spare parts/ components could be taken up for indigenisation are as follows: -

13.1. Barrels and liners for various guns.

13.2. Proximity cut-off devices for gun systems.

13.3. Bore gauges for checking condition of barrels.

13.4. Various elastomers for gun systems.

13.5. Mechanical components such as springs, levers and screws of various gun systems.

13.6. Hydraulic buffers and recuperators of various gun systems.

13.7. Proximity fuze for 30 mm and 76mm ammunition.

13.8. Steel cartridge case for 76mm ammunition.

### 13.9. MOC dispersal mechanism.

## Missile Systems

14. The missile systems held in the *IN* inventory and those which are being inducted are procured from OEMs or Indian DPSUs. The requirement of missile systems is envisaged to grow significantly in the upcoming years with the induction of a large number of ships, submarines and aircrafts. The missile technology is ever changing and platforms would need to be equipped with state-of-the-art missiles with better capabilities at all times.

15. *IN* has achieved success in indigenisation of various missile explosives viz; booster powder charges and ignitors, sustainer powder charges and ignitors, various pyros and missile batteries. Though the other missile components are being catered through the OEM, there exists a greater need to indigenise fast moving missile consumables.

16. **Indigenisation Envisaged.** The list of equipment for which spare parts/ components could be taken up for indigenisation are as follows: -

16.1. Homing heads of missiles.

16.2. Warheads, rocket motors and exploders.

16.3. Airframes, control surfaces and actuators of missiles.

16.4. Sealants.

16.5. Enamels and paints.

16.6. Various elastomers and rubber components.

16.7. Weapon health monitoring system.

## Electrical/ Electronic Systems

17. The electrical/ electronic systems play a very important role, be it within the naval armament stores or the test equipment being used. Most

of the electrical/ electronic systems held in the *IN* inventory are predominantly procured from OEMs. The electrical/ electronic systems primarily include: -

17.1. Test equipment for missile and torpedo preparation.

17.2. Simulators.

17.3. PCBs of various missiles sections and torpedoes.

18. **Indigenisation Envisaged.** The list of electrical/ electronic systems which could be taken up for indigenisation are as follows: -

18.1. Muzzle velocity and discharge pressure measuring device.

18.2. Torpedo simulators.

18.3. Invertors, converters and frequency stabilisers for torpedoes.

18.4. PCBs of various missiles and torpedoes.

18.5. Motors, actuators, power amplifiers and sensors of torpedoes and missiles.

18.6. Portable and ship borne presetters.

## **Weapon Systems**

19. Indigenisation of weapon systems is being driven through close collaboration with industry partners and DPSUs. These partnerships have enabled progressive replacement of imported components and systems with indigenous alternatives. Over the past few years, significant progress has been achieved in replacement of vintage gunnery and missile control systems and associated sub-systems. This has resulted in progressive replacement of foreign origin systems such as Uran, Club, Korall, PUMA, Bagira, Garpun and Purga with indigenous systems viz. BrahMos, SSR, Lynx, EON51 and IAC MOD C onboard our platforms.

20. **Indigenisation Envisaged.** The list of system/ sub-systems for which spare parts/ components could be taken up for indigenisation are as follows: -

- 20.1. AESA radars.
- 20.2. Anti-missile/ anti-drone defence system.
- 20.3. Optical and electronic components of submarine periscopes.
- 20.4. RF and solid state amplifiers.
- 20.5. Weapon health monitoring system.

### **Framework and Organisation**

21. Directorate of Naval Armament Production and Indigenisation (DAPI) was established at NHQ in April 2019. The role and responsibility of indigenisation of naval armament stores has been entrusted to DAPI since its inception. Subsequently, following Indigenisation Cells (ICs) were created at:-

- 21.1. Controllorate of Naval Armament Inspection (West), Mumbai/ CNAI (W).
- 21.2. Controllorate of Naval Armament Inspection (East), Vishakhapatnam/ CNAI (E).
- 21.3. Controllorate of Naval Armament Inspection (South), Alwaye/ CNAI (S).
- 21.4. Controllorate of Naval Armament (Ordnance Factories), Pune/ CAN (OF).
- 21.5. Controllorate of Naval Armament (Defence Production), Hyderabad/ CAN (DP).

22. In addition, following NAI cells at DRDO labs have been mandated to associate during the R&D activities being undertaken for NA stores:-

22.1. NAI Cell at HEMRL, Pune.

22.2. NAI Cell at ARDE, Pune.

22.3. NAI Cell at NSTL, Vishakhapatnam.

23. Naval armament stores being indigenised under 'Make-II' are as follows: -

| Ser No. | Naval Armament Store                                                                            |
|---------|-------------------------------------------------------------------------------------------------|
| 1       | Universal proximity and DA fuze for 76/62 SRGM with electronic adaptable to 76-127mm Ammunition |
| 2       | 5" Mobile Target Emulators for C303/S countermeasure system                                     |
| 3       | Limpet Mines Mk 414(7kg) and Mk 430(15Kg)                                                       |

24. Some of the naval armament stores proposed for indigenisation under various indigenisation routes are as follows: -

| Ser No.           | Naval Armament Store              |
|-------------------|-----------------------------------|
| <b>Missiles</b>   |                                   |
| 1                 | Missile Balwanka                  |
| 2                 | Missile Mockup                    |
| 3                 | Lightweight Supersonic Target     |
| <b>Torpedoes</b>  |                                   |
| 4                 | Exploders for torpedoes           |
| 5                 | Consumables for torpedo and decoy |
| 6                 | Torpedo simulator                 |
| <b>Ammunition</b> |                                   |
| 7                 | Signal flares                     |
| 8                 | Flare launchers                   |
| 9                 | SSE ejector                       |
| 10                | Insensitive energetics            |

| Ser No.                            | Naval Armament Store                                 |
|------------------------------------|------------------------------------------------------|
| 11                                 | Homing system for underwater rockets                 |
| <b>Decoys</b>                      |                                                      |
| 12                                 | Passive off-board decoys including inflatable decoys |
| 13                                 | Active off-board decoys                              |
| 14                                 | Ship launched IR and smoke decoys                    |
| 15                                 | A/c launched IR flares and chaff                     |
| 16                                 | Anti-sonar decoys (submarines)                       |
| <b>Test and Handling Equipment</b> |                                                      |
| 17                                 | Torpedo and missile loading gears                    |
| 18                                 | Decoy loading gears                                  |

### Indigenisation Through Academia

25. Naval armament stores proposed for indigenisation through academia are as follows: -

| Ser No. | NA store                                                                            | Institute   |
|---------|-------------------------------------------------------------------------------------|-------------|
| 1       | Advanced artillery smart shell design – SUDARSHAN                                   | IIT Kanpur  |
| 2       | Finite element analysis of SRGM barrel                                              | IIT Kanpur  |
| 3       | Design and development of polymer/ composite based driving band for gun ammunition. | IIT Delhi   |
| 4       | Identification of molecules for making insensitive explosives                       | IIT Chennai |

26. **Major Stores Imported.** The list of major stores still being imported is as tabulated below:-

| Ser No. | Naval Armament Store                                    |
|---------|---------------------------------------------------------|
| 1       | Light weight and heavy weight torpedoes                 |
| 2       | Light weight and heavy weight torpedo test equipment    |
| 3       | Torpedo countermeasure systems                          |
| 4       | Surface to Air Missiles and Surface to Surface Missiles |

| Ser No. | Naval Armament Store                                              |
|---------|-------------------------------------------------------------------|
| 5       | Missile test equipment                                            |
| 6       | Small calibre ammunition for Negev, Tavor, Galil, Dragonov Rifles |
| 7       | Proximity and direct action fuzes                                 |
| 8       | Chaff payloads                                                    |
| 9       | Flare countermeasures                                             |

27. As in the case of any onboard equipment, the optimum self-reliance of weapon systems is of vital importance for both strategic and economic reasons. In order to synergise and enhance national capabilities in producing state-of-the-art systems or equipment within timelines and cost that are globally competitive, all viable approaches such as formation of consortia, joint ventures and public-private partnerships are necessary.

28. Private industry has been involved in manufacture of various missiles, rockets, torpedoes, mines and launcher for rockets and torpedoes. A number of missile handling equipment have also been manufactured by industry and are being used onboard ships. However, the number of vendors is limited and larger participation would be desirable. Some of the firms viz. M/s L&T, Mahindra Defence, Tata Power Strategic Electronics Division (SED) have ventured in this field and successfully partnered Navy in development of these launchers and handling equipment.

29. The entire industrial might of the country, whether it is the PSUs, DPSUs, large private industries or MSMEs need to partner to achieve the goal of self-reliance of the Indian Navy.

### **Indigenisation Requirements**

30. A list of requirement for indigenisation of stores integral to missiles, torpedoes and other underwater stores, guns, gun ammunition, etc. is placed at **Appendix D**.

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**PART – IV**

**NAVAL AVIATION**

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## CHAPTER 8

### NAVAL AVIATION EQUIPMENT

1. The indigenisation activities in the Naval Aviation commenced in the year 2005, wherein, thrust and emphasis was laid on achieving 'Self-Reliance' utilising indigenous resources with an ultimate objective of developing substitutes to ensure limited dependence on foreign suppliers. In recent years, deliberate efforts and emphasis have been made towards indigenisation of aircraft spares, repair processes and test facilities through following levels of sustenance:-

1.1. Micro - Obsolescence management and import substitution.

1.2. Macro - Reduce dependence on foreign OEM, enhance capability.

1.3. Futuristic - Major indigenisation projects under Buy (Indian-IDDM), Buy and Make (Indian).

2. In order to establish a streamlined procedure towards indigenisation of air stores, a document titled Procedure for Indigenisation of Air Stores (PINAS) was initially promulgated. Subsequently, Manual for Indigenisation of Air Stores (MINAS) was promulgated in 2009 covering all aspects in the indigenisation process of air stores including DPM-09 provisions. In the year 2017, the Naval Aviation Indigenisation Roadmap comprising the indigenisation requirements of components of aircrafts (Five year requirements, 2017-2022) was published. Subsequently, on culmination of the first five year period, a revised Naval Aviation Indigenisation Roadmap for the period 2022-2027 was published in March 2022. Indigenisation of airborne stores is mainly based on its classification as flight critical / non-flight critical.

2.1. **Flight Critical (FC).** Those items whose malfunction would jeopardize the airworthiness/ safety of the aircraft and/or crew in flight are covered under Flight Critical. Items fitted on engine, flight controls, fuel systems, flight instruments etc. generally belong to this category. The airworthiness certification for the said items is accorded by

DRDO's Centre for Military Airworthiness and Certification (CEMILAC) through respective Regional Centres for Military Airworthiness (RCMA).

**2.2. Non-Flight Critical (NFC).** These are Non Flight Critical items pertaining to airborne stores, items of Ground Support Equipment, tools, test equipment etc. The airworthiness certification for the said items is accorded by Naval Aeronautical Quality Assurance Services, Kochi (NAQAS).

**3. Partnership with Indian Industry.** The Indian private sector has seen an exponential growth in defence aviation sector with the programmes such as Light Combat Aircraft (LCA), Advanced Light Helicopter (ALH) and UAVs in the recent past. In addition there is active involvement of private industry in collaboration with DRDO and DPSUs in developing different platforms and systems for naval aviation. The aerospace, particularly defence aerospace sector is ever growing in both macro and micro levels of indigenisation. The various upgrade programmes of naval aircraft and systems are progressed with Indian industry's support. A few examples are IFF, ESM Systems, Communication systems including SATCOM, Network Centric Capabilities etc. At micro level, the focus has been to achieve obsolescence management and import substitution to avoid OEM dependency. In these cases the indigenisation approach has been platform centric, with long term perspective. A few examples are Batteries, Tyres, Brake units, Multi-Function Displays (MFD) etc.

**4. Challenges and Opportunities.** The challenges of small fleet of platforms and associated business volume notwithstanding, a steady progress has been made on indigenisation in naval aviation, with support from DRDO, DPSU, CEMILAC and Indian private industry. The challenges and opportunities in this regard are as brought out below:-

**4.1. Micro.** Obsolescence management and sustenance of legacy platforms such as Kamov-28 helos of Russian origin and Sea king Helo of Western origin have been a huge challenge. The indigenisation efforts have not been restricted to one-to-one replacement of imported items, but are aimed at improving operational efficiency and reliability through re-engineering, ab-initio

design and technology enhancement. Approximately 1200 spares (by type) have been indigenised till date and over 300 are in the pipeline.

4.2. **Macro.** Greater focus is on long term sustenance, increased self-reliance and enhanced capabilities on new generation platforms such as MiG- 29K carrier borne fighter, Hawk AJT, KM 31 ASW helos and P8I LRMR aircraft. In addition to indigenisation of systems and items, setting up of Deep Repair Facilities (DRF) in partnership with Indian Industry is being actively pursued.

4.3. **Futuristic.** Future induction of platforms would be largely based on Strategic Partnership model, Buy (Indian-IDDM), Buy and Make (Indian) concept such as NUH and NMRH helos. Traditional concepts of Deep Repair Facilities (DRF) within services/ DPSU would have to be complemented or replaced with capabilities of Indian Production Agency (IPA) through their MRO facilities and Performance Based Logistics (PBL) concepts. Such new concepts present its own challenges and opportunities for Naval Aviation and the Industry.

## **Indigenisation Requirements**

5. List of requirement for indigenisation of Naval Aviation Systems which are envisaged for indigenisation is placed at **Appendix E**.

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**PART – V**

**ELECTRONICS AND ELECTRICAL  
SYSTEMS**

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## CHAPTER 9

### ELECTRICAL/ ELECTRONIC SYSTEMS

1. A large number of electrical/ electronic equipment for *IN* ships have been developed and supplied by the Indian Industry. Products like Microprocessor Based Air Circuit Breakers, Automated Power Management System (APMS), Combat Management System, Echo sounder, Log, surveillance radars, GbE based Ship Data Network (SDN), EW system, Multi-Function Displays, Software Defined Radios (SDR), Low weight shore supply cables, Static Frequency Converter (SFC), Rotary and Static Converters/ Inverters etc. have been indigenised by industry partners/ DPSUs and are used onboard *IN* ships.

2. Some of the indigenisation efforts progressed with potential areas of development by the industry are summarised in the subsequent paragraphs.

#### Navigational Aid Equipment

3. **Gyros.** Fibre Optic based/ contemporary Gyros with drift rates.

4. **Logs.** Indigenised through M/s Keltron. New technology in Log systems (eg. Doppler Velocity Log etc.) may be explored by the industry.

5. **Echo Sounder.** Indigenised through M/s Keltron. Indigenisation of transducer for the Keltron Log has also been completed.

6. **Indigenous ILMEN-GUVK.** Successful development of an indigenous ILMEN-GUVK system (utilised for transfer alignment of Ship borne Gyro parameters to Kamov helicopters) for Talwar & Teg Class ships has been undertaken through the industry and the contract for six systems for Talwar & Teg Class ships has also been concluded. Indigenisation of similar systems installed onboard other platforms is envisaged through private industry.

7. **GPS.** Development of Indigenous Satellite Based Navigation Systems with compatibility for GPS/ GLONASS/ IRNSS/ GAGAN, with jamming resistant and anti-spoofing technology is envisaged.

8. **Electronic Chart Displays (ECDIS).** ECDIS equipment provides the necessary ability to select, display and interpret relevant information, including the use of navigational functions associated with route planning, monitoring and knowing what proper action to take in case of malfunction. The equipment is being sourced as Commercial off the Shelf (COTS) equipment, however the present vendor base is limited and can be expanded with participation of the private industry.

9. **Auto-Plotter.** The function of an auto-plotter is to plot and record the position and track of own ship and be used by Action Information Organisation (AIO) for providing integrated track management for targets using ships sensors for tactical operations. At present the vendor base for the auto plotter in the *IN* is limited and can be expanded with participation of capable private industry partners.

10. **HVLAS.** HVLAS is a visual landing aid system installed onboard *IN* ships for providing visual indications to the pilot of a helicopter, coming onboard a ship for recovery. The system has been indigenised by M/s Elcome Marine. However, there is a requirement to expand the vendor base.

11. **AFC Equipment.** Air Facility Complex are being employed onboard aircraft carriers for flying operations. The present equipment fit onboard is Russian origin. Design and Development of various systems is in progress through various route viz iDEX, D&D and Make.

11.1. **Luna.** Optical landing aid helps pilot to navigate aircraft for final approach path. Indigenisation of the system is in progress through iDEX route.

11.2. **MTK.** Visual landing aid which helps LSO (Landing Safety Officer) to help navigate the aircraft for recovery. Indigenisation of the system is being progressed through iDEX route.

**11.3. Rezistor-E.** Rezistor-E is an instrumental landing system comprising of sub systems like RB, SR, FMSC, ACS and MLS. The system is being indigenised under various routes.

## **Communication Equipment**

**12. Rukmini.** A case for indigenous development of Rukmini (C and Ku Band) has been initiated by the *IN* for both above and below deck equipment. AIP for the case has been accorded in Apr 22 and the project is presently at feasibility study stage. Participation of the private industry in the indigenous development of the system is solicited.

**13. SATCOM Terminals for Submarines.** Design and Development of Ku Band SATCOM terminals has been completed by BEL (Gad) with successful trials. Procurement case is being progressed by NHQ.

**14. Communication Sets.** Most of the communication sets in VLF, V/UHF, HF frequency ranges are being sourced through import initially and later being produced/ serviced through PSUs like HAL, BEL and ECIL who process ToT from concerned OEM. Although these high technology/ capital extensive systems are generally taken up for development through DRDO or other PSUs, Private Industry may partner with these organisation for development of sub-systems and assemblies.

**15. Digital Beam-Forming Based Satellite TV (DB2ST).** View frequent failure of servo drives of Satellite TV antenna terminal onboard ships at sea, development of 'Digital Beam Forming Based Satellite TV (DB2ST)' is being progressed under 'Make-II' category. The technology requirement of DB2ST entails development of an antenna with no movable part and electronic beam steering. The SSCT has been successful on *IN* platform. RFP formulization is in progress.

**16. Integrated Mast (IM).** The development of UNICORN antenna is being progressed with M/s ATLA, Japan with BEL (Bg) as production partner which, aims at integrating V/UHF Communication, EW, IFF, TACAN, Wi-Fi, Link-16, in a single radome structure. However, the lead time for realisation of UNICORN antenna, customised for *IN* requirements is likely to be 2-3 years view technological challenges and finalisation of

terms and conditions for technology transfer. Therefore, as an interim solution, a parallel project for in-house development of an Indigenous Integrated Mast (IIM) (in limited scope) for *IN* Ships on fast-track basis is being undertaken through BEL (Bg). IIM envisages integration of multiple system antenna on a single mast without radome viz IIM version I and II have been installed onboard *IN* platforms.

**17. Development of Integrated Communication and Surveillance System (ICSS) for Submarines.** One of the most crucial aspects of submarine operations is the RCS when, the submarine is at periscope depth. With the advancements of technology, there is a requirement to minimise the number of masts which are protruding above the sea surface. In order to lower the probability of interception, there is a requirement to downsize and integrate sensor payloads so as to fit them on a single mast. The solution is expected to integrate optical surveillance R-ESM, C-ESM, SATCOM and communication antenna payloads. With integration of these payloads, one mast can integrate surveillance, communication and NCO requirements of an underwater platforms. Once developed and inducted on conventional submarines, these solutions can also be suitably adopted for AUVs/ UUVs which, have an inherent restriction of available space.

**18. Advanced Multifunction Antenna Systems (Submarine Application).** Existing multifunction antenna systems onboard submarines support VHF, UHF, S-Band, GPS, IFF and AIS functionalities. However, there are separate antenna systems for VLF, HF and Satellite communication. In order to optimise the available space onboard submarines and obviate the requirement of towed wire antennas for VLF communication, advanced multifunction antenna systems can be developed which support communication from VLF to K bands. Once designed and developed, these antenna systems can be configured to meet the requirements of submarines and well as AUVs/ UUVs. The development will require integration of multiple antennae in a pressure proof radome connected to the inboard equipment of the submarine through hybrid pressure tight cables. Further, these multifunction antenna systems can be installed on all classes of present and future submarine platforms in order to achieve standardisation of antenna systems.

19. **Software Defined Radios (SDR).** Secure and reliable communication is the backbone of any military operation. Great advancements have been made in the field of military communication around the world. The SDRs are not only compact but also provide multiple modes of communication from a single set. It is felt that efforts should be invested in the indigenous fructification of this technology.

## **Electronic Warfare**

20. **Ship and Air Borne EW Systems.** Development of new generation indigenous Electronic Warfare (EW) systems is being steered through DLRL (Hyd) under programme 'Samudrika'. The programme was sanctioned on 06 Jul 12 for development of seven types of EW systems (03-Ship Borne and 04 Air Borne) and are at various stages of implementation. As a sequel to the Programme Samudrika, development of next generation Advanced integrated EW and COMINT systems is being targeted for which the industry may also consider to undertake design and development efforts in collaboration with DRDO.

21. **Indigenisation of Network Components.** The Indian Navy's captive network hosts a resilient architecture, of which over 85% of the networking stack is comprised of indigenous make equipment viz. M/s Tejas, M/s Nivetti, M/s HFCL, etc. Indian Navy's sustained endeavour is to gradually progress towards a captive network, operating primarily on indigenous network components. Towards this, *IN* has been actively engaging with indigenous firms to enable them to understand the Navy's network requirement so that they may enhance the capabilities of their products to meet *IN* standards.

22. **TR Modules.** *IN* is progressing a case for development of 'T/R module-based EW systems, using Active Aperture Electronically Scanned Phased Array' for incorporation in indigenous EW projects. Involvement of private industry is also solicited in the design and development efforts which, is being progressed by DRDO. These modules are envisaged to be a game changer technology in the domain.

23. **Drone Based ELINT System.** As part of the future inductions in the field of EW systems, development of drone-based ELINT system is being undertaken through BEL (Hyd). While system specifications have been finalised and procurement of hardware for the ELINT payload has been

completed, there is an enormous scope of R&D in the domain as the present system is targeted in a specific frequency range only. Participation of the private sector in development of drone based ELINT systems in the entire spectrum is envisaged.

**24. Modular ESM Receivers.** Modular design and BLI technology-based ESM receiver for GHz frequency range is a likely field of interest to the *IN* as it aims to reduce the size of the antennae and provide the flexibility akin to a plug-in module. Further, development of Base Line Interferometry (BLI) based low band antenna for ESM coverage for MHz frequency band is also envisaged in the future. Participation of the private industry in development of such modular and technologically advanced systems is recommended.

### **Power Generation & Distribution (PGD) Equipment**

**25. Induction of Lithium-Ion Batteries.** Case for Li-Ion Batteries (LIB) for submarine propulsion is being progressed by the *IN*. Development, trial and testing of LIB module has been completed by M/s HBL through NSTL. Upscaling of the project is being progressed.

**26. Vendor Base Expansion.** Vendor base expansion in respect of the following systems is being progressed and capable industry partners are encouraged to engage with *IN* for offering products for trials as per promulgated specifications: -

- 26.1. Automated Power Management System (APMS) and Main Switchboard.
- 26.2. Alternators.
- 26.3. Motors.
- 26.4. Helo Starting Rectifiers (HSR).
- 26.5. LED luminaries.
- 26.6. Ruggedised UPS and ATS.

27. **Axial Flux Motors.** Conventional Induction motors used onboard ships are Radial Flux Machines wherein, the magnetising flux is generated in a direction perpendicular to the shaft axis. Axial Flux Motors generate the magnetising flux in a direction parallel to the shaft axis. This design makes the motor power dense and compact. The technologies required for realisation of these machines, which needs to be taken up by the private industry are as under:-

27.1. **Electrical Machine Design.** Design of stator and rotor based on available sources of magnetizing current and core properties.

27.2. **Permanent Magnet Material.** Use of permanent magnets would yield the performance results from axial flux machines.

27.3. **Power Conversion Electronics.** The motor control (speed and torque) will be achieved using voltage and current control by a power electronic converter.

28. **Inertial Energy Storage System.** Inertial Energy Storage System (IESS) is an ancient technology. However, with the advancements in power electronics, this technology is being increasingly used as a replacement of batteries for energy storage devices. IESS comprises a high speed dual feed electrical machine coupled with a flywheel. IESS can be utilised for high power transitional power supply applications for safety critical equipment like Steering Gear Motors. The technologies required for realization of these systems, which needs to be taken up by the private industry are as under:-

28.1. **Electrical Machine Design.** Design of a suitable electrical machine with very high speed of rotation (1,00,000 RPM).

28.2. **Material Science.** Use of carbon fiber reinforced materials which can withstand the centrifugal forces at high RPM.

28.3. **Magnetic Bearings.** The high-speed rotating assembly is required to be suspended using magnetic bearings in a vacuum

chamber to nullify the effect of drag and maximum utilization of Flywheel energy.

### **Sensors/ C<sup>3</sup> Equipment and their Integration**

29. **Navigational Radars.** These radars, essential for navigation, are low power, magnetron-based COTS radars supplied by foreign OEMs. Indigenous, SSPA based navigation radar would eliminate foreign dependency.

30. **Air Surveillance Radars.** Early Warning radars have traditionally been sourced from M/s BEL in the past. Even though these radars include some foreign content, the maximum constituents of these are sourced by the DPSU from indigenous vendors and MSME. With rapid transformation of technology, contemporary radars have migrated from TWT based mechanically steered to SSPA based, electronically steered AESA. Further, radars implementing Quantum technology are being conceptualized across the globe. There is a requirement for *IN* to collaborate with private industries and PSUs to remain ahead of technology curve.

31. **Command Control & Communication Systems (C<sup>3</sup>).** Command, Control and Communication system is an information system which incorporates strategic and tactical systems viz. combat direction system, tactical data system, or warning and control system with associated human function. The increasing need for responsive command & control systems is being driven by the rapidity with which weapons can be deployed. In a complex multi-threat combat environment, automated combat direction systems make it possible for people to deal with a large number of targets and compressed reaction times of modern warfare. The complex C<sup>3</sup> functions required to keep track of hundreds of friendly, neutral, and enemy ships, aircraft, and weapons, would be impossible by manual methods. Some of the Indian vendors assessed by Navy having capacity and capability as prospective developers include M/s TPCL, Tata Advanced Systems, M/s BEL, TCS etc. C<sup>3</sup> systems are required to be developed to incorporate following areas in support of commanders engaged in command and control: -

31.1. Reconnaissance and surveillance.

31.2. Environmental observation and forecasting.

31.3. Intelligence analysis.

31.4. Electronic warfare.

31.5. Navigation.

31.6. Strategic and tactical weapons deployment.

32. **C2 System with Integrated Data Link.** *IN* is conceptualising development of a C2 system comprising CMS, SDN and Data link. The technology required for the same is the principal man-machine interface for realisation of combat capability in a networked environment. It should have latest processing capabilities and hardware adaptable as per *IN* requirements for fitment on Naval platforms. The system is also envisaged to be integrated with SDN and a data link for networking with other platforms.

33. **High Speed Data Link.** The indigenous Data Link system has been developed using combination of in-house expertise (WESEE) and M/s BEL. The system has been inducted onboard ships.

34. In order to address the long term supportability issues of Ships procured from foreign countries, replacement of complete equipment/ components/ modules of certain non-technology intensive general purpose equipment could be considered by Indian industry.

### **Indigenisation Requirements**

35. The list of requirement for indigenisation of Electrical/ Electronic equipment and systems anticipated for fitment onboard is placed at **Appendix F**.

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**CHAPTER 10****PROJECTS COMPLETED/ PROPOSED WITH DRDO/ PRIVATE INDUSTRY**

1. *IN* is in the process of developing certain technology intensive projects through DRDO, towards which synergy meetings/ interactions with DRDO clusters are held periodically. The aim is to achieve the desired outcomes in a time bound manner with active participation of all stakeholders. Some equipment have also been identified for development through Private Industry under 'Make' category of chapter III of DAP-2020.
2. Projects envisaged to be/ being progressed under 'Make' category, Innovations for Defence Excellence (iDEX) scheme, Technology Development Fund (TDF) scheme and miscellaneous products to be taken up for development are placed at **Appendices G, H, J & K** respectively.
3. Similarly, a number of equipment for new construction ships have been developed through DRDO/ pvt industry. These indigenous equipment are being installed onboard all new construction ships, indigenously constructed Indigenous Aircraft Carrier (IAC)/ Anti Submarine Warfare (ASW) Corvettes and other ships. List of these equipment is placed at **Appendix L**.
4. Notwithstanding, any private industry/ MSME/ Startup interested in any of these projects may approach *IN* through the POC listed at the appendices to discuss their proposal and take it forward, keeping the co-ordinating directorate informed. The list of co-ordinating directorates is placed at **Appendix N**.

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## **PART – VI**

### **FUTURE TECHNOLOGIES**

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## CHAPTER 11

### FUTURE TECHNOLOGIES

1. Rapid and profound technological change is one of the most potent factors shaping the modern world. It creates significant opportunities, but drives increasingly complex, ambiguous and destabilising global threats, and catalyses profound societal, economic and political shifts. Technology is a strategic force; the nations that are best able to anticipate and exploit technological opportunities may have a decisive edge in future conflicts. In a resource constrained environment and given the breadth and relentless pace of technological change, focusing of effort is essential. The *IN* needs access to the right capability base (people, knowledge, facilities, industrial capacity etc.) to understand and develop technologies that offer the most promising cross-cutting applications so that it can exploit these technologies at a speed of relevance for transformative real-world impact.

2. Future wars will be characterized by deployment of unmanned weapon systems, robotic soldiers and sophisticated machines which can operate in all environments. Space, cyber space and asymmetric dimensions are likely to assume greater importance. Advancement in critical technologies, sensors, robotics, communication and electronics are shaping the future battle space. The technologies that would have defence related applications are:-

2.1 Advanced electronics and computation.

2.2 Sensors (photonics, laser, MEMS).

2.3 Advanced weapons.

2.4 C<sup>4</sup>ISR and Network Centric Operations.

2.5 Advanced propulsion, energy storage and power systems.

2.6 Warship design.

2.7 Stealth.

2.8 Advanced materials.

2.9 Artificial Intelligence.

2.10 Software Defined Radio (SDR).

2.11 Remotely deployable command and control system.

3. Fundamental technology developments will largely take place outside the government sector, and effective defence modernisation must be a partnership with DRDO, industry and academia. *IN* intends to engage with them in pursuit of better and quicker capability outcomes. The technologies outlined in the succeeding paragraphs would be the backbone of future *IN*.

### **Advanced Electronics and Computation**

4. Advanced electronics and computing are concerned with information processing, systems that are programmable, and the technologies that support them. It includes silicon-based digital information processing technologies like traditional microprocessors; specialist chips such as Graphical Processing Units (GPUs); Field Programmable Gate Arrays (FPGAs); Application- Specific Integrated Circuits (ASICs); and system-on-chip computing boards. It includes supporting elements like memory and associated software development environments. It also includes emerging information technologies like neuromorphic processors, and non-silicon-based quantum and DNA computing.

5. Rather than supporting a range of specific defence applications, advanced electronics and computing are of critical importance to defence as a foundational technology supporting other systems. Almost all platforms, systems and services contain a programmable element, and in many cases, this is critical to delivering the capability. Examples include the targeting systems for weapons, the processing of sensor data, and the flight control systems for aircraft. In addition, since programming is comparatively easy to change, this technology family contributes towards the agility necessary to counter today's rapidly-changing threats.

6. High-performance and fast computation capabilities have already emerged as essential ingredients for almost every conceivable application viz. management, networking, decision making, equipment performance enhancement, design and training & simulation studies. Advances in related technologies are continuously driving towards more and more miniaturization, increase in computational speed and power, and lowering of costs, a trend that will continue at a rapid pace during the current century. Powerful and smaller computers will enable development of more compact and powerful weapons, sensors, and crucial systems.

7. Automated systems have already found their way on board naval platforms for management of machinery, power and battle damage assessment systems. Automated systems hold tremendous potential for providing highly reliable performance to naval platforms, with reduced manning requirements, reduced platform size without compromising on capabilities, increasing surveillance, intelligence gathering and warfare conducting capabilities and minimising exposure of personnel to hostile actions.

8. The advancements in computation and sensor technologies, together with the advancements in Micro Electronic Mechanical Systems (MEMS) and nano-technologies, the next 20 years will witness an increased availability of sophisticated automated systems for a wide range of naval applications. Thus, computers, microprocessors, and related software that provide computation and automation capabilities are among the most important technologies that will impact the entire spectrum of technologies related to the Navy, and thus will strongly influence the future performance of the Armed Forces.

9. **Technology Trends.** The impact of computation in future naval operations is expected to be enormous. Combined with advanced distributed sensors, computation will be the primary enabler for achieving and exploiting complete situational awareness and will provide more and more computational power to the processing and interpretation of the digitised sensor signals. Sensing elements will become fully integrated with their supporting digital computer hardware to produce smart sensors or sensors-on-a-chip. More systems will become adaptive, processing in real-time the observed signature and altering their system parameters in

response to the observations to optimise their actual performance. Fusion of data from multiple sources, extraction of meaningful information contained therein, real-time control, and high accuracy will result in considerable optimisation in the effectiveness of future naval operations.

**10. Integrated Platform Management Systems.** A possible example of Automation Technology would be the Integrated Platform Management Systems (IPMS). New construction ships are already being fitted with IPMS for control and monitoring of platform-wide machinery and systems including propulsion, power generation and distribution, auxiliaries, damage control, steering and stabilisation. At present, group of 'dumb' sensors are connected to the processors with intelligence residing primarily in the central processor. With the significant increase in processing power and memory and reduction in the price, embedded processors will penetrate virtually every I/O point and thereby make each of them an 'intelligent appliance'. For example, an intelligent motor should be able to provide more information such as its history, part number, specifications, operating instructions, diagnostics, repair instructions, replacement alternatives, alarm messaging, pre-failure warnings, etc. Presently, this information resides in the documents or with the experts. A significant intelligent characteristic is diagnostic, not only after the failure has occurred, but also predictive (before the failure) and advisory (providing maintenance instructions). This kind of 'intelligence' will reside not only in the central processor but will be embedded in the equipment itself.

## **Sensor Technologies**

**11.** A sensor detects a physical phenomenon such as an electrical field, vibration or particle, and generates a response, such as the transmission of digital information or a change in colour to represent a detected chemical. Data from sensors, appropriately stored and analysed, builds our understanding of the operating environment, identifies items within it, and combines to provide situational awareness. Sensing therefore informs decisions at all levels.

**12.** Sensing technologies are diverse and include: electromagnetic sensing (e.g. electro-optic, infra-red, radar and electronic surveillance); gravity sensing; acoustic sensing; position navigation and timing (PTN);

chemical, biological, radiological and nuclear (CBRN); explosive sensing; quantum sensing; and sensor fusion. Sensors are deployed on a range of platforms operating in a variety of environments – and need to overcome congestion and clutter, detect difficult (including fast or stealthy) targets, continue to function despite adversary jamming attempts and counter-surveillance techniques, and conform to stringent size and weight requirements.

13. Developments in technology related to semi-conductors, super conductors, computers, signal processing algorithms are resulting in the increasing availability of high performance sensors with improved range, resolution and fidelity. While considerable indigenous R&D efforts are already in progress in various areas, these need to be pursued in a more focused manner for overcoming existing technology gaps. Considerable commonality of technologies exist in various types of sensors and therefore R&D efforts in various associated technology areas could be shared among different projects.

14. **Electromagnetic Sensors.** These include the complete range of radars, ESM/ECM, IR and laser systems. Dedicated DRDO labs are already undertaking R&D activities in these areas and considerable success has been achieved in specific areas. Important areas for sustained indigenous R&D effort are broadly outlined in the succeeding paragraphs.

15. **Distributed Acoustic Sensing (DAS).** DAS utilises optical fibre as a continuous sensing element for detection, classification and localisation of acoustic and vibrational disturbances over considerable distances. The technology enables a single fibre network to function as a distributed array of sensors and has potential application in both terrestrial and underwater environments. DAS could augment persistent surveillance of harbour approaches, seabed infrastructure, maritime approaches and areas of operational interest, including detection of underwater activity.

16. **Miniaturised Hydrophones for Underwater Detection.** Miniaturised hydrophones are compact underwater acoustic sensors designed to detect, receive and characterise acoustic signatures generated by submarines, unmanned underwater vehicles, surface vessels and other underwater activities. Advances in low-noise sensing, miniaturised

electronics and digital signal processing can enable development of small form factor hydrophones with enhanced sensitivity and reduced power requirements, facilitating their deployment in distributed and space constrained platforms. Such miniaturised hydrophones could augment underwater surveillance and ASW capabilities towards persistent detection and localisation of underwater targets.

**17. Radars.** With their all-weather and long-range capabilities for detection and tracking, radars will remain the primary electromagnetic sensors for Naval platforms. A revolution is already taking place in radar technology with the availability of high power solid-state electronics replacing conventional Traveling Wave Tubes (TWT), replacement of rotating radar dishes with steerable solid state arrays (providing increased reliability and scanning speeds), faster processing and digitisation for returning radar signals, smarter algorithms for improving signal processing, reducing clutter and false alarms, Track While Scan (TWS) capabilities, capability to track much larger number of targets simultaneously, identifying targets and providing motion analysis. Future radars will utilise solid-state phased arrays antennae for almost all frequency bands, with increasing use of active multi-function radar systems. Signal processing will be almost entirely digital beam forming, confining the analog microwave portions to the extreme front-end interface of the antenna with the outside world. Signals received at the antenna elements will be digitised at the element after minimal analog processing and passed on in digital form over wideband fibre-optic links to convenient remote locations for further signal processing, doing away with the requirement of wave-guides. Similarly, during transmission, digitally created waveforms will be generated and distributed via fibre-optics to individual antenna elements where Digital to Analog (D/A) conversion and Monolithic Microwave Integrated Circuit (MMIC) based power amplification will take place. Major application areas that need to be pursued through in-house R&D efforts include the following:-

17.1. Development of multifunction phased array radars.

17.2. Development of Synthetic Aperture Radars (SARs).

17.3. Development of Low Probability of Intercept (LPI) radars.

#### 17.4. Development of Millimetre Wave Radars (MWR).

### Quantum Technology

18. **Quantum Radars.** A quantum radar is an advanced sensing technology that uses principles of quantum mechanics, particularly quantum entanglement or quantum illumination, to detect targets with greater precision and resilience than a conventional radar. By generating entangled photon pairs and analysing the correlation between transmitted and received signals, quantum radars can identify low reflectivity or stealth targets even in noisy, cluttered, or jamming prone environments. This make them highly promising for next generating defense and surveillance systems, offering improved detection range, reduced probability of interception, and enhanced performance against electronic countermeasures.

19. **QINS (Quantum Inertial Navigation System).** QINS utilizes quantum sensors, such as atom interferometers and quantum gyroscopes to measure acceleration and rotation with exceptional precision, enabling accurate navigation without relying on GPS. By exploiting quantum properties like matter-wave interference, QINS offer superior long-term stability and resistance to signal jamming or spoofing, making them ideal for submarines, spacecraft and operations in GNSS-denied environments. This cutting-edge technology is being actively developed for defense and strategic platforms to ensure resilient and autonomous navigation in critical scenarios.

20. **Rydberg Atom-Based Quantum Sensing.** Rydberg atom-based quantum sensing exploits highly excited atomic states to achieve highly sensitive detection and measurement of electromagnetic fields and RF signals. The technology offers potential for wideband, highly sensitive and precise RF sensing, with applications extending to communications and Electronic Warfare. The technology could augment electronic support measures, spectrum awareness and passive RF surveillance capabilities through enhanced detection, identification and characterisation of electromagnetic emissions.

21. **Tunable Laser.** Tunable lasers for Directed Energy Weapons (DEWs) offer dynamic wavelength selection, enabling optimized atmospheric transmission, target material interaction, and reduced vulnerability to countermeasures. These lasers provide high beam quality ( $M^2 \sim 1-1.5$ ) crucial for long-range precision engagement and minimal beam divergence. Their adaptability enhances effectiveness across varied operational conditions, such as weather, range, and target type, making them highly suitable for naval and airborne platforms. Ongoing advancements focus on power scaling, thermal management, and robust beam control for deployment in real world combat scenarios.

22. **Active Sonar.** Submarines are increasingly becoming stealthier, limiting the traditional advantage of passive narrow-band processing. The trend of utilising active sonar operation, especially in the context of littoral warfare using multi-static operation with transmission from a platform or buoy exploited by all other sonar systems in vicinity, will gain tactical usage. Development of active sonar systems with multi-static capability, efficient receiver designs to overcome reverberation and low frequency transducers will therefore continue to receive more and more attention.

23. **Low Frequency Active Sonars.** Lower frequency could result in increased ranges due to low propagation losses. However, this is also handicapped by increased ambient noise and size of arrays. In near future, the frequency of active Hull Mounted Sonar would reduce even further. The advantages of any further reduction in transmission frequency, especially in the coastal tropical water would have to be weighed, before undertaking development of very low frequency sonar systems which will lead to bulkier arrays and significant increase in costs.

24. **Passive Sonars.** Passive sonar operation is an attractive option in deeper waters with low frequency of operation. The submarine sonars would essentially remain passive systems with flank and towed arrays to enable operation below 300 Hz. Efficient array systems with Left/ right ambiguity resolution, advanced classifiers and passive target motion analysis would have to be developed.

25. **Mine & Obstacle Avoidance Sonar.** Mine hunting and obstacle avoidance sonar would necessarily need to use high frequencies for better

target resolution and acoustic image processing for target classification. Improvement of ranges at higher frequencies will be a major challenge. This is a vital area where indigenous development has not made any significant progress. Demand of higher spatial and range resolution would require development of synthetic aperture sonars. Offline data-base management system would be another important dimension of mine sweeping requiring significant impetus.

26. **Air Borne Sonars.** Dunking sonars which employ low frequency active operation (1.5 – 3 kHz) would continue to perform the key role in underwater surveillance systems. The use of dunking sonar in multi-static active operation would require networking with ship-borne systems. Sonobuoys will provide cost-effective surveillance tools with development of Vertical Line Array DIFAR Buoy (VLAD), Directional Frequency Analysis and Recording (DIFAR), Command Activated Active Sonobuoys (CAAS), apart from passive buoys with LOFAR & DEMON processing available at present. The sonobuoy technology will have significant use in the field of harbour defence networks also.

27. **Non Acoustic Sensor System.** Alternate methods of underwater detection using Magnetic Anomaly Detection (MAD), satellite images and lasers will compliment acoustic detection. MAD will provide confirmation on detection of targets by acoustic means. Satellite imagery, both optical and from Synthetic Aperture Radar (SAR) will provide advance and panoramic detection capability.

## **Weapons**

28. Emerging threats and increasingly complex and congested environments present a new threat and there is a need to improve existing weapons, further enhancing precision in addition to new capabilities which deliver non-conventional effects.

29. Conventional weapons such as bombs and missiles are designed to cause kinetic damage to a target – physically destroying it or degrading it. Although kinetic damage is an appropriate response to some threats, modern threats and scenarios may require non-kinetic engagement. The presence of civilians or civilian infrastructure may preclude the use of

current conventional weapons. As such, enhanced precision guidance and 'smart' munitions are the need of the hour, the latter being able to distinguish its target from its surroundings and providing directional lethality. Other targets may not be suitable for conventional engagement due to their dispersed nature, imprecise or hidden location information, or resilience to conventional attack. In this situation, alternative weapons including offensive cyber and non-lethal weapons provide additional options for the commander and may allow the target to be engaged. In addition, next-generation weapons can deliver scalable or temporary effects, in situations where military action is required but lethal force is not desirable. Hypersonic and high-speed weapons could provide a rapid response to emerging threats and time-sensitive targets.

30. There are a range of technologies that could be weaponised, including radio frequency and laser Directed Energy Weapons (DEW), and offensive cyber. Radio frequency-DEW allows the engagement of targets containing electronic-rich systems or subsystems, potentially including mobile threats, targets within infrastructure, hostile sensors, and command and control. Laser-DEWs can counter a broad target set from improvised unmanned aerial vehicles to complex missiles. Offensive cyber weapons can deny or even destroy adversaries' capabilities affecting their ability to understand the world. Even when not used, these effects can act as a deterrent.

31. Next generation guidance and navigation systems utilising miniaturised multimodal sensors and advanced algorithms will enable precise delivery of effects onto a target in a GPS denied environment. Exploiting technologies and manufacturing processes from the commercial sector enables a range of new opportunities for defence. This is being demonstrated in DEW systems which are developed from RF and laser technologies first used in the civil domain.

32. Highly potent air-defence systems, anti-ship weapons, mines, torpedoes, and soft-kill weapons are becoming available to our potential adversaries including non-state actors at a low cost. The offensive and defensive capabilities on naval platforms will, therefore, need to be suitably configured with hard-kill and soft-kill weapons operating in networked environment with Co-operative Engagement Capabilities (CEC).

33. Indigenous R&D effort, therefore, needs to be directed towards development of suitable missiles, guns and soft-kill weapons for AMD, precision longer range missiles for offensive action against ship and land targets, guns with suitable ranges for providing Naval gun fire support and anti-ship and anti-submarine torpedoes.

34. **Anti-Ship Missile Defence.** Technological advances will result in the development of highly manoeuvrable, stealthy, sub-sonic, and/ or supersonic anti-ship ballistic and cruise missiles which the potential adversaries could be expected to possess. Many of them will be sea skimmers that would provide very little reaction times for employing effective defensive measures. Further, these missiles will be delivered from platforms at beyond the visual and stand-off ranges. Credible missile defence capabilities need to comprise quick-reaction high-performance Surface-to-Air Missile (SAM) systems, high rate of fire Close-in Weapon System (CIWS) guns and in future, Directed Energy Weapons (DEW).

35. **SAM Systems.** SAM systems will continue to be the back bone of Anti-Missile Defence (AMD) systems. However, their capabilities and effectiveness would need to be significantly enhanced for providing credible AMD. Development/ acquisition of SAM systems, with longer range, detection and CEC, are therefore essential to enhance the standoff ranges and serve as deterrence to the launch platforms.

36. **CIWS Guns.** CIWS guns will continue to remain the last means of defence within the inner boundary of kill zone of SAM systems. The AK-630 gun has been standardised as the CIWS gun for the Navy. However, with threats becoming increasingly stealthy, manoeuvrable, and supersonic, their performance improvements will need to be pursued. These include increasing the firing rate and developing improved ammunition such as Advanced Hit Efficiency And Destruction (AHEAD) ammunition.

37. **Attack and Fire Support Missions.** In order to prosecute threats and provide Naval Gun Fire Support (NGFS), precision anti-ship missiles, land-attack missiles and large caliber guns with appropriate ammunition need to be developed/ procured. Suitable small calibre guns are also required for engaging small craft, boats, etc., when operating in the littoral

environment or engaging non-state actors in policing/ low intensity conflict roles. Anti-ship and land-attack missiles should be capable of being launched from ships, submarines and aircraft.

38. **Attack Missiles.** Due to their longer ranges and inherent accuracies, cruise and sea-skimming missiles launched from ships, submarines and aircraft will remain the most effective and potent means for engaging enemy warships and land targets. However, as the surveillance, ECM and AMD capabilities of our potential adversaries are expected to improve, they will need to be countered by longer range, stealthier, faster and smarter missiles with enhanced ECCM facilities.

39. The cost of guidance subsystem generally dominates the weapon cost. Typically, guidance electronics may be half of the total cost of the weapon. Therefore, the reduction of the cost of guidance electronics is of utmost importance. Infra-Red (IR) and video seekers, one-way (command) data links, GPS, and new Inertial Measurement Unit (IMU) weapon navigation systems tend to be low-cost components. Two-way, high-data-rate links and long-range radar seekers are examples of high-cost components of a guidance system. System designs that utilise lower-cost components, standardised across weapons using similar components can significantly contribute in lowering the costs and hence need to be pursued.

40. **Guns.** Extending the barrel and recoil of conventional guns could enhance the range by a few kilometres. Conventional guns, however, have inherent limitations in the velocity of projectile and the range that can be achieved. The limits of gas expansion prohibit the launching of unassisted projectiles to velocities greater than 1.5 km/s and, therefore, the ranges that can be achieved are limited.

41. Considerable research is already in progress in developed countries for the development of Extended Range Guided Munition (ERGM) projectiles for larger calibre (127 mm, 155 mm and even larger) guns. The ERGM projectile with ranges up to 70 miles, with in-built GPS and INS, are expected to be available within the next decade. 155 mm shells with additional rocket motor drive and in-built intelligence are also under development and are expected to provide maximum ranges of up to 200 miles. Similarly, shells with Course Correction Fuzes (CCF) provide

accurate targeting and could be used in NGFS role. This will significantly enhance shore bombardment and NGFS capabilities of warships and need to be indigenously developed.

**42. Kinetic Energy Weapons.** Land-attack missiles are obviously not a cost-effective option for applications where a large amount of fire power is required. An affordable extension of the gun-ranges, therefore, requires an unconventional approach. It is in this context that the development of Kinetic Energy Weapons such as the Electro-Magnetic (EM) rail gun assumes importance. Experiments have demonstrated that the projectiles could be accelerated to achieve speeds up to 2.5 km/s. It is projected that hypersonic velocities of up to 6 km/s could be achieved. The EM rail guns can deliver the capabilities of hypersonic missiles at gun-like costs and has the potential to meet every naval fire support requirement. The kinetic energy weapons provide considerable advantages in terms of high projectile velocity, lethality, safety, enhanced ammunition carrying capacity, and enhanced ranges. As related technologies mature, they are also expected to become cost-effective. Development of pulsed power sources is a critical bottleneck in the realisation of EM rail gun. In the interim, Electro-Thermal-Chemical guns which require considerably lesser amount of pulse energy could be attempted to enhance the range of existing guns.

**43. Directed Energy Weapons (DEWs).** Technology developments in future generation anti-ship missiles will make them increasingly difficult threats for countering with the conventional SAM systems. Hence, the role of Directed Energy Weapons (DEWs), which operate at the speed of light, assume increasing importance. They use a beam of concentrated electromagnetic energy or atomic or sub-atomic particles primarily as a direct means to damage or destroy the intended target. With progressive miniaturisation of electronics, MEMS technologies, availability of high-power components, increased computation power, DEWs can provide tremendous potential for undertaking both offensive and defensive operations. As an example, compact DEWs mounted on aircraft or remote vehicles can be used to severely degrade an adversary's electronics, surveillance, command, control, and communication capabilities. Indigenous DEW programme for the development of such weapons, therefore, needs to be accorded high priority. The technology areas, which need attention, broadly include the following:-

**43.1. Laser Weapons.** They use a laser beam of concentrated energy to directly damage or destroy the intended target. In the next 5-10 years, laser weapons are expected to be deployed on naval surface ships as Close-in-Weapon Systems, and provide effective defence against anti-ship missiles. High-energy lasers are already under advanced stages of development in the USA, China, Russia and Israel.

**43.2. High-Power Microwave (HPM) Weapons.** Unlike the directed energy laser weapons, which aim to physically destroy the target, the HPM weapons use the high-power electro-magnetic energy to disrupt the performance of sensitive electronics in computer, communication, and electronic systems.

**44. Underwater Weapons.** Torpedoes, rockets, and mines are commonly used underwater weapons. However, the basic limitation of the torpedo is its speed which makes it liable to detection, tracking, and destruction. Higher speed torpedoes, therefore, need to be developed. Further, the range of ship/ air/ submarine-launched torpedoes also needs to be increased. Development of the light-weight/ portable mines that can be launched from air, and ASW rockets will also need to be progressed to counter underwater threats.

### **Command, Control, Communication, Computers, Intelligence, Surveillance, Reconnaissance (C<sup>4</sup>ISR) and Network Centric Operations (NCO)**

**45.** Effective command and control is an essential ingredient for conduct of naval operations, both in peace and in war. With improvements in surveillance capabilities, communications, weapon application and networking technologies, timely availability of all relevant information for conduct of naval operations is no longer a constraint. Emerging command and control systems will be valuable assets for managing the entire battle space with emphasis shifting from platform centric operations to network centric operations. Cooperative engagement capabilities will seek to exploit the range advantage provided by modern weapons and networked sensors, which may be decoupled from the weapons platform. NCO is emerging as

a tremendous force multiplier, which will enable availability of all relevant information in near real-time to decision makers permitting substantial compression of time lines for decision making.

46. **Command & Control Systems.** The architecture of new generation command and control systems will need to be modular and scalable with adequate built-in redundancies. They will need to be integrated with a host of equipment with varying interface protocols. The architecture shall support 'plug and play' features for ease of integration. The software will need to include expert algorithms with AI and auto-learning features to support fast decision making, and meeting the requirements of changing scenarios. Most importantly, the application software should provide for network centric operations and subsequently upgradable to incorporate Cooperative Engagement Capability as we transit from platform-centric to Network-Centric Operations.

47. **Remotely Deployable Command and Control System (RDCCS).** A robust and secure command and control system is paramount for a successful special operation. Ability to relay and receive time information between the deployed teams and command post greatly enhance effective decision making. This would require development of high speed modems and a reliable high bandwidth communication backbone.

48. **Communication.** The *IN*'s aspirations to become a truly blue-water Navy in next few years will become a reality only if naval commanders at sea are able to synchronize and integrate high-tempo operations anywhere in the world. This in essence would require global end-to-end information exchange among the units as a critical mission capability and would serve as a force multiplier for worldwide readiness, mobility, responsiveness, and operations. This information exchange would need to be provided by a network of efficient communication systems.

49. The most important requirement of naval communications is ship-to-shore and extended-range (beyond line of sight) ship-to-ship communications. The extended ranges and extended durations of ship deployments create unique challenges and complexities. These need to be met, in general, by satellite communications (SATCOM) resources. Communication systems will need to support voice, data and video

exchanges, with capabilities such as video conferencing. High demands will be placed on capabilities of the communication network. Network centric operations and cooperative engagement would require tremendous bandwidths, which cannot be met by conventional communication systems. This trend is certain to continue and supplying a dedicated channel to each communication task will become increasingly untenable.

**50. Technology Status and Trends.** Advances in C<sup>4</sup>ISR have been driven by the tremendous improvements in the field of communication technology, primarily driven by the commercial sector. Communications technology encompasses transmission, networks, applications development, and terminal/ application equipment. Communication transmission technology has already progressed from wire line to all digital and optical fibre or digital microwave. Networks are now electronically switched and have progressed from circuit-switched hierarchical configurations for telephony and data to packet-oriented data networks. Communications applications and related termination equipment now form a virtual continuum, expanding from traditional messaging and telephony to data, imagery, and live video. Progress in encoding methods for data compression continues, and asymmetrical approaches are being made in many applications, wherein brief queries to databases, for example, elicit voluminous responses of graphic or other data. Developments in the following areas of communication are required to be pursued:-

**50.1. SATCOM PCS.** 100% indigenised SATCOM Personal Communication System (PCS) for global service for hand held telephone with capability to exchange voice, video and high speed data links worldwide need to be realised which will require a constellation of satellites and would be developed/ launched by coordinated efforts of ISRO and Defence Space Agency.

**50.2. Security Overlay and Interoperability.** As part of development of Joint Services Interoperable Waveforms for tri-service interoperability, DRDO has been nominated as the development agency for the waveforms which will be ported over SDRs.

**50.3. Electronic Warfare.** The design and development model has augured well for *IN* and has resulted in strengthening of the development of EW system and support infrastructure in the country. Since sufficient expertise remains with the development agency DLRL and production partner BEL (Hyd), one of the most capable EW systems worldwide is available with *IN*. However, an advanced integrated EW system incorporating future technologies need to be progressed to meet the current and future challenges.

**51. Intelligence, Surveillance and Reconnaissance.** Intelligence must be able to provide timely, usable, detailed intelligence to allow naval forces including Special Forces teams to out-think and out-manoeuve enemy forces. However, the information gathered is also required to be disseminated to the relevant units at sea in near-real time and in a format, which could be readily utilised for effective decision-making. We need to develop means to download the extremely large amount of data/information collected in real-time and disseminate it to the relevant units. This would require high speed modems and reliable, high-bandwidth communication backbone.

**52. Network Centric Warfare.** A C<sup>4</sup>ISR system is in effect a network of systems at platform level with linkages to the outer world through tactical data links. The technology now exists to integrate all such platforms by a high speed, high bandwidth network so that the firepower of all netted units can be effectively utilised. Network Centric Warfare or Operations is already a reality and needs to be pursued. Towards this, the important technologies that need to be developed include tactical data links, networking and development of higher capacity algorithms for command & control systems that would facilitate in decision support.

**53. Co-operative Engagement Capability (CEC).** The key to CEC is to evolve a Common Operating Picture (COP) and make it available across the units. The concept of CEC is particularly relevant during a theatre-level operation or during a joint operation like amphibious operation and involves sharing of resources between the ships of a Task Force and other arms of the defence forces. It allows all available information from all the sensors such as radars, sonars, EW equipment and the weapons systems to be used against an adversary. CEC comprises hardware and software that

enables real-time distribution and fusion of weapons and sensor data so that individual units can also act as a unified force. This implies that all the CEC equipped units would utilize identical algorithms to create a tactical display. The main advantage would be greater reaction time for forces as there would be an early detection of targets. However, robust communication systems with high bandwidths, resistant to electronic countermeasures with a highly accurate positioning system would be the prime requirement of CEC.

54. **Common Information Grid.** Since the C<sup>4</sup> aspect of the NCO would enable all the relevant units to obtain a common picture of the battle space, the units would be operating on a common information grid. The common information grid would provide the decision makers with information, planning and analysis tools to make appropriate and timely decision.

55. **Weapon Grid.** The weapon grid can enable increase of the combat power by exploiting high levels of awareness through utilization of high-speed automated weapon-target pairing algorithms. These algorithms can rapidly determine near-optimal weapon-target pairings after taking into account the threat and resources available e.g. number of remaining targets, remaining rounds, and the probability of kill of remaining rounds.

56. **Interoperability.** In order to harness the advantages of network centric operations and cooperative engagement capability, it is essential that the command & control systems, tactical data links, associated communication systems, algorithms used for data fusion and data presentation are standardised or at least be interoperable. Though feasible, this is a major challenge, as it requires that the current systems are downward compatible with existing (legacy) systems and will be upward compatible with future inductions. It is essential that the requirement of interoperability is adequately addressed at the time of new inductions.

57. **Network Security.** Protection of C<sup>4</sup>ISR systems/ NCO systems against deliberate or inadvertent, unauthorised acquisition, disclosure, manipulation, loss or modification of sensitive information will have to be ensured. Development of secure firewalls and guards that need to be continuously upgraded to match the dynamic threat scenario will need to be undertaken. Capabilities such as automatic network intrusion detection

and response will also need to be developed. The data encryption techniques like key distribution and management by public crypto system or by private crypto systems also assumes significance. The field of normal security techniques like frequency hopping and spread-spectrum still needs to be realised to their full potential. Further, in case of local breach of network security, there should be a provision for dynamic allocation of computing resources while at the same time isolating the affected system.

**58. Disaster Management System.** A full-fledged disaster management system needs to be developed so that valuable data generated over a period is not lost due to intentional/ unintentional disaster. Data storage and recovery systems locally or in remote locations need to be accordingly put in place.

## **Propulsion and Power**

**59. Gas Turbines.** There is a need to develop indigenous gas turbines in the range of 11-15 MW and 20-25 MW for fitment on future ships as main propulsion units. The Inter-cooled Recuperated WR 21 gas turbine developed by Rolls-Royce and Northrop Grumman offers a 30% reduction in fuel consumption and a flat Specific Fuel Consumption (SFC) curve over entire operating range, when compared to contemporary Gas Turbines. These GTs combine the best of diesel and gas turbines, i.e., low SFC at part loads and high power density and fulfills the role of both cruise diesel and boost gas turbines. Such gas turbines, with reduced IR signatures due to their low exhaust temperature, have to be developed. Adequate emphasis has to be laid on development of gas turbines with enhanced aero-thermo-dynamics. This may involve improved designs of compressors for attaining higher pressure ratios as well as better combustion chamber designs for achieving higher turbine entry temperatures, thereby achieving higher power output. Developments in the field of advanced materials for combustion chamber and turbine blades would also be required to achieve enhanced power outputs.

**60. Diesel Engines.** Developments in the field of diesel engines are driven by stringent environmental regulations and requirements of multi-fuel operation and long service life. Technological advancements are required for reduction of emissions and improving combustion efficiency in diesel

engines. Development of technology for use of rheological fluids for torsional damping in diesel engines may be taken up for achieving better power to weight ratios and better torsional damping characteristics, across the entire power range of the engine.

**61. Air Independent Propulsion (AIP).** The trends in the area of non-nuclear AIP propulsion system have been mainly focused on development of Stirling engines, the MESMA steam turbine system and fuel cell power packs. Further, operational considerations like low noise levels, shallow water capability, size and manoeuvrability issues had rekindled interest in non-nuclear AIP solutions. It confers tactical flexibility by cutting down the indiscretion ratio thereby improving the survivability of a non-nuclear submarine. Development of these technologies would also reduce the dependence on fossil fuels.

**62. Fuel Cells.** Fuel cell technology is receiving considerable attention worldwide as it provides a viable AIP solution. The fuel cell power packs could be developed for submarine main propulsion as well as energy sources for various prime movers. The various types of fuel cells are elaborated as follows:-

**62.1. Proton Exchange Membrane Fuel Cells (PEMFC).** The electrolyte in the PEM fuel cell is a thin polymer membrane (such as poly perfluorosulphonic acid, Nafion<sup>TM</sup>, which is permeable to protons, but does not conduct electrons, and the electrodes are typically made from carbon). Hydrogen flows into the fuel cell on to the anode and is split into hydrogen ions (protons) and electrons. The hydrogen ions permeate across the electrolyte to the cathode, while the electrons flow through an external circuit and provide power. Oxygen, in the form of air, is supplied to the cathode and this combines with the electrons and the hydrogen ions to produce water. Each cell produces around 0.7 V, in order to generate a higher voltage a number of individual cells are combined in series to form a structure known as a fuel cell stack. PEM cells work at high efficiencies, producing around 40-50% of the maximum theoretical voltage, and can vary their output quickly to meet shifts in power demand. These are already available commercially for low power applications and can be used to provide back-up power supplies.

**62.2. Alkaline Fuel Cells (AFC).** The alkaline fuel cell uses an alkaline electrolyte such as potassium hydroxide. NASA originally used such fuel cells on space missions. The electrochemistry is somewhat different in that hydroxyl ions ( $\text{OH}^-$ ) migrate from the cathode to the anode where they react with hydrogen to produce water and electrons. These electrons are used to power an external circuit then return to the cathode where they react with oxygen and water to produce more hydroxyl ions. Alkaline cells operate at a similar temperature to PEM cells (around  $80^\circ\text{C}$ ) and therefore start quickly, but their power density is around ten times lower than that of a PEM cell so they are more bulky. These are the cheapest type of fuel cells to manufacture. However, their temperature requirements and size considerations restrict their utility for naval applications.

**62.3. Direct Methanol Fuel Cells (DMFC).** The direct-methanol fuel cell (DMFC) is similar to the PEM cell, as it uses a polymer membrane as an electrolyte. However, a catalyst on the DMFC anode draws hydrogen from liquid methanol, eliminating the need for a fuel reformer. Therefore, pure methanol can be used as fuel. These are still under development and may have utility as back-up supplies for low power applications.

**62.4. Molten Carbonate Fuel Cells (MCFC).** Molten carbonate fuel cells use either molten lithium potassium or lithium sodium carbonate salts as the electrolyte. When heated to a temperature of around  $650^\circ\text{C}$ , the salts melt and generate carbonate ions, which flow from the cathode to the anode where they combine with hydrogen to give water, carbon dioxide, and electrons. These electrons are routed through an external circuit back to the cathode, generating power on the way. The high temperature at which these cells operate enables them to internally reform hydrocarbons, such as natural gas and petroleum, to generate hydrogen within the fuel cell structure. At these elevated temperatures there is no problem with carbonmonoxide poisoning, and the platinum catalysts can be substituted for less expensive nickel. The excess heat generated can also be harnessed and used in combined heat and power plants. These fuel cells can work at up to 60% efficiency and this could

potentially rise to 80% if the waste heat is cogenerated. Development work needs to be undertaken to improve their efficiency, as these hold good promise for naval applications.

**62.5. Phosphoric Acid Fuel Cells (PAFC).** Phosphoric acid fuel cell (PAFC) consists of an anode and a cathode made of a finely dispersed platinum catalyst on carbon and a silicon carbide matrix that holds the phosphoric acid electrolyte. Phosphoric acid cells work at slightly higher temperatures than PEM or alkaline fuel cells – around 150 to 200°C – but still require platinum catalysts on the electrodes to promote reactivity. The anode and cathode reactions are the same as those in the PEM fuel cell with the cathode reaction occurring at a faster rate due to the higher operating temperature. This increased temperature also imparts a slightly higher tolerance to impurities and phosphoric acid cells can function with 1-2% Carbon Monoxide (CO) and a few ppm of sulphur in the reactant streams. Phosphoric acid cells though having lower efficiency and requirement of warming up time, have advantages like simple construction, stability and low electrolyte volatility. These have high potential for providing high power outputs, suitable for naval propulsion systems including remote vehicles.

**62.6. Regenerative Fuel Cells (RFC).** This technology works on the same basis as a conventional PEM cell. The difference is that the regenerative cell also performs the reverse reaction that is electrolysis. The water generated in the fuel cell is fed to a solar powered electrolyser where it is separated into its constituent components of hydrogen and oxygen, which are then fed back to the fuel cell. In this way a closed system is formed which does not require external hydrogen generation. Dependence of these fuel cells on solar power may rule out their utility for naval applications.

**62.7. Solid Oxide Fuel Cells (SOFC).** Solid oxide fuel cells operate at 800 to 1,000°C and use a solid ceramic electrolyte, such as Zirconium Oxide ( $\text{ZrO}_2$ ) with Yttrium Oxide ( $\text{Y}_2\text{O}_3$ ), instead of a liquid. These cells can reach efficiencies of around 60%. Energy is generated by the migration of oxygen ions from the cathode to the anode to oxidise the fuel gas, which is typically a mixture of hydrogen

and carbon monoxide. The electrons generated at the anode move via an external circuit back to the cathode where they reduce the incoming oxygen, thereby completing the cycle. These cells are resistant to poisoning by carbon monoxide as this is readily oxidised to carbon dioxide. This removes the need for external reforming to extract hydrogen from fuel and these cells can again use petroleum or natural gas directly. Development of such fuel cells is still in an infancy stage.

63. **Fuel Possibilities.** Most types of fuel cells (FC) ultimately require hydrogen as a fuel source which can be generated in a number of ways, either from renewable sources, such as solar power, or from hydrocarbons, such as natural gas or alcohols, by reforming. It is possible to supply hydrogen gas directly and store in tanks on the vehicle. The alternative option is to use liquid fuels and generate hydrogen within the fuel cell itself by the use of on-board reformers.

64. Of all the AIP systems under development, the phosphoric acid fuel cell is widely accepted potentially as the most viable solution. Fuel cells allow direct noiseless generation of electric power with much better efficiency than existing power plants. Efforts would have to be made to indigenously develop such fuel cells for marine applications.

65. **Electric Propulsion.** Electric propulsion technology is maturing at a fast pace for marine applications. This technology provides considerable advantages in terms of higher efficiency, increased flexibility in installation, improved survivability, lower noise signatures, reduced maintenance and manning requirements and considerable savings in through-life ownership costs. Due to these inherent advantages, commercial shipping has already adopted this technology extensively and the technology is being increasingly adopted for warship applications. Advanced navies like the US Navy, Royal Navy and French Navy already have inducted electric propulsion in their platforms and in the not too distant future, this is expected to become the standard technology for naval propulsion packages including electric OBMs for smaller boats.

66. Most of the elements required for adoption of this technology in warship applications are already available in the international market.

Though no special R&D efforts are required for adoption of this technology, indigenous production and high capacity power electronics related systems design capabilities need to be built up through the ToT route. The progressive development in fuel cells and super-conductivity technology will make the electric propulsion option more attractive.

## 67. Marine Engineering Systems

**67.1. Optimal Pipe and Duct Design.** Computational Fluid Dynamics studies for aerodynamic (low-noise) fluid flow in ducts and pipes needs to be taken up. The flow-induced noise through pipes and ducts constitutes a major component of the overall underwater noise emanated from the ship besides contributing to adverse habitability conditions on board. Irregular flow patterns are also the main factors for high wear rate of the pipe and ducting systems. Tools such as CFD can be employed for optimal design of ducts and pipes to attain better fluid flow characteristics leading to reduced noise levels, lesser wear rate and better heat transfer.

**67.2. Low-noise Gearboxes.** Noise generated from a gearbox contributes considerably to the overall noise level of the ship. Techniques such as finite element analysis should be developed to design compact and silent gearboxes. Advanced manufacturing techniques, metallurgical processes and materials are required to be developed to meet the silent gearbox standards.

**67.3. Advanced Motion Control Systems/ Motion Interceptors for Roll and Pitch Stabilisation for Naval Platforms.** The motion interceptor is primarily a plate extending below the transom, which intercepts the flow of water. It reduces the flow velocity locally thereby increasing the pressure on the hull and generating a lift force. The forces generated by blade immersion are controlled to provide trim and list stabilisation and damping of pitch and roll rate accelerations. An interceptor system comprises of a sensor package, central processor, display unit, hydraulic power pack, servo controller/manifolds, actuators and interceptor blades. The interceptors are ideally suited for high-speed crafts for speeds above 25 Kn. The same concept could be developed for the entire speed range for exploitation

of the surface combatants. The advantages of the motion interceptors over the existing Stabiliser systems are lightweight, low power and non-vulnerability to damage.

## 68. **Production and Design Technology**

68.1. It is essential to develop technology for use of air-lubricated bearings in high-speed turbines, rotating machinery etc. Air lubricated bearings would offer advantages of reduced friction levels, operating temperatures, longer life due to lower wear rate and reduced Specific Fuel Consumption of turbines.

68.2. Developments in design and manufacturing technology would help in arriving at futuristic aspects of shipbuilding and repair yard technology. Some areas of potential development are as follows:-

68.2.1. Analytical tools, viz., bond graphs for machine design.

68.2.2. Advanced machining technologies for manufacturing components.

68.2.3. Computer-aided production, planning & control relevant to warship aspects.

68.2.4. Investment casting technology.

## **Warship Design**

69. **Introduction.** The *IN* has an ambitious on-going ship construction programme with majority of the ships being constructed indigenously. Indigenous ship construction activities have basically utilised conventional hull forms, largely utilising ferrous materials such as carbon steel, low alloy steel and cast irons. Non-ferrous materials like aluminium, titanium and copper alloys are also being utilised for limited applications. Emerging technology trends in warship design, material sciences and stealth technology are set to revolutionise warship building, providing platforms with better speeds and sea keeping qualities, higher equipment package

density without compromising on weight to power ratio, enhanced stealth features, reduced maintenance efforts and more comfortable living conditions within the platforms. Advanced Navies are already making rapid strides in various associated areas towards enhancing their capabilities. Indigenous development & early realisation assumes urgency keeping in view the large gestation period of these and resultant ship building efforts.

70. **Hull Forms.** At present, our indigenous ship-building programme is predominantly based on conventional mono-hull forms. Development in new hull forms are expected to open up a wide range of possibilities in designing ships for different operational roles, with better sea keeping capabilities, higher speeds, larger pay loads and improved survivability. Certain important newer hull forms are broadly outlined in the succeeding paragraphs.

71. **Air Cushion Vehicles (ACV).** ACVs riding on a cushion of relative low-pressure air, with speeds in excess of 80 knots are already available in the international market. These vehicles have enormous potential for fast attack missions, over-the-beach assault capabilities and even mine-hunting. Landing Craft Air Cushion (LCAC) have already emerged as key ingredients for amphibious operations with its inherent ability to launch assaults from extended ranges against almost any beach head.

72. **Surface Effect Ships (SES).** The SES, like the ACV utilises pressurised air cushion to reduce resistance to motion. These incorporate rigid catamaran – style side hulls to enhance stability and maneuverability. High speed and improved sea-keeping make them suitable candidates for fast attack missions, and this hull type is less susceptible to below water level mine explosions compared to mono- hulls.

73. **Small Water-plane Area Twin Hull (SWATH).** This hull form has a pair of fully submerged hulls on which slender struts are mounted to support a cross-structure. In addition to providing better sea keeping quality compared to mono-hull vessels, SWATH exhibits less fall-off in speeds with increasing sea state. This hull form permits providing big-ship platform steadiness and ride quality in smaller vessels, with ability to sustain high proportion of normal cruising speed in rough head seas. SWATH ships are expected to have less than 50% water-plane area compared to mono-hulls

of equivalent displacement. SLICE hull, a derivative of SWATH, with four strut hulls, or pods, are also under development and are claimed to provide higher speeds compared to mono-hulls with the same power, lower installed power and fuel consumption for the same speed, higher flexibility in strut/hull arrangements and lower wake signature at high speeds. SWATH mine hunters are already under design by some countries, and, in future, may also be utilised for deploying and recovering remote vehicles.

74. **Catamaran.** Vessels with two parallel and abreast hulls attached to a common deck have been demonstrated commercially to exhibit better performance than mono-hulls in a speed range of 35 to 40 knots. At present, their use is limited for restricted/ coastal water applications due to their inferior sea keeping qualities in the open-seas. However, design improvements and derivatives like trimaran and pentamaran hulls have promising potential. Littoral Combat Ships based on trimaran hull, high speed corvettes and versatile frigates designs utilising pentamaran hulls are already on the drawing board in certain countries.

75. **Specialised Crafts for Discreet Usage.** The warship design program should include research in design and fabrication of specialised crafts for clandestine operations by Special Forces. These include fully submersible and semi-submersible manned crafts with the ability to traverse both on surface and under-water.

76. **Other Hull forms.** Various other newer hull forms like Delta hulls, Planing hulls, monohull forms and hybrid hull forms are also under extensive investigation by other advanced navies.

## **Stealth**

77. Incorporation of stealth features in warships is gaining increasing importance to counter emerging threats due to rapid advancements in the field of sensor technology, signal processing and intelligent ammunition. Concepts such as integrated topside systems and vertical launch weapons for reducing RCS, development of acoustic silencing techniques for underwater signature reduction and cooling techniques for IR signature reduction are receiving increasing attention in ship design / construction. The process of building-in stealth in new constructions necessarily needs

to commence at the drawing board stage itself. Important aspects that need to be covered for realizing stealthy warships are broadly outlined in the succeeding paragraphs.

**78. Radar Signatures.** Structural surfaces and corners, deck fittings, weapon mountings, Masts, radar antennae, communication antennae, etc., are good reflectors of EM energy and contribute to increasing the RCS of ships. RCS reduction techniques involve suitable shaping of upper structures including multi-surfacing, rounding of corners, concealment of high EM energy scatterers and use of special radar absorbent/ transparent materials. Existing knowledge base on RCS management needs to be continually developed for implementation on new constructions. While RCS minimising measures are best incorporated in new constructions, development of suitable radar absorbent paints would enable some degree of RCS reduction on existing ships also. Radar Absorbent Paints (RAP) in the frequency range of 8-12 GHz has been developed by NMRL and inducted for application onboard snort and periscope mast of submarines. Development of higher frequency range upto 40 GHz needs to be further explored.

**79. Acoustic Signatures.** Radiated noise of ships and submarines could be structure-borne (machinery, propeller, shafting, gears, transformers etc.), airborne (machinery) and water-borne (propeller, underwater openings, flow noise). Incorporation of suitable noise suppression measures, therefore, needs to be emphasized during ship design and construction. Measures incorporated include design of machinery foundations, low noise propellers with high cavitation speeds, system pipes arrangements, noise isolation acoustic/ pads, flexible deck and bulkhead glands, use of flexible bellows/ couplings, raft mounting of noisy equipment, etc. Noise signatures of current and future platforms can be reduced substantially by use of double mounting of equipment, use of further suitable sound and vibration isolation materials, isolation techniques and active vibration and acoustic signature control. Reduction of hydrodynamic flow noise and delayed onset of cavitation are also to be consistently worked upon. New propulsion concepts are also evolving for reducing acoustic emissions, with integrated electrical propulsion being a forerunner. While certain noise reduction techniques are already being incorporated in new constructions, progressive improvements need to be

targeted. This therefore remains another focus area for indigenous R&D and equipment selection/ installation. Mastic coating for reduction of underwater radiated noise ranging from 200-2500 Hz resulting in vibration damping of the order of 10-15 dB has been developed by NMRL and inducted for onboard application on as required basis. Development of similar coatings for vibration damping in lower frequencies < 200 Hz need to be further explored.

**80. Infrared (IR) Signature.** Principal sources of IR signatures are exhaust arrangements, impingement of exhaust gases on ship structures creating hot spots and hot superstructure surfaces due to radar heating. Controlling IR signature involves reducing the emissivity of exhaust gas outlet and plume and exposed hot surfaces. Since, hot spots are easy to detect, these need to be cooled or screened from direct view of IR detection sensors. Use of IR suppression devices for hot exhaust gases, low emissivity paints, foil-covered windows, shaping hull and superstructures to reduce sunlight reflection, etc., are some of the conventional measures being adopted to reduce IR signatures. Emerging trends include alternate exhaust arrangements like shipside/ transom exhaust arrangements with exhaust gas cooling by water injection, hybrid IR suppression system like eductor-diffuser integrated with water injection systems, good thermal design principles, application of proper ventilation and insulation to exterior bulkheads to reduce outer skin temperatures, plume cooling, active cooling of hot surfaces with sea water, water mist systems, etc. IR measures are accordingly being incorporated in new design ships with developmental work being progressed through DRDO.

**81. Miscellaneous.** Emerging technologies are also being adopted for management of magnetic signatures, underwater EM signature and Extremely Low Frequency Emissions (ELFE) from Impressed Current Cathodic protection (ICCP) systems.

## **Materials**

**82.** A variety of materials are required for ship construction/ upkeep. These range from structural steels to composites and encompass insulation materials, deck covering materials, materials for piping and fixtures, coating door and latches, deck blocks, cable chains, main machinery, sonar domes

and paints for surface protection. Until recently we were completely dependent on imported steels for warship construction. While this situation has now been remedied to a large extent, continual R&D effort is required for developing emerging exotic materials, composites and paints.

83. **Ship Building Steel.** DMR 249A steel for ship building and DMR 301 & 249B certified steel for submarine application has been developed successfully for indigenous ship and submarine building programmes. Development of further high strength steels with yield strength of 1000 MPa for submarine constructions is in hand for which industry support would be required.

84. **Weld Consumables.** Sources need to be developed to make weld consumables HLES steel used on Submarines.

85. **Composites.** High grade composites need to be developed for the following:-

85.1. Fabricating items such as doors, hatches, ventilation flaps, hanger shutters etc.

85.2. High grade Carbon Fibre Reinforced Plastic (CFRP) composites for masts, super structures, which can thereafter be suitably integrated with the main hull to provide stealth and reduce top weight of warships.

85.3. Propellers for ship as well as torpedoes based on composite materials are required to be developed in order to improve stealth features.

85.4. Suitable composite armour materials also need to be identified/ developed to provide protection for personnel against small and medium arms firing. These materials can be embedded in panels which can be fitted at select locations on-board or slung on the side of the craft, and would not affect the endurance and speed of the vessel.

86. **Titanium.** Due to its inherent properties, use of titanium has major advantages in fabrication of structures such as sonar domes, high pressure pipelines, etc. Indigenous development in these areas needs to be pursued.

87. **Cladded Metals.** Cladded steels are excellent materials with both strength and chemical resistant properties. These are particularly suitable for battery storage compartments, which are highly prone to electrolytic corrosion/ erosion.

88. **Direct Metal Deposition.** Casting complicated shaped items through conventional moulding techniques suffers from large rejection rates. New techniques in fabricating 3-D forms utilise direct metal deposition techniques, using LASER cladding. Consequently, dimensional accuracies are assured and rejection minimized. Technology in this field needs to be developed.

89. **Metallic Foams.** Metal foams have the potential to be used as sandwich/ honeycomb material for minor bulkheads providing noise and weight reductions.

90. **Special Materials.** Future naval systems will require technological advancements in the areas of superconductors and magnetic materials, organic materials and coatings, energetic materials, and high-temperature semiconductors. Naval applications for superconductivity include:-

90.1. Superconducting magnets for electrical motors and ship propulsion.

90.2. Superconducting magnetic sensors for mine detection.

90.3. Superconducting magnetic systems that store energy for burst power.

90.4. High-Q cavities for high-resolution radar system.

90.5. Low-power analog and digital circuits.

91. Further technology developments in materials engineering, manufacturing, and systems integration will be needed for realizing the benefits of superconductivity in naval applications. Since the discovery of High Temperature Semiconductors (HTS) in 1986, numerous applications have emerged, including superconducting cables, transformers, motors, and energy-storage devices. HTS conductors are typically fabricated as a multi-filamentary flat tape. These conductors use a ceramic precursor powder placed in a silver billet. The billet is then formed into a thin filament using commercial deformation processes, and multiple filaments are then placed into a silver tube and deformed again into a bundle of filaments. These steps are repeated until the conductor contains the appropriate number of filaments. The conductor is then rolled into a flat configuration and heat treated to transform the ceramic precursor into a superconductor. This process is referred to as Oxide Powder In Tube (OPIT). OPIT conductors have shown linear performance improvements over the last 10 years, and manufacturing costs have steadily declined. It is now required to develop the next generation of HTS-coated conductors. Coated conductors use a thin film of HTS deposited onto a substrate; they exhibit significant performance gains as compared with OPIT conductors and can be significantly less expensive to manufacture.

92. **Engine Materials.** Materials to be used for future naval engines should have reduced weight, increased temperature capabilities, improved mechanical properties, and better corrosion and oxidation resistance. Such high-performance materials include organic matrix composites, titanium alloys, and inter-metallic compounds. For turbine components, Nickel Aluminium (Ni-Al) polycrystalline materials could be extended so that they are available in a single-crystal form. Inter-metallic compounds, along with titanium-based metal-matrix composites such as Titanium Aluminium Niobium (TiAlNb) with Silicon Carbon (SiC) fibres, may be useful for compressors. Static engine components will require high-modulus inter-metallic compounds such as Gamma Titanium Aluminium (g-TiAl). The high-temperature capability of super-alloys based on Ni-Al is expected to meet the 2,000°C requirement.

93. **Magnetic Materials.** Improved magnetic materials will be required for magneto-optic devices and high-sensitivity, low-cost magnetic sensors to be utilised as magnetometers, radio-frequency antennas, and biological

and chemical sensors. Improvements in material properties through enhanced processing techniques and modelling will enable these applications.

94. **Advanced Energetic Materials.** The naval forces, in addition to improved warhead explosion devices, require a competitive edge in the power and range of missiles. Advances in techniques for the synthesis of very dense organic compounds that are highly substituted with energetic groups will be required. The approach will be computationally based initially, followed by a synthesis simulation and prototype production. Continued development of new chemical processes to produce novel energetic materials and improvements of initial chemical processes to produce novel structures economically and environmentally are essential.

95. **Insensitive Energetics.** Insensitive explosives are much safer than conventional explosives in handling, storage and operational exploitation. Research into insensitive energetics is focused on converting the whole explosive chain, from primary initiators to warheads into insensitive compositions. *IN* plans to induct armament with insensitive energetics in the future. Therefore, there is a need for enhanced focus on development of insensitive energetics.

96. **Organic Materials–Flame-resistant, High-temperature Organic Composites.** Polymers and polymeric composites are required for superior flame-resistant and high-temperature properties. These proposed materials are phthalonitrile-based composites with thermo-oxidative stability up to 500°C. These novel flame-resistant materials will enhance ship and submarine safety.

97. **Smart Materials and Sensors.** Smart materials technology consists of the application of ferromagnetic, ferro-electric, and ferro-elastic materials, better known as Shape-Memory Alloys (SMA), as mechanical actuators and/ or sensors to improve the performance of components, structures, and systems. It is envisioned to integrate smart materials with nano-scale electronic processors resulting in mechanically and electrically adaptive elements. Many proposed systems will benefit from the utilisation of smart sensors. For example, smart sensors could increase the performance and efficiency of personnel and equipment in areas such as

condition-based maintenance. Overall, a full assessment of smart materials and MEMS materials will need to be carried out. System integration including data sampling, networking, and communication issues will have to be addressed. Smart materials on the micro-scale will be combined with electronics on the nano-scale to form smart sensors, all as part of a micro-nano-electronic technology thrust.

98. **Nano-Phase Materials.** A new emphasis in material science centers on the nanometer ( $10^{-9}$  meter) size regime, which is intermediate between the well-studied macroscopic and atomic size regimes. The understanding of structural and compositional features in the nanometer size range will facilitate the control of the magnetic, electrical, and optical properties of materials. Nano-phase or nano material is an area of prime importance for future naval applications, especially with the expected conversion of most ships to integrated electric power and propulsion systems. Magnetic nano-materials may offer dramatically improved performance for magnetic-storage applications. The enhanced strength of nano-phase coatings and the potential for improved mechanical behavior of consolidated nano-crystalline has obvious applications in the area of structural materials. One important example is the super-plasticity of nano-crystalline materials, a property appropriate for missile nose cones and armour. Nano-phase materials could be combined with nano-scale electronics to produce a new class of sensors able to achieve ultra-high-speed and low-power dissipation.

99. The capacity to carry out high-resolution lithography capable of manufacturing devices with critical dimensions on the order of a nanometer is required before nano-phase materials technology can become practical for naval applications. Other related technologies that will require further development before nano-phase materials can be widely deployed include plasma-etch technologies and interconnects for quantum electronics. In photonic systems, nano-phase structures will enable the development of nonlinear optical systems or possibly smart nano-sensors that are optically interconnected to form a highly capable meta-sensor.

100. **High-temperature Structural Materials and Coatings.** High-temperature materials and coatings, include metal composites, ceramic-metal composites, inter-metallic alloys, and carbon-carbon composites.

They are amenable to low-cost synthesis through the application of computational materials design and useful in a number of applications including aircraft engine components. Metal-matrix composites will meet most of the requirements for materials that can withstand temperatures up to 500° C. Oxide materials, such as the Yttrium Aluminum Oxides ( $\text{Y}_2\text{O}_3$ ) are needed for systems, which require components to withstand 1,000 to 2,000° C. Metallic and ceramic surface coatings are currently used to improve the performance, prolong the service life and reduce maintenance of advanced turbine materials. Protective coatings used in aircraft, marine, and powergeneration turbines to increase operating temperatures extend component life by providing protection from high-temperature oxidation and high-temperature corrosion. Advances in ceramic coatings will be required for future naval systems. In the temperature range of 1,500 to 2,100°C, materials such as silicon carbide, silicon nitride, and other systems are able to limit oxidation will be needed. Microwave and laser processing technologies have to be developed for these difficult-to-shape materials. For systems above 2,000°C, carbon-carbon composites, diamond-like coatings, synthetic-diamond thick films, and carbides such as boron tetra-carbides and titanium carbides will be needed.

**101. Processing and Synthesis of High Temperature Structural Materials.** Technologies that may enable the manufacture of high-temperature structural materials are rapid solidification (splat cooling) and electron-beam evaporation. These techniques will allow the development of lamellar composition and functionally graded materials. Methods of processing of fiber with a polymer matrix that combine joining processes with material synthesis will be needed. Research into development of polymer driving bands for ammunition is underway at IIT Delhi. Development of novel polymers for more defence applications is needed, especially in lighter, fire resistant ammunition packaging.

**102. Coating Technology.** Coating of materials provides thermal protection and increased abrasion resistance. There is an urgent need for development of high temperature coatings especially in gun barrel and cartridge case applications.

**103. Newer Materials.** In the future entirely new and enhanced materials are expected to be designed and manufactured using a computational

approach and atomic seal understanding of material physical and mechanical properties. Monoplane materials, smart materials, heterogeneous materials, superconducting materials, high temperature materials, functional materials are a few examples which have high potential for Naval applications.

**104. Protective Technologies.** Protective coatings involving Stratified anticorrosive/ antifouling coating and Non-skid coating for flight decks needs to be developed for applications on warships.

**105. Stealth Materials.** In order to reduce acoustic signature suitable development of low frequency multiple layer damping coating, vibration damping coatings is needed for applications on warships.

**106. IR Reflective Coating.** Development of corrosion resistant IR reflective coating for improving habitability onboard warships by minimising the heat transfer from sun radiation to the substrate is required.

### **Autonomous Systems and Robotics**

107. Autonomous systems exploit sensors and other data sources to gather information on their environment, use advanced algorithms and Artificial Intelligence to process and understand it, and make decisions about how to respond, and perform tasks – whether physical or virtual – to achieve assigned goals. Robotic systems are automated machines that carry out complicated actions independently of, or in conjunction with, humans. Some of the illustrative applications are:-

107.1. Replacing human operators with machines in high-risk environments, such as logistics resupply or explosive ordinance disposal.

107.2. Maximising the effectiveness by allowing personnel to focus on complex tasks while the simple and low- value tasks are delegated to machines.

107.3. Exceeding the performance of a human operator by taking actions autonomously, such as in response against anti-ship missile threat.

107.4. Generating physical mass in the battlespace through resilient swarms of low-cost systems.

107.5. Integrated human-machine teams which use the respective strengths of both humans and autonomous systems.

107.6. Supporting an active military presence in areas where it would not traditionally be possible.

108. **Unmanned Vehicles.** Unmanned vehicles will progressively find increasing use in the naval applications. Unmanned Aerial Vehicles (UAVs) launched from shore/ ships provide tremendous potential and force multiplication for reconnaissance, surveillance, co-operative engagement and as platforms for autonomous weapon release. Rapid evolution of technologies related to increasing mission pay-loads, improving sensors (including sensors combined with weapon systems) and aeronautical technologies (navigation, autonomous control, propulsion) make UAVs very valuable tools for a variety of naval operations. The operational spectrum of these UAVs will include reconnaissance, C2, target discrimination and identification, battle damage assessment, data transfer, Electronic Counter Measure (ECM), Electronic Support Measure (ESM), Electronic Counter Counter Measure (ECCM) and combat support/ identification in case of shore bombardment and amphibious operations. UAVs will act as force multiplier and represent the 'eyes' of naval units in the future, providing them the possibility to see in real-time-over-the horizon. They may in future be used in-lieu of helicopters for certain roles.

109. **Autonomous Surface Vehicle.** ASVs have evolved over a period of time and have a diverse employability for the *IN*. Apart from benign missions, ASVs are needed for advance long range patrolling of EEZ and hostile harbours. They could be trained and utilised for escorting high value merchant assets entering and leaving harbour. The Shore Control Centre for these ASVs could feed combined data to IFC-IOR for enhanced MDA.

**110. Autonomous Underwater Vehicles (AUVs).** There have been numerous developments towards enhancement of design, development and operational capabilities of Indian Naval agencies and associated industry partners for underwater autonomous vehicles. Future AUV missions may be extended to long range ISR, torpedo tube launched AUVs and seabed based loitering AUVs. The ongoing efforts for development of UUVs capable of mine laying and ISR must be progressed along with development of attack AUVs capable of firing torpedoes and operating in swarms. The conceptualisation of high speed Kamikaze AUVs is the need of the hour, considering lessons learnt from the recent Russia-Ukraine war and US-Israel-Iran war.

**111. Multi- Domain Vehicles.** Underwater vehicles have an advantage of stealth while aerial vehicle have speed and surface vehicles have range/ endurance. For clandestine attack mission, or quick response ASW mission, or for battle space surveillance, the ability of uncrewed vehicle to transition from one medium/ domain to another would offer significant advantages. Concepts of UAV-dropped AUV, underwater launched UAV, and semi-submersible USVs are example of such concept that need to be realised technologically to enable formulation of innovative CONOPS.

### **Artificial Intelligence (AI)**

**112.** Technological advancements in AI and fuzzy logic will help in making advanced decision-making and decision support systems available. The new generation platforms that the *IN* operates are equipped with cutting edge technology systems. This puts it in an advantageous position to develop and absorb new AI/ ML based technologies that are becoming increasingly popular with the military and industry. Some of the areas where AI/ ML technologies can be implemented are as follows:-

**112.1.** Automated computer-network defence—real time anomaly detection and patching of vulnerabilities.

**112.2.** Logistics – improved and automated stock management and resupply.

112.3. Performance optimisation – real-time monitoring of data about equipment to predict problems and target appropriate interventions such as repairs.

112.4. Intelligence analysis – new kinds of advanced analytics to identify patterns and anomalies in large, diverse datasets, freeing up human analytical capacity and supporting more complex assessments.

112.5. Autonomous platforms– systems that sense and understand their environment, decide how to respond, and then perform tasks to achieve goals, overseen by humans.

112.6. Streamlining administrative back office functions such as HR and finance.

113. **Agentic AI for Uncrewed Platforms.** Agentic AI enables uncrewed platforms to perceive their environment, undertake reasoning, formulate plans and execute multi-step tasks with a higher degree of autonomy while operating within defined objectives and human imposed constraints. The technology has the potential to enable adaptive mission execution rather than merely following pre-programmed instructions, thereby improving responsiveness in dynamic operational environments. Agentic AI could augment the employment of UAVs, USVs and UUVs through autonomous mission planning, dynamic re-tasking, collaborative decision making and coordinated operations in complex and contested maritime environments.

## **Air Warfare**

114. **Hypersonic Projectiles.** Hypersonic projectiles are higher-velocity kinetic projectiles capable of achieving speeds in excess of Mach 5, thereby significantly reducing time of flight and providing enhanced terminal energy against designated targets. These high velocity projectiles have potential to reduce the reaction time available to an adversary, while offering an alternative to conventional projectiles. Hypersonic projectiles could augment long range naval precision fire and provide high speed kinetic engagement capability against maritime and land based target.

**115. Hypervelocity Interceptors.** Hypervelocity Interceptors are high-speed intercept systems intended to engage incoming threats within significantly compressed reaction timelines. Their high velocity can provide greater engagement opportunities against fast and maneuvering targets, while potentially complementing conventional missile-based interception systems. These Hypervelocity Interceptors could augment layered ship borne air and missile defence, particularly against high-speed maneuvering and saturation threats.

**116. Co-operative Missile Swarms.** Cooperative Missile Swarms comprise multiple networked missiles capable of sharing information and coordinating aspects of their engagement behavior to collectively prosecute targets and overcome adversary defensive measures Cooperative Missile Swarms could augment offensive maritime strike capability through distributed and coordinated engagements, while imposing greater complexity and saturation on adversary Air Defence systems.

### **Additional Area of Interest**

117. The following capability/ technology also need to be developed to enable the *IN* transform into a future ready force:-

117.1. Development of AUVs and interfaces to enable their launch from Torpedo Tubes.

117.2. Indigenous development of Thruster and Actuator assembly for AUV/ XLAUVs.

117.3. Development of Li-Ion & Solid state batteries for AUV/ HEAUV/XLAUV.

117.4. Development of INS+ DVL for AUV/ HEAUV and XLAUVs.

117.5. Development of compact indigenous sensors for AUVs (Sonar, Radar, Depth Sensor, etc.).

117.6. Underwater recharging of AUVs.

**APPENDIX A**  
(Refers to Para 23 Chap 3)

**INDIGENISATION REQUIREMENT OF EQUIPMENT AND SYSTEMS  
MARINE ENGINEERING**

| Ser No.                          | Description                                                                        |
|----------------------------------|------------------------------------------------------------------------------------|
| <b>Main Propulsion Equipment</b> |                                                                                    |
| 1                                | Electric Propulsion System (Capacity: 6-10 MW)                                     |
| 2                                | Shafting System-Plummer Blocks and Shaft (with capability to design and integrate) |
| 3                                | Main Propulsion Control System for Gas Turbine                                     |
| <b>Power Generators</b>          |                                                                                    |
| 4                                | Steam Turbo Generators (Capacity: 1-2 MW)                                          |
| <b>Auxiliary Equipment</b>       |                                                                                    |
| 5                                | Magnetic Bearing Compressor for AC Plant                                           |
| 6                                | Variable Stroke Gear (VSG) Pump for Steering and Stabiliser System                 |
| 7                                | Magnetic Bearing Pumps                                                             |
| 8                                | Fuel Transfer Pump with Motor (400 TPH)                                            |
| 9                                | AVCAT Transfer Pump                                                                |
| 10                               | Turbo Blower Unit-INS Vikramaditya                                                 |
| 11                               | Turbo Driven Forced Lubrication Pump-INS Vikramaditya                              |
| 12                               | Turbo Driven Circulator Pump-INS Vikramaditya                                      |
| <b>Miscellaneous Item</b>        |                                                                                    |
| 13                               | Bow Thrusters                                                                      |

**Point of Contact:-**

Directorate of Marine Engineering  
E-205, 2<sup>nd</sup> Floor, East Wing  
Nau Sena Bhawan, Delhi Cantt  
New Delhi -110011  
Email: dme@navy.gov.in

**APPENDIX B**  
(Refers to Para 6 Chap 4)

**INDIGENISATION REQUIREMENT OF EQUIPMENT  
AND SYSTEMS OF SUBMARINES**

| Ser No. | Description                                         |
|---------|-----------------------------------------------------|
| 1       | Integrated Platform Management System (IPMS) of P75 |
| 2       | Operating Rams of Hoistable Masts                   |
| 3       | System Valves (Hull and Doubler)                    |
| 4       | MU12 Volumetric Pump                                |
| 5       | MU12 B Hydraulic Pump                               |
| 6       | MU12 D1 De-Mineralised Pump                         |
| 7       | MU12 D2 Self Priming Pump                           |
| 8       | MU12 D3 Centrifugal Pump                            |
| 9       | Diesel Exhaust Valves of P75 class                  |
| 10      | Turbo Charger of EKM class                          |
| 11      | De-Ballasting Pumps of EKM Class (6MBx2 and 2P1)    |

**Point of Contact: -**

Directorate of Marine Engineering  
E-205, 2<sup>nd</sup> Floor, East Wing  
Nau Sena Bhawan, Delhi Cantt  
New Delhi -110011  
Email: [dme@navy.gov.in](mailto:dme@navy.gov.in)

**APPENDIX C**  
(Refers to Para 2 Chap 5)

**INDIGENISATION REQUIREMENT OF  
AIRCRAFT HANDLING EQUIPMENT**

| <b>Ser No.</b> | <b>Description</b>                                                               | <b>Point of Contact</b>                                                                                                                                                                                                   |
|----------------|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1              | Ship Based Hoisting and Lifting Equipment (Aircraft / Vehicle/ Lifts and Cranes) | Directorate of Marine Engineering<br>E-205, 2 <sup>nd</sup> Floor, East Wing<br>Nau Sena Bhawan<br>New Delhi -110011<br>Email: <a href="mailto:dme@navy.gov.in">dme@navy.gov.in</a>                                       |
| 2              | Arresting and Restraining Gear                                                   |                                                                                                                                                                                                                           |
| 3              | Carrier Based Fixed Wing Aircraft Arrestor Wire Recovery System                  |                                                                                                                                                                                                                           |
| 4              | Aircraft Catapult Launch System                                                  |                                                                                                                                                                                                                           |
| 5              | Dynamic Positioning System                                                       |                                                                                                                                                                                                                           |
| 6              | Flight Deck & Hangar Fixed Fire Fighting System                                  | Directorate of NBCD<br>2 <sup>nd</sup> Floor, 'D' Block,<br>Defence Offices Complex,<br>Africa Avenue,<br>New Delhi -110023<br>Telephone: 011-26771564<br>Email: <a href="mailto:dnbcd@navy.gov.in">dnbcd@navy.gov.in</a> |

**APPENDIX D**  
(Refers to Para 30 Chapter 7)

**INDIGENISATION REQUIREMENT OF  
NAVAL ARMAMENT STORES**

| Ser No. | Item Description                                | End Use                          | Point of Contact                                                                                                                                                                                              |
|---------|-------------------------------------------------|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | FIAM MOD 3 (SET) with accessories WMP 324400405 | Air Launch of Underwater Article | Directorate of Armament & Production<br>Indigenisation,<br>Naval Headquarters<br>West Block -V,<br>Wing No. 5 (FF)<br>RK Puram,<br>New Delhi – 110 066<br>Tele: 01126194691<br>Email:<br>dapi.ihq@navy.gov.in |
| 2       | Indigenous Propulsion System                    | Underwater Article               |                                                                                                                                                                                                               |
| 3       | Practice Head (PHs) for Modified Oxygen Torpedo |                                  |                                                                                                                                                                                                               |
| 4       | Contact Exploder N-239                          |                                  |                                                                                                                                                                                                               |
| 5       | Contact explosive device                        |                                  |                                                                                                                                                                                                               |
| 6       | Igniter – 3T-10 (for booster and combat motor)  | Air Armament                     |                                                                                                                                                                                                               |
| 7       | Booster stage GG                                |                                  |                                                                                                                                                                                                               |
| 8       | Igniter – 3T-20 (for booster and combat GG)     |                                  |                                                                                                                                                                                                               |
| 9       | Combat stage GG                                 |                                  |                                                                                                                                                                                                               |
| 10      | Booster Motor 3Л -10M with propellant 3Ш-10M    |                                  |                                                                                                                                                                                                               |
| 11      | SPME (Combat motor) 3Д-52 with propellant 3Ш-59 |                                  |                                                                                                                                                                                                               |
| 12      | Gas generator -Ш-521                            |                                  |                                                                                                                                                                                                               |
| 13      | Electro-Magnetic Fusing Device (EMFD)           |                                  |                                                                                                                                                                                                               |
| 14      | Air Launch Accessories (ALA)                    | Underwater Article               |                                                                                                                                                                                                               |
| 15      | Booster Engine 78 Д -Т                          |                                  |                                                                                                                                                                                                               |

| Ser No. | Item Description                                                            | End Use                | Point of Contact                                                                                                                                                                         |
|---------|-----------------------------------------------------------------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16      | Ignition Cartridge K-716-1 (Y-418) (for ignition of Booster Engine Igniter) | Air Armament           |                                                                                                                                                                                          |
| 17      | Igniter B-287 (for ignition of solid propellant charge of booster engine)   |                        |                                                                                                                                                                                          |
| 18      | Safety & Actuating Mechanism (9E129/ PIM 9E129)                             |                        |                                                                                                                                                                                          |
| 19      | SRGM Ordnance                                                               | Gun                    | Directorate of Armament Production & Indigenisation, Naval Headquarters West Block -V, Wing No. 5 (FF) RK Puram, New Delhi – 110 066<br>Tele: 01126194691<br>Email: dapi.ihq@navy.gov.in |
| 20      | Indigenisation of Chaff Cartridges for MiG 29K                              | Air Armament           |                                                                                                                                                                                          |
| 21      | Indigenisation of Chaff Cartridges for P8I                                  |                        |                                                                                                                                                                                          |
| 22      | Development of Limpet Mines Mk-414 (07 Kg) and Mk-430 (15 Kg)               | Clandestine operations |                                                                                                                                                                                          |
| 23      | Indigenisation of Signal Flares (Red Star) for P-75 class Submarines        | Submarines             |                                                                                                                                                                                          |
| 24      | Indigenisation of Signal Flares (Green Star) for P-75 class Submarines      |                        |                                                                                                                                                                                          |
| 25      | Indigenisation of Signal Flares (Red Smoke) for P-75 class Submarines       |                        |                                                                                                                                                                                          |
| 26      | Indigenisation of Signal Flares (Green Smoke) for P-75 class Submarines     |                        |                                                                                                                                                                                          |
| 27      | Indigenisation of Anti-Submarine Decoy for P-75 class Submarines            |                        |                                                                                                                                                                                          |
| 28      | Rocket S-8 KOM HE/ Practice                                                 | Air Armament           |                                                                                                                                                                                          |

| Ser No. | Item Description                                                                                                           | End Use             | Point of Contact                                                                                                                                  |
|---------|----------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 29      | Indigenous Development of Effectors for Anti Torpedo Countermeasure System (5" Mobile Target Emulator) for P-75 Submarines | Underwater Decoy    |                                                                                                                                                   |
| 30      | Insensitive Munition (IM)                                                                                                  | Naval warheads      |                                                                                                                                                   |
| 31      | Universal FIAMs                                                                                                            | Underwater Articles |                                                                                                                                                   |
| 32      | Standalone Miniaturised Telemetry Package                                                                                  | Missiles            |                                                                                                                                                   |
| 33      | Breaking disc                                                                                                              | Underwater Article  | Controllerate of Naval Armament Inspection (West)<br>Naval Dockyard, Gun Gate, Mumbai 400023<br>Tele: 022-22751977<br>Email: wncnaimb@navy.gov.in |
| 34      | Emergency battery                                                                                                          |                     |                                                                                                                                                   |
| 35      | Inverter of mod 3                                                                                                          |                     |                                                                                                                                                   |
| 36      | Sensor Box W003198                                                                                                         |                     |                                                                                                                                                   |
| 37      | DAS Recorder WMP324400029                                                                                                  |                     |                                                                                                                                                   |
| 38      | Gyroscope w018940                                                                                                          |                     |                                                                                                                                                   |
| 39      | Inverter (ex-head) w036615                                                                                                 |                     |                                                                                                                                                   |
| 40      | Recording rack assembly (with cards) w036560                                                                               |                     |                                                                                                                                                   |
| 41      | Propulsion motor assembly (MOD 3) WTP324400120                                                                             |                     |                                                                                                                                                   |
| 42      | Steering control W000474                                                                                                   |                     |                                                                                                                                                   |
| 43      | Gyroscope W002198                                                                                                          |                     |                                                                                                                                                   |
| 44      | Propulsion Motor MOD-0 W018367C                                                                                            |                     |                                                                                                                                                   |
| 45      | Arming Device OF MOD 0 AND MOD 3 W002257                                                                                   |                     |                                                                                                                                                   |

| Ser No. | Item Description                                                | End Use         | Point of Contact                                                                                                                                                  |
|---------|-----------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46      | Inclinometer<br>N215000100                                      |                 |                                                                                                                                                                   |
| 47      | SRP Bag W036494                                                 |                 |                                                                                                                                                                   |
| 48      | Diode & piles box                                               |                 | Controllerate of Naval<br>Armament Inspection<br>(West)<br>Naval Dockyard,<br>Gun Gate,<br>Mumbai 400023<br>Tele: 022-22751977<br>Email:<br>wnccnaimb@navy.gov.in |
| 49      | Shaft propeller assembly<br>WMP 32440009                        |                 |                                                                                                                                                                   |
| 50      | Steering control<br>assembly W WMP<br>324400392                 |                 |                                                                                                                                                                   |
| 51      | Electromechanical<br>assembly W018370                           |                 |                                                                                                                                                                   |
| 52      | Hydraulic Pump with<br>Reduction Unit<br>2517.011.0000-01       |                 |                                                                                                                                                                   |
| 53      | Tail Unit 2517.020.0000                                         |                 |                                                                                                                                                                   |
| 54      | Steering Engine<br>(829.25.03)                                  |                 |                                                                                                                                                                   |
| 55      | Steering Engine<br>(810.11.10)                                  |                 |                                                                                                                                                                   |
| 56      | Starting Device -<br>2517.038.0000                              |                 |                                                                                                                                                                   |
| 57      | Towed Reel<br>BK4.769.010-01                                    |                 |                                                                                                                                                                   |
| 58      | A- spool kw 20 279.648<br>683                                   |                 |                                                                                                                                                                   |
| 59      | Exercise Section I<br>EF6037G049                                |                 |                                                                                                                                                                   |
| 60      | Exploder(Exploder DM1<br>9A1 279.601 027                        |                 |                                                                                                                                                                   |
| 61      | Ignition Amplifier<br>(Ignition Amplifier DM16<br>) 279.994 340 |                 |                                                                                                                                                                   |
| 62      | Safety & Actuating<br>Mechanism                                 | Air<br>Armament |                                                                                                                                                                   |
| 63      | Solid Propellant Rocket<br>Motor                                |                 |                                                                                                                                                                   |

| Ser No. | Item Description                          | End Use        | Point of Contact                                                                                                                                             |                                  |
|---------|-------------------------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|
| 64      | RM Igniter                                |                |                                                                                                                                                              |                                  |
| 65      | Igniter Cartridge                         |                |                                                                                                                                                              |                                  |
| 66      | Thermal Battery Assembly                  |                |                                                                                                                                                              |                                  |
| 67      | Battery Igniter                           |                |                                                                                                                                                              |                                  |
| 68      | Safety & Actuating Mechanism              |                |                                                                                                                                                              |                                  |
| 69      | Solid Propellant Rocket Motor             |                |                                                                                                                                                              |                                  |
| 70      | RM Igniter                                |                |                                                                                                                                                              |                                  |
| 71      | Gas Generator Propellant                  |                |                                                                                                                                                              |                                  |
| 72      | Gas Generator Igniter                     |                |                                                                                                                                                              |                                  |
| 73      | Igniter Cartridge                         |                |                                                                                                                                                              |                                  |
| 74      | Thermal Battery Assembly                  |                |                                                                                                                                                              |                                  |
| 75      | Battery Igniter                           |                |                                                                                                                                                              |                                  |
| 76      | Sensor Block                              |                |                                                                                                                                                              |                                  |
| 77      | Central Tube of SM-39                     |                |                                                                                                                                                              |                                  |
| 78      | Sequencer                                 |                |                                                                                                                                                              |                                  |
| 79      | Nozzle Jet Deft & AFD Unit                |                |                                                                                                                                                              |                                  |
| 80      | Uran SDD                                  | Missile Mockup | Controllerate of Naval Armament Inspection (East)<br>PO: Naval Armament Depot,<br>Vishakhapatnam 530009<br>Tele: 0891-2571143<br>Email: encznaiv@navy.gov.in |                                  |
| 81      | Memory Box                                |                |                                                                                                                                                              |                                  |
| 82      | Laser Guided Bombs along with accessories |                |                                                                                                                                                              | Air Armament                     |
| 83      | Imitator-R                                |                |                                                                                                                                                              | Simulator for underwater article |
| 84      | Sea trial kit                             |                |                                                                                                                                                              | Under water article              |
| 85      | Steering Engine KЯ2-503-026               |                |                                                                                                                                                              |                                  |
| 86      | Steering Engine 243.08.000-013            |                |                                                                                                                                                              |                                  |

| Ser No. | Item Description                                                 | End Use | Point of Contact |
|---------|------------------------------------------------------------------|---------|------------------|
| 87      | Steering Engine<br>810.10.11-01                                  |         |                  |
| 88      | SFE and Barrel<br>243.59.000                                     |         |                  |
| 89      | Horizontal Rudder<br>Independent Control<br>Mechanism 243.19.022 |         |                  |
| 90      | Cassette – АСАКС-НВ<br>(СНЕ-ІЕ) 468332.071                       |         |                  |
| 91      | CGM КЯ2.300.019 ПС                                               |         |                  |
| 92      | UID 825.52.000 Т                                                 |         |                  |
| 93      | Converter 253.58.000-І<br>МЭ                                     |         |                  |
| 94      | Nozzle Box 243.40.000<br>МЭ                                      |         |                  |
| 95      | UID M825.01.000                                                  |         |                  |
| 96      | Starting Valve<br>243.10.000                                     |         |                  |
| 97      | Combustion Flask<br>243.12.000                                   |         |                  |
| 98      | Depth and Heel<br>Corrector 243.58.000                           |         |                  |
| 99      | Stop Valve unit<br>243.14.000                                    |         |                  |
| 100     | Valve Unit 243.06.003-І                                          |         |                  |
| 101     | Hydraulic pump<br>2517.011.0300                                  |         |                  |
| 102     | Relay unit р5-7<br>2517.053.0500                                 |         |                  |
| 103     | Homing Head<br>778248.001                                        |         |                  |
| 104     | Pack 2517.040.0050-01                                            |         |                  |
| 105     | AIE (Mod) 778211.002                                             |         |                  |
| 106     | Torpedo Reel                                                     |         |                  |
| 107     | Distance Gear -<br>2526.010.000                                  |         |                  |

| Ser No. | Item Description                                          | End Use               | Point of Contact                                                                                                                                                         |
|---------|-----------------------------------------------------------|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 108     | Forward Propellers<br>A666.393.030-01                     |                       |                                                                                                                                                                          |
| 109     | Aft Propellers<br>A666.393.031-01                         |                       |                                                                                                                                                                          |
| 110     | Pack 2517.040.0050                                        |                       |                                                                                                                                                                          |
| 111     | Pack 2517.040.0300-1                                      |                       |                                                                                                                                                                          |
| 112     | Pack 2517.040.0300                                        |                       |                                                                                                                                                                          |
| 113     | Stern Bush<br>260.019.0102                                |                       |                                                                                                                                                                          |
| 114     | Forward Propeller<br>260.021.010                          | Underwater<br>Article | Controllerate of Naval<br>Armament Inspection<br>(East)<br>PO: Naval Armament<br>Depot,<br>Vishakhapatnam 530009<br>Tele: 0891-2571143<br>Email:<br>enccnaiv@navy.gov.in |
| 115     | After Propeller<br>260.021.011                            |                       |                                                                                                                                                                          |
| 116     | Converter and<br>Frequency Stabilizer<br>ПТО-1000 & БР42Н |                       |                                                                                                                                                                          |
| 117     | ADKPC 260.07.001                                          |                       |                                                                                                                                                                          |
| 118     | Electronic Pack 2517-<br>040-0300                         |                       |                                                                                                                                                                          |
| 119     | Relay unit p5-7<br>2517.058.0000-01                       |                       |                                                                                                                                                                          |
| 120     | Relay unit p5-10<br>2517.054.0050                         |                       |                                                                                                                                                                          |
| 121     | Motor АП-19У1                                             |                       |                                                                                                                                                                          |
| 122     | Long Storage Battery                                      |                       |                                                                                                                                                                          |
| 123     | Start Battery 26 HKM-5<br>(ЙПВЕ.563511.011)               |                       |                                                                                                                                                                          |
| 124     | Towed Reel                                                |                       |                                                                                                                                                                          |
| 125     | Torpedo Reel                                              |                       |                                                                                                                                                                          |
| 126     | Tail Section<br>(2556.020.000)                            |                       |                                                                                                                                                                          |
| 127     | On Board Computer<br>Complex (OBCC)<br>БЦВМ3АРЯ-43        | Air<br>Armament       |                                                                                                                                                                          |
| 128     | 3M54E W/H                                                 |                       |                                                                                                                                                                          |
| 129     | 3M54TE W/H                                                |                       |                                                                                                                                                                          |

| Ser No. | Item Description                                | End Use                 | Point of Contact                                                                                                                                             |
|---------|-------------------------------------------------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 130     | Radar Homing Head Y554-5                        | Under water Article     |                                                                                                                                                              |
| 131     | Thermal Battery (Part No. 6277205)              |                         |                                                                                                                                                              |
| 132     | Engine Igniter (Part No. 7054065)               |                         |                                                                                                                                                              |
| 133     | Engine Propellant (Part No. 3209534)            |                         |                                                                                                                                                              |
| 134     | Short CO2 Pressure Cylinder (Part No. 7021666)  |                         |                                                                                                                                                              |
| 135     | Activation Valve                                |                         |                                                                                                                                                              |
| 136     | Dry Battery (Part No. 5992780)                  |                         |                                                                                                                                                              |
| 137     | Scuttle Battery (Part No. 8210870-2)            |                         |                                                                                                                                                              |
| 138     | Rocket motor Igniter (9X253)                    | Air Armament            | Controllerate of Naval Armament Inspection (East)<br>PO: Naval Armament Depot,<br>Vishakhapatnam 530009<br>Tele: 0891-2571143<br>Email: enccnaiv@navy.gov.in |
| 139     | TGPSU (Turbo Generator Power Supply Unit)       |                         |                                                                                                                                                              |
| 140     | Gas generator Section-IV                        |                         |                                                                                                                                                              |
| 141     | Propulsion System Squib (9X456)                 |                         |                                                                                                                                                              |
| 142     | RM Igniter (9X522)                              |                         |                                                                                                                                                              |
| 143     | Safety & Actuating Mechanism (9E129/ PIM 9E129) |                         |                                                                                                                                                              |
| 144     | Gas Supply System                               |                         |                                                                                                                                                              |
| 145     | Rocket Motor                                    |                         |                                                                                                                                                              |
| 146     | Warhead (9H318)                                 |                         |                                                                                                                                                              |
| 147     | 30mm ADEN HE                                    | Gun Ammn                |                                                                                                                                                              |
| 148     | Missile Balwanka 3M14eBW (Separable Type Only)  | Mock up Missile article |                                                                                                                                                              |

| Ser No. | Item Description                                                            | End Use               | Point of Contact                                                                                                                                                        |
|---------|-----------------------------------------------------------------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 149     | Missile Mockup<br>3M14ETBM and<br>3M54ETBM                                  |                       | Controllerate of Naval<br>Armament (S)<br>PO:NAD Aluva 683563                                                                                                           |
| 150     | Actuating Gear<br>1392253-100012                                            | Underwater<br>Article | 0484-2838384<br>Email:                                                                                                                                                  |
| 151     | Sealing Paste Y-303-5                                                       | Air Article           | sncnaia@navy.gov.in                                                                                                                                                     |
| 152     | Refilling of A244S War<br>head                                              | Underwater<br>Article | The Controllerate of<br>Naval Armament<br>(Ordnance Factories)<br>Ammunition Factory<br>Khadki<br>Pune – 411003<br>Tele: 020-2592 2760<br>Email:<br>naipune@navy.gov.in |
| 153     | Mk 1 Mod 3 Squib<br>(Motor disconnecter) for<br>A244S                       |                       |                                                                                                                                                                         |
| 154     | Ejection Safety System                                                      | Air<br>Armament       |                                                                                                                                                                         |
| 155     | SRGG (ITT-95)                                                               |                       |                                                                                                                                                                         |
| 156     | KH-35 Explosive Bolts                                                       |                       |                                                                                                                                                                         |
| 157     | TGPSU (Turbo<br>Generator Power<br>Supply Unit)                             |                       |                                                                                                                                                                         |
| 158     | Rocket Motor                                                                |                       |                                                                                                                                                                         |
| 159     | Safety and Actuating<br>Mechanism alongwith<br>Detonator, Squib &<br>Pellet |                       |                                                                                                                                                                         |
| 160     | TVC Explosive Bolts                                                         |                       |                                                                                                                                                                         |
| 161     | Thermal Battery squib<br>and Ignition Tape                                  |                       |                                                                                                                                                                         |
| 162     | Igniter SquibS-4753<br>with P/N R01S0010A                                   |                       |                                                                                                                                                                         |
| 163     | Limpet Mine 7kgs and<br>15kgs                                               | Mines                 |                                                                                                                                                                         |
| 164     | P-50T Bomb                                                                  | Bomb                  |                                                                                                                                                                         |
| 165     | SBP for 100mm Ammn                                                          | 100mm<br>Ammn         |                                                                                                                                                                         |
| 166     | ACOUSTIC HEAD FOR<br>MOD 3 TORPEDO<br>WMP324400429                          | Underwater<br>Article | The Controller of Naval<br>Armament                                                                                                                                     |

| Ser No. | Item Description                                               | End Use         | Point of Contact                                                                                                                                                                                         |
|---------|----------------------------------------------------------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 167     | AG 2000 RACK<br>WMP324400277                                   |                 | Controllerate of Naval<br>Armament (Defence<br>Production)<br>Naval Armament<br>Inspectorate<br>PO – Kanchanbagh<br>Hyderabad – 500 059<br>Tele: 040-2434 2595<br>Email:<br>naihyderabad@navy.gov.<br>in |
| 168     | SCAN BOARD WM<br>9940119900                                    |                 |                                                                                                                                                                                                          |
| 169     | I/O BOARD WM<br>9940120600                                     |                 |                                                                                                                                                                                                          |
| 170     | DSP BOARD WM<br>9940120700                                     |                 |                                                                                                                                                                                                          |
| 171     | PPC BOARD WM<br>9940133200                                     |                 |                                                                                                                                                                                                          |
| 172     | DC/DC CONVERTER<br>WTP 324400206                               |                 |                                                                                                                                                                                                          |
| 173     | A244/s MOD 3 D& P<br>TORPEDO with<br>container<br>WMP324400046 |                 |                                                                                                                                                                                                          |
| 174     | Transmitting Load<br>DM16 M1298                                |                 |                                                                                                                                                                                                          |
| 175     | DM16 for SUT Torpedo                                           |                 |                                                                                                                                                                                                          |
| 176     | VSM Rocket Motor                                               | Air<br>Armament |                                                                                                                                                                                                          |
| 177     | AM Rocket Motor                                                | Air<br>Armament |                                                                                                                                                                                                          |
| 178     | Igniter of AM Rocket<br>Motor (Booster)                        |                 |                                                                                                                                                                                                          |
| 179     | Gas Generator<br>(GGEMA)                                       |                 |                                                                                                                                                                                                          |
| 180     | Jet Deflector thermal<br>Battery                               |                 |                                                                                                                                                                                                          |
| 181     | Pyrotechnic thermal<br>battery                                 |                 |                                                                                                                                                                                                          |
| 182     | Ancillary thermal battery                                      |                 |                                                                                                                                                                                                          |
| 183     | Homing head thermal<br>battery                                 |                 |                                                                                                                                                                                                          |
| 184     | Missile thermal battery                                        |                 |                                                                                                                                                                                                          |
| 185     | Homing head                                                    |                 |                                                                                                                                                                                                          |

| Ser No. | Item Description                                                                                                                                   | End Use                | Point of Contact                                                                                                                                                                                                             |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 186     | Locking Pad Gas Generator                                                                                                                          |                        |                                                                                                                                                                                                                              |
| 187     | Ignition Cartridge (ДП4-3)                                                                                                                         |                        |                                                                                                                                                                                                                              |
| 188     | Ignition cartridge ДП4-3М) (Qty -03) (02-breaking pneumatic unit diaphragms, 01-operation of pyrotechnic valve of fuel tank pressurization system) | Air Armament           | The Controller of Naval Armament<br>Controllerate of Naval Armament (Defence Production)<br>Naval Armament Inspectorate<br>PO – Kanchanbagh<br>Hyderabad – 500 059<br>Tele: 040-2434 2595<br>Email: naihyderabad@navy.gov.in |
| 189     | Igniter Squibs (ПС-95ТМО)                                                                                                                          | Air Armament           |                                                                                                                                                                                                                              |
| 190     | Igniter Squibs (ПС-95ТМ) (Qty -02) (for relighting in case of SE flame out) (Used along with Electric Igniter эВП-19)                              | Air Armament           |                                                                                                                                                                                                                              |
| 191     | Auto-pilot БУ-10                                                                                                                                   | Air Armament           |                                                                                                                                                                                                                              |
| 192     | Section No.4<br>9M381э.0401.000-01                                                                                                                 | Air Armament           |                                                                                                                                                                                                                              |
| 193     | Radar Homing Head (RHH) 9э501э                                                                                                                     | Air Armament           |                                                                                                                                                                                                                              |
| 194     | Section 1 Assembly<br>9M317.0100.000-05                                                                                                            | Air Armament           |                                                                                                                                                                                                                              |
| 195     | Section 4 Assembly<br>9M317.0400.000-02                                                                                                            | Air Armament           |                                                                                                                                                                                                                              |
| 196     | Thermal battery                                                                                                                                    | Mockup Missile Article |                                                                                                                                                                                                                              |
| 197     | Ship-Borne Close-in Weapon Systems                                                                                                                 | Misc                   | Directorate of Weapons Equipment<br>W-314, 3 <sup>rd</sup> Floor, West Wing                                                                                                                                                  |
| 198     | Anti-Submarine Rocket Launchers                                                                                                                    | Misc                   |                                                                                                                                                                                                                              |

| Ser No. | Item Description                                          | End Use | Point of Contact                                                                   |
|---------|-----------------------------------------------------------|---------|------------------------------------------------------------------------------------|
| 199     | Ship-Borne Medium Range Gun                               | Misc    | Nau Sena Bhawan<br>New Delhi -110011<br>Tel:011-26771356<br>Email: dwe@navy.gov.in |
| 200     | Torpedo Tube Launcher for Light Weight Torpedoes          | Misc    |                                                                                    |
| 201     | Ship-Borne Sonars for Large Ships                         | Misc    |                                                                                    |
| 202     | Hull Mounted Submarine Sonar                              | Misc    |                                                                                    |
| 203     | Expandable Aerial Targets                                 | Misc    |                                                                                    |
| 204     | Anti-Torpedo Decoy                                        | Misc    |                                                                                    |
| 205     | Ship-Borne Surface Surveillance Radar                     | Misc    |                                                                                    |
| 206     | Portable Diver Detection Sonar                            | Misc    |                                                                                    |
| 207     | Composite Sonar Dome for Ships                            | Misc    |                                                                                    |
| 208     | Upgraded 76 mm SRGM                                       | Misc    |                                                                                    |
| 209     | AWS Fire Control System for Ships                         |         |                                                                                    |
| 210     | Heavy-weight Torpedo Launcher for Ships                   |         |                                                                                    |
| 211     | Multifunction Surveillance & Threat Alert Radar for Ships |         |                                                                                    |
| 212     | Ship based Medium Range Surface to Air Missile            |         |                                                                                    |
| 213     | Loitering Munitions                                       |         |                                                                                    |
| 214     | Anti-Submarine Warfare Sonar for shallow water            |         |                                                                                    |
| 215     | Ship Based Vertical Launched Short Range                  |         |                                                                                    |

| Ser No. | Item Description                                             | End Use | Point of Contact                                                                                                                               |
|---------|--------------------------------------------------------------|---------|------------------------------------------------------------------------------------------------------------------------------------------------|
|         | Surface to Air Missile System                                |         | Directorate of Weapons Equipment<br>W-314, 3 <sup>rd</sup> Floor,<br>West Wing, Nau Sena Bhawan<br>New Delhi -110011 Email:<br>dwe@navy.gov.in |
| 216     | Supersonic Weapon Imitating Flying Target                    |         |                                                                                                                                                |
| 217     | Mine Counter Measures (Autonomous Surface Vessel)            |         |                                                                                                                                                |
| 218     | Ship-Borne Gun Direction Fire Control Radar                  |         |                                                                                                                                                |
| 219     | Ship-Borne Electro Optic System for Weapons                  |         |                                                                                                                                                |
| 220     | Ship-Borne Electro System Stabilised Optronic Pedestal (SOP) |         |                                                                                                                                                |
| 221     | Ship based Expendable Aerial Target                          |         |                                                                                                                                                |
| 222     | Expendable Underwater Target for Naval Applications          |         |                                                                                                                                                |
| 223     | Automatic Missile Detection Radar for Ships                  |         |                                                                                                                                                |

**APPENDIX E**  
(Refers to Para 5 Chap 8)

**INDIGENISATION REQUIREMENT OF  
NAVAL AVIATION STORES/ EQUIPMENT**

| Ser No.        | Part No                          | Description                   |
|----------------|----------------------------------|-------------------------------|
| <b>MiG 29K</b> |                                  |                               |
| 1              | 088.53.8037                      | Splitter Ring                 |
| 2              | V5-33-GOST 8107-75               | Valve Core                    |
| 3              | 8-28D-An.Oks-OST 1 10571-72      | Bolt                          |
| 4              | 8-26D-An.Oks-OST 1 10571-72      | Bolt                          |
| 5              | 5.41.0220.0014.98                | Cable                         |
| 6              | 5.41.6100.1263.98                | PAZ MK Connector Metallic Cap |
| 7              | 5.41.0410.0000.15                | Wire                          |
| 8              | 8D2.966.134-01                   | Active Fuel Filter (Casing)   |
| 9              | 8.21.0100.0111.98                | Bolt                          |
| 10             | 11VF 20A                         | Filter                        |
| 11             | 8-24D-An.Oks-OST 1 10571-72      | Bolt                          |
| 12             | 8-30D-An.Oks-OST 1 10571-72      | Bolt                          |
| 13             | 056-062-36-1-035-A-OST1 00980-80 | Sealing Ring                  |
| 14             | 072-078-36-1-035-A-OST1 00980-80 | Sealing Ring                  |
| 15             | 054-060-36-1-035-A-OST1 00980-80 | Sealing Ring                  |
| 16             | 5.41.6113.0250.00                | Filter                        |
| 17             | 5.41.6100.2250.00                | Telescopic Assembly           |
| 18             | 563M55-24-TS                     | Ring                          |
| 19             | 5-28D-An.Oks-OST 1 10574-72      | Bolt                          |
| 20             | 43-155-OST1 10855-72             | Hose                          |
| 21             | 5.41.6100.1230.00                | Telescopic assembly           |
| 22             | 5.41.6100.1140.00                | Telescopic assembly           |
| 23             | 5.15.6100.0280.00                | Telescopic unit               |
| 24             | KT211M.060                       | Rotor plate                   |

| Ser No. | Part No           | Description                         |
|---------|-------------------|-------------------------------------|
| 25      | KT211M.040        | Pressure Back Plate                 |
| 26      | KT211M.030        | Pressure Plate                      |
| 27      | KT209.180         | Stator Plate                        |
| 28      | 8D2.966.664       | Filter Element                      |
| 29      | 380700560         | Filter Section                      |
| 30      | 8D5.866.157       | Active Fuel Filter                  |
| 31      | 8D2.966.664       | Fuel Filter Engine                  |
| 32      | 8D2.966.022-6     | Hydraulic Return Line Filter        |
| 33      | 340.042A          | Filter Element                      |
| 34      | 5.01.6113.0130.00 | Aircraft Fuel Filter                |
| 35      | 5.47.0604.0190.00 | Canopy Inflatable seal              |
| 36      | GMM BOM           | Dummy BOM                           |
| 37      | C-7029-5000-01    | Hose Assembly PAZ-MK                |
| 38      | 5.41.9920.1300.00 | Eqpt for pressure check shock strut |
| 39      | 051.08.0500       | AAGB Box                            |
| 40      | KN35.007          | Valve Body                          |
| 41      | 5.41.2210.1007.09 | Bolt                                |
| 42      | 781-2-E           | Small Sized Avionics Clock          |
| 43      | 5.41.5313.8440.00 | Clamping block                      |
| 44      | 5.41.5313.8410.00 | Clamping block                      |
| 45      | 5.41.5313.8425.00 | Clamping block                      |
| 46      | 5.41.5313.8450.00 | Clamping block                      |
| 47      | 20407198020       | Shim                                |
| 48      | 5.41.5313.8460.00 | Clamping block                      |
| 49      | TK 7849-5120-550  | Oxygen Hose                         |
| 50      | 15 M              | Air Hose                            |
| 51      | 2-1000            | Hose                                |
| 52      | 3-1500            | Hose                                |
| 53      | TK 7849-5120-450  | Oxygen Hose                         |

| Ser No. | Part No                                       | Description            |
|---------|-----------------------------------------------|------------------------|
| 54      | TK-7849-5120-01                               | Oxygen Hose            |
| 55      | TK-7849-5300-01                               | Hose                   |
| 56      | 8D0.447.005-01-28                             | Fluoroplastic sleeve   |
| 57      | 8D0.447.005-20-28                             | Fluoroplastic sleeve   |
| 58      | 8D0.447.005-20-41                             | Fluoroplastic sleeve   |
| 59      | 8D0.447.005-20-46                             | Fluoroplastic sleeve   |
| 60      | 8D0.447.018-20-47                             | Fluoroplastic sleeve   |
| 61      | 8D0.447.024-30-35                             | Fluoroplastic sleeve   |
| 62      | 8D0.447.005-30-47                             | Fluoroplastic sleeve   |
| 63      | 5125A-86-2                                    | Ring                   |
| 64      | 007-01019-2-043 ost 1 00980-80                | Ring                   |
| 65      | 2267A-517-2                                   | Sealing ring           |
| 66      | 5125A-83-2                                    | Ring                   |
| 67      | 5.15.6407.8001.98                             | Screw                  |
| 68      | 8.21.0100.0131.98                             | Screw                  |
| 69      | TKS2010DL                                     | Contactor              |
| 70      | M5-6Yekh 16.109.30kh GSA.029<br>GOST 10336-80 | Instrument Panel Screw |
| 71      | 5.47.7701.0600.00                             | Screw                  |
| 72      | 5.47.7701.0500.00                             | Screw                  |
| 73      | 3-8-khim pas-OST 131544-80                    | Screw                  |
| 74      | 3-10 KHIM PAS-OST 131544-80                   | Screw                  |
| 75      | 5.01.7110.0130.00                             | Static Discharger      |
| 76      | 5.41.0430.0441.09                             | Rivet                  |
| 77      | 5.41.0430.0444.09                             | Washer                 |
| 78      | 5.41.0106.0005.98                             | Bolt                   |
| 79      | 5.41.4200.1200.09                             | Rubber Bar             |
| 80      | 5.31.4701.0030.00                             | Buffer                 |
| 81      | 5.41.0430.0080.00                             | Piano Hinge Rod        |
| 82      | 8.21.0100.0131.98                             | Screw                  |
| 83      | 5.41.0100.0033.09                             | Screw                  |
| 84      | BA8.0920.021-12                               | Bolt                   |
| 85      | BA8.920.021-07                                | Bolt                   |
| 86      | FAZ.811.001 (YUSP-3)                          | HUD Alignment Tool     |

| Ser No. | Part No                          | Description                                                 |
|---------|----------------------------------|-------------------------------------------------------------|
| 87      | 052-058-36-1-035-A-OST1 00980-80 | Ring                                                        |
| 88      | 021720051                        | Flange                                                      |
| 89      | 027-031-25-2-OST 100980-80       | Ring                                                        |
| 90      | 5-20-KHIM.PAS.OST1 31504-80      | Screw                                                       |
| 91      | 903-7200-1400                    | AIT Battery for Ejection Seat / Self-contained power source |
| 92      | 5.41.9850.1400.00                | Sling for mounting and Canting                              |
| 93      | 5.15.9927.0070.91                | Blanking for Air Intake (LH & RH)                           |
| 94      | 5.15.9927.0070.92                | Blanking for Air Intake (LH & RH)                           |
| 95      | 5.41.9915.7500.00                | Mounter for wings                                           |
| 96      | G15                              | Appliance for removing insp. hole blank                     |
| 97      | G22                              | Appliance for removing insp. hole blank                     |
| 98      | A3819-0000                       | Maintenance Stand                                           |
| 99      | 1320-0000                        | Tyre 300 x 125 Model 5A (For Trolley A1320M-0000)           |
| 100     | 5.17.9915.1300.00                | ZHUK-ME Monoblock Lifting Slings                            |
| 101     | A1326-0000                       | Wheel Remover                                               |
| 102     | G103-1                           | Dial                                                        |
| 103     | G103-2                           | Wrench                                                      |
| 104     | 5.41.9915.3500.00                | KSA-33M Support                                             |
| 105     | 561032900                        | Safety blank for HPT graphitic sealing                      |
| 106     | 561034300                        | Engine bench (for vertical mounting of engine)              |
| 107     | 561035900                        | Fan ring                                                    |
| 108     | 561844970                        | Device for fan mounting (mounting shaft)                    |

| Ser No. | Part No                       | Description                                                                           |
|---------|-------------------------------|---------------------------------------------------------------------------------------|
| 109     | 561056800                     | Retainer for 1 support nut tightening                                                 |
| 110     | 564953070                     | Device for LPT dismantling without fan                                                |
| 111     | 561036400                     | Turbine compressor lifting ring                                                       |
| 112     | 561046200                     | Wrench with retainer for LPT nut with torque up to 45 kgf-m                           |
| 113     | 942860100                     | Support for LPT rotor                                                                 |
| 114     | 988812000                     | Rig for engine assembly (tilting device)                                              |
| 115     | 988891400                     | Support for block 08                                                                  |
| 116     | 591811900                     | Rack for fan storing                                                                  |
| 117     | 565051500                     | Extension for rod 561031900                                                           |
| 118     | 561031900                     | Rod for checking coaxiality for LP nozzle guide vanes relative to fan rotor pivot pin |
| 119     | 1-2-OST1 10108-85             | Device (Brake Bleeding Kit)                                                           |
| 120     | TK-7849-4290                  | De-Nitrification Kit (for BKDU)                                                       |
| 121     | A 1029M-0000                  | Hydraulic Jack                                                                        |
| 122     | NA                            | L Shaped Adapter                                                                      |
| 123     | 388500900                     | Engine Cranking Tool                                                                  |
| 124     | NA                            | Tyre Charging Adaptor                                                                 |
| 125     | 3882520000                    | Preservation Hose                                                                     |
| 126     | 558500900                     | Turbo Cooler Charging Tool                                                            |
| 127     | 302651.001-01 & 302651.001-02 | Radar Ground Functioning LENA Hose                                                    |
| 128     | IBPA.203727D49-01             | Optical Cable                                                                         |
| 129     | IBPA.203727D49-02             | Optical Cable                                                                         |
| 130     | IBPA.203727D49-03             | Optical Cable                                                                         |
| 131     | IBPA.203727D49-04             | Optical Cable                                                                         |
| 132     | IBPA.203727D49-05             | Optical Cable                                                                         |
| 133     | IBPA.203727D49-06             | Optical Cable                                                                         |
| 134     | IBPA.203727D49-07             | Optical Cable                                                                         |
| 135     | IBPA.203727D49-08             | Optical Cable                                                                         |

| Ser No.       | Part No                     | Description                                           |
|---------------|-----------------------------|-------------------------------------------------------|
| 136           | IBPA.203727D49-09           | Optical Cable                                         |
| 137           | EBN-1KM                     | Operational flight data recorder                      |
| 138           | RMM-12                      | Recoverable memory module                             |
| 139           | DR-29                       | Data recorder                                         |
| 140           | PT1-6B                      | Potentiometer                                         |
| 141           | 9.31.4201-73                | Leg Steering Housing<br>Securing Screw                |
| 142           | 743.595.900                 | Graphite Seal Assembly                                |
| 143           | SVS-2TS-2 SER3              | Air Data Computer                                     |
| 144           | MV-4.2                      | High Voltage Module                                   |
| 145           | NA                          | Rubberized cooling hose for<br>BKTS-2                 |
| 146           | NA                          | Fiber optic Cable X21 & X23                           |
| 147           | NA                          | Crimping wire of nose cone<br>small detachable panels |
| 148           | NA                          | Anchor nuts of IFF upper<br>antenna panel behind      |
| 149           | NA                          | Radar mono-block installation<br>nuts                 |
| 150           | NA                          | Nose cone installation nuts                           |
| 151           | NA                          | BOM panel rubberized<br>sealing ring                  |
| 152           | NA                          | BOM air-conditioning metallic<br>connector            |
| 153           | 4-10-AN.OKS-OST1 34040-79   | Rivet                                                 |
| 154           | 4-9-AN.OKS-OST1 34040-79    | Rivet                                                 |
| 155           | 3.5-11- AN.OKS-OST134040-79 | Rivet                                                 |
| 156           | 5.41.0430.0312.17           | Rivet                                                 |
| 157           | 5.41.0430.0312.21           | Rivet                                                 |
| <b>MH 60R</b> |                             |                                                       |
| 158           | M83248/1-022                | Packing                                               |
| 159           | M83248/1-031                | Packing                                               |
| 160           | M83248/1-141                | Packing                                               |
| 161           | M83248/1-238                | Packing                                               |

| Ser No. | Part No           | Description                   |
|---------|-------------------|-------------------------------|
| 162     | M83248/1-910      | Packing                       |
| 163     | M83248/2-908      | Packing                       |
| 164     | M83248-1-026      | Packing                       |
| 165     | M83248-1-128      | Packing                       |
| 166     | MS29513-211       | Packing Preformed             |
| 167     | MS29512-06        | Packing Preformed             |
| 168     | MS29512-12        | Packing Preformed             |
| 169     | MS20995C32        | Safety Wire                   |
| 170     | MS20995C47        | Safety Wire                   |
| 171     | MS21094-4004      | Bolt Self Locking             |
| 172     | MS21094-4006      | Bolt, Self-Locking            |
| 173     | SS5211-4H10       | Bolt, Shear                   |
| 174     | SS5211-4H12       | Bolt, Shear                   |
| 175     | MS28778-10        | Packing Preformed             |
| 176     | M39029/4-110      | Pin Contact                   |
| 177     | M7928/1-42        | Lug, Terminal (Pwr)           |
| 178     | M7928/1-41        | Lug, Terminal (Gnd)           |
| 179     | 70400-38159-102   | Bolt Machine                  |
| 180     | 70400-38159-103   | Bolt Machine                  |
| 181     | 70400-38159-104   | Bolt Machine                  |
| 182     | MS20995CY20       | Shear Wire                    |
| 183     | MS20995NC20       | Safety Wire                   |
| 184     | MS20995NC32       | Safety Wire                   |
| 185     | NAS847            | Protective Caps and Plugs     |
| 186     | 3609044-1         | Oil Filter Element            |
| 187     | 3882693-1         | Filter Assy                   |
| 188     | 3B940-TC, LS14500 | Battery, Lithium              |
| 189     | 9010A038          | Locknut, Self-Locking         |
| 190     | ASTM D 5486       | Tape, Pressure Sensitive      |
| 191     | Formit-18-Fan     | Spray Extension Tube, 18 Long |
| 192     | M83461/1-011      | Packing Preformed             |
| 193     | M83461/1-018      | Packing, Preformed            |
| 194     | 01-118-5543       | Tyre Assy MLG                 |
| 195     | 01-480-5161       | Tyre Assy NLG                 |

| Ser No. | Part No                 | Description           |
|---------|-------------------------|-----------------------|
| 196     | M81757/14-1             | Aircraft Main Battery |
| 197     | AG768000-04             | Gasket                |
| 198     | MS35650-302             | Nut                   |
| 199     | MS21044C5               | Nut (APU)             |
| 200     | SS4424-04               | Gasket                |
| 201     | 70400-08119-108         | Insulator             |
| 202     | AN3-14                  | Bolt                  |
| 203     | MS17826-3               | Nut Self Locking      |
| 204     | MS24694C59              | Screw                 |
| 205     | SB5303-103              | Self-Aligning Bearing |
| 206     | M7444-1-11(m7444-1-1-1) | Polyurethane Tubing   |
| 207     | NAS1523C12B             | Washer                |
| 208     | 2491153                 | Bolt                  |
| 209     | MS24665-334             | Cotter Pin            |
| 210     | NAS1305-68D             | Bolt                  |
| 211     | MS28775-011             | Packing               |
| 212     | 79698-820               | Insert, Screw         |
| 213     | 37362-1                 | O-Ring                |
| 214     | 70105-28006-101         | Shim                  |
| 215     | 70102-28025-102         | Shim                  |
| 216     | NAS1149E0663P           | Washer                |
| 217     | NAS1149E0616P           | Washer                |
| 218     | NAS1149C1232R           | Washer                |
| 219     | 65104-11022-102         | Shim                  |
| 220     | 2012A96                 | Shim Laminated        |
| 221     | NAS1149D0416K           | Washer Flat           |
| 222     | NAS76B3-027P            | Bushing               |
| 223     | SS5112-316              | Bolt Self Locking     |
| 224     | SS5092-3                | Nut Plain             |
| 225     | MS16624-4125            | Ring, Retaining       |
| 226     | NAS1149D0516J           | Washer                |
| 227     | NAS1149F0563P           | Washer                |
| 228     | NAS1304-16H             | Bolt                  |
| 229     | 3501614-3               | Quill Shaft           |

| Ser No. | Part No          | Description                           |
|---------|------------------|---------------------------------------|
| 230     | 21C7088P01       | Cover, Multiple Purpose, T-700 Engine |
| 231     | 21C7396P01       | Cover, Inlet Engine                   |
| 232     | 3218AS760-1      | MMR R/T Sled                          |
| 233     | 70700-20460-041  | Cover, Pitot Tube                     |
| 234     | 70700-20500-043  | Plug Engine Exhaust                   |
| 235     | 70700-77106-044  | Plug Engine Inlet                     |
| 236     | 70700-20502-043  | Plug APU Exhaust                      |
| 237     | 70700-77108-042  | Plug Exhaust Fan-SO Cooling           |
| 238     | 71700-77500-041  | Plug Assy                             |
| 239     | 71700-77500-042  | Plug Assy                             |
| 240     | 71700-77501-041  | Plug Assy                             |
| 241     | 135947-0001      | Pins Safety CMDS                      |
| 242     | 89SDSCC-D-0162-1 | Engine Cover                          |
| 243     | 89SDSCC-D-0162-2 | Engine Cover                          |
| 244     | TPSESM001        | ESM Antenna Cover                     |
| 245     | 1509AS300-1      | Chock Land Based                      |
| 246     | 1610AS100-2      | Grounding System Helicopter           |
| 247     | 1479AS400-1      | Tow Bar 24 ALBAR                      |
| 248     | 70700-77112-041  | Bar Assembly Steering                 |
| 249     | 3218AS171-1      | Hose Assy, Sump Drain, Fuel Tank      |
| 250     | 70073-85000-013  | Universal Lifting Sling Assy          |
| 251     | 70700-77515-043  | Restraint Set Main Rotor Blades       |
| 252     | 70700-77499-041  | Locking Collar TLG                    |
| 253     | 3218AS538-1      | Accumulator Damper Service Line T3    |
| 254     | 9824             | Servicing Unit Hydraulic              |
| 255     | 061477-100       | Transmission Fluid Fill Unit          |
| 256     | 53D22020         | Jack Aircraft Axle, 5 Ton             |
| 257     | 21C7298G01       | Dispenser Water Wash                  |
| 258     | 061475-100       | Engine Fluid Servicing Unit           |
| 259     | 1317AS100-2      | Nitrogen Servicing Unit               |

| Ser No. | Part No         | Description                              |
|---------|-----------------|------------------------------------------|
| 260     | 07180A01        | Tool Set, Bridge Removal                 |
| 261     | 1428AS100       | Cylinder Assy- Nitrogen Portable         |
| 262     | 1480AS100-1     | Trailer, Engine Transportation           |
| 263     | 18C2268-1       | Spline Socket-PAS                        |
| 264     | 18C2268-2       | Spline Socket- LDS                       |
| 265     | 21C7324G02      | Stand Shipboard                          |
| 266     | 21C7445G01      | Hose, Preservation, Fuel System          |
| 267     | 2L8636          | Kit, Desiccant Breather                  |
| 268     | 3218AS501-1     | Wedge, 20 Degree                         |
| 269     | 3218AS502-1     | Wedge, 30 Degree                         |
| 270     | 3218AS503-1     | Wedge, 10 Degree                         |
| 271     | 3218AS674-1     | Tool, Taper Pin Removal                  |
| 272     | 3218AS999-1     | Tool, Monk Rigging                       |
| 273     | 3909AS1400-1    | Reeling Machine Bracket, ALFS            |
| 274     | 3909AS1425-1    | Wrench, Oil Line Nut                     |
| 275     | 3909AS1670-1    | Cable Tension Adapter Assy               |
| 276     | 6509861-1       | Acoustic Attenuator                      |
| 277     | 70700-20324-047 | Blade Clamp Assembly                     |
| 278     | 70700-77116-041 | MRB/ TRB Adapter Storage and Transport   |
| 279     | 70700-77200-041 | Cart Adapter                             |
| 280     | 70700-77205-041 | Rig Set, Flight Control                  |
| 281     | 70700-77383-041 | Bushing, I.D. Wearing Tool               |
| 282     | 70700-77408-046 | Lifting Bar Assembly, engine/ Components |
| 283     | 70700-77669-041 | Check/ Fill Unit, Nitrogen               |
| 284     | 70700-77684-041 | Pin, Rigging                             |
| 285     | 915-11515-1     | Trim Tab Bending Tool Set                |
| 286     | M85352/1        | Inflator Assembly                        |
| 287     | 70700-77342-041 | Elastomeric Bearing Suppressor           |
| 288     | 3218AS780-1     | Cable Reel Lift Table                    |

| Ser No. | Part No           | Description                                |
|---------|-------------------|--------------------------------------------|
| 289     | CJ69J1270         | Jack Tripod, 12 Ton, Model T12-1FH         |
| 290     | 3218AS770-1       | Pedestal Cover, Cable Reeling Machine      |
| 291     | 57L414            | Hydraulic Fluid Contamination Analysis Kit |
| 292     | 3218AS790-1       | SONAR Accessory Kit (AN/AQS-22)            |
| 293     | 65700-10072-041   | Valve assy, Bleed                          |
| 294     | 70700-77306-043   | Remover/ Installer, Damper bearing         |
| 295     | D730L             | Drain hose assy                            |
| 296     | 3218AS505-1       | Adapter cable, test set                    |
| 297     | 3218AS633-1       | Wrench, TLG shock strut                    |
| 298     | 3218AS100-1       | Adapter set, Pitot-static                  |
| 299     | NIV               | Adapter, HP Air/ Nitrogen                  |
| 300     | NIV               | Adapter nitrogen service unit              |
| 301     | 30003-3218AS567-1 | Inspection Gauge Rod end Bearing           |
| 302     | 1366921           | Transducer Cradle, AN/AQS-22               |
| 303     | NIV               | Main Wheel Adapter                         |
| 304     | 7347114-10        | Chuck, Air Inflating 70 degree             |
| 305     | NIV               | Actuator, Electro Mechanical, Rotary       |
| 306     | NIV               | Receiver Transmitter, Sonar RT             |
| 307     | NIV               | Receiver-Transmitter, Radar                |
| 308     | NIV               | Blade, Rotary Wing                         |
| 309     | NIV               | Main Module, Gear Box Assy                 |
| 310     | NIV               | Control, Sonar Hoist-Train Mechanism       |
| 311     | NIV               | Sensor, Electro-optic                      |
| 312     | NIV               | Receiver-Transmitter RADALT RT             |

| Ser No. | Part No | Description                            |
|---------|---------|----------------------------------------|
| 313     | NIV     | Receiver-Transmitter IFF Transponder   |
| 314     | NIV     | Armament Control PA Indicator          |
| 315     | NIV     | Control Panel Assembly RAST            |
| 316     | NIV     | Altimeter, Encoder                     |
| 317     | NIV     | Antenna Control Sub Assy               |
| 318     | NIV     | Control Panel, Radio                   |
| 319     | NIV     | Roll Trim Actuator                     |
| 320     | NIV     | Computer, Digital                      |
| 321     | NIV     | Relay Assembly                         |
| 322     | NIV     | Control Unit, Supervisory, Turbine     |
| 323     | NIV     | Hoist, Main Probe                      |
| 324     | NIV     | Receiver-Transmitter                   |
| 325     | NIV     | Computer Processor,                    |
| 326     | NIV     | Control, Servo, Automatic Pilot        |
| 327     | NIV     | Computer Subassembly                   |
| 328     | NIV     | Computer Digital                       |
| 329     | NIV     | SDSR, Aircraft Equip                   |
| 330     | NIV     | Generator APU, Aircraft                |
| 331     | NIV     | Actuator, Electro Mechanical, Rotary   |
| 332     | NIV     | Power Supply                           |
| 333     | NIV     | Reservoir, Hydraulic                   |
| 334     | NIV     | Stabilator                             |
| 335     | NIV     | Converter, Analog to Digital           |
| 336     | NIV     | Power unit, Aircraft (APU Assy Garret) |
| 337     | NIV     | Antenna Array WRA                      |
| 338     | NIV     | Reeling Machine, Air                   |
| 339     | NIV     | Reel and Cable Assy                    |

| Ser No.        | Part No          | Description                         |
|----------------|------------------|-------------------------------------|
| 340            | NIV              | Active Vibration Control Computer   |
| 341            | NIV              | Arc 210 Radio Control Unit          |
| 342            | NIV              | Receiver Transmitter Radar (MMR RT) |
| 343            | MS24665-300      | Cotter Pin                          |
| 344            | MS24665-155      | Cotter Pin                          |
| 345            | MS24665-370      | Cotter Pin                          |
| 346            | MS24665-151      | Cotter Pin                          |
| 347            | MS24665-153      | Cotter Pin                          |
| 348            | MS24665-304      | Cotter Pin                          |
| 349            | MS24665-374      | Cotter Pin                          |
| 350            | MS24665-376      | Cotter Pin                          |
| 351            | NA               | Single Cylinder Nitrogen Trolley    |
| <b>Seaking</b> |                  |                                     |
| 352            | 566286-2         | Stud                                |
| 353            | AN6290-10        | Seal                                |
| 354            | BAS160-6-5-24-16 | Sleeve Connecting                   |
| 355            | BAS160-6-5-32-16 | Sleeve                              |
| 356            | S6130-80009-2    | Bolt                                |
| 357            | 575311           | Pin Cotter                          |
| 358            | BL-5497-1        | Tube Swivel Hook Keeper Retaining   |
| 359            | 624AG5HD         | Nut Generator Mount                 |
| 360            | 567080           | Washer, Cup Bullet Starter          |
| 361            | 2752-054RET      | Retainer Nut                        |
| 362            | NK4-11A          | Bolt                                |
| 363            | AN381-3-18       | Pin Cotter                          |
| 364            | A103CT           | Nut                                 |
| 365            | AS3492-01        | Gasket                              |
| 366            | 577327           | Gasket                              |
| 367            | SS4021-5-16B     | Seal                                |
| 368            | N13219           | Washer Sealing                      |
| 369            | AN6236-1         | Element Filter                      |

| Ser No. | Part No           | Description      |
|---------|-------------------|------------------|
| 370     | S6130-80110       | Nut              |
| 371     | N6595             | Nut Lock         |
| 372     | N12935            | Tab Washer       |
| 373     | S6110-21085-5     | Element Lock     |
| 374     | WD01-60-90005-17  | Tube Assy        |
| 375     | WD01-60-90005-19  | Tube Assy        |
| 376     | WD01-60-90005-21  | Tube Assy        |
| 377     | WD01-60-90005-35  | Tube Assy        |
| 378     | WD01-73-90141-1   | Hose Assy        |
| 379     | WD01-73-90141-2   | Hose Assy ALT    |
| 380     | S6165-20531-77    | Tube Assy        |
| 381     | S6165-20531-129   | Tube Assy        |
| 382     | S6130-80415-1     | Hose Assy        |
| 383     | WD01-57-90060-69  | Tube Assy        |
| 384     | WD01-73-90060-105 | Tube Assy        |
| 385     | S6165-20531-23    | Tube Assy        |
| 386     | S6165-20531-125   | Tube Assy        |
| 387     | WD01-73-90140-22  | Hose Assy        |
| 388     | S6165-20531-59    | Tube Assy        |
| 389     | S6165-20531-9     | Tube Assy        |
| 390     | WD01-73-90060-109 | Tube Assy        |
| 391     | S6165-62070-868   | Tube Assy        |
| 392     | S6165-20531-85    | Tube Assy        |
| 393     | S6165-62070-285   | Tube Assy        |
| 394     | 272-982051-IKV    | Sleeve Adaptor   |
| 395     | 2837-003E         | Filter           |
| 396     | 2837-002E         | Seal             |
| 397     | WD01-81-51119     | Clip             |
| 398     | 2622              | Gasket           |
| 399     | S6110-26032-1     | Boot             |
| 400     | SS7016-1          | Wire Ground      |
| 401     | D660              | Connector        |
| 402     | D2370-120         | Element, Sensing |
| 403     | X5-49348          | Fastener         |
| 404     | 601002-12D0362    | Hose Assy        |

| Ser No.    | Part No           | Description                               |
|------------|-------------------|-------------------------------------------|
| 405        | S6135-20842-1     | Bush Assy                                 |
| 406        | NE1258275         | Packing                                   |
| 407        | 5007205           | Lining Brake                              |
| 408        | BL-4              | Clip                                      |
| 409        | 4582              | Filament Lamp                             |
| 410        | 4580              | Filament Incandescent                     |
| 411        | WD4282-13040-041  | Mic/Tel Connector Assy.(External)         |
| 412        | WD4282-13040-045  | Mic/Tel Connector Assy. (Pilot/ Co-Pilot) |
| 413        | WD4282-13040-047  | Mic/Tel Connector Assy. (Tacco/Senso)     |
| 414        | R16936            | Boot                                      |
| 415        | MS25171-4S YELLOW | Boot protective yellow                    |
| 416        | SBS103-1          | Plug igniter                              |
| 417        | B6657-1           | Boot                                      |
| 418        | 328961            | Terminal                                  |
| 419        | 327636            | Adapter insert                            |
| 420        | 80/10/1250        | Front glass assy                          |
| 421        | 80/10/1224        | Filter assy                               |
| 422        | NAS487-15         | Plate nut                                 |
| 423        | NDN9222-01        | 5" Attitude Indicator                     |
| 424        | NDN5783           | 3" Attitude Indicator                     |
| 425        | 306DC52-4         | Dual Torque Indicator                     |
| 426        | GV57746           | Gasket MOD 2603                           |
| 427        | 2006T07P01        | Washer                                    |
| 428        | 577306            | Gasket MOD 2552                           |
| 429        | 577312            | Gasket                                    |
| 430        | N6594             | Nut, Self-locking                         |
| 431        | N4907             | Washer Sealing Union                      |
| 432        | 6869              | Ring Backing                              |
| 433        | 571933            | Clamp                                     |
| <b>P8I</b> |                   |                                           |
| 434        | MC960002-4        | Wing Pylon Lifting Assy                   |
| 435        | F70200-18         | Strut Inflation Tool (SIT)                |

| Ser No.         | Part No               | Description                                     |
|-----------------|-----------------------|-------------------------------------------------|
| 436             | APS06030              | Main Wheel Tyre                                 |
| 437             | 275K22-1              | Nose wheel tyre                                 |
| 438             | 1072288P-5            | Flat panel monitor                              |
| 439             | MODEL CTT-24-IRJ      | Chock Transportation Trolley                    |
| 440             | MODEL K2922-IRJ       | Lavatory Service Cart Adapter                   |
| 441             | MODEL ARRHT-24-IRJ    | Aft Radar Radome Handling Trolley               |
| 442             | MODEL ETRF-24-IRJ     | EOIR TDU Removal/ Fitment GSE                   |
| 443             | MODEL MC960006-57-IRJ | Wing Pylon Inspection Trolley                   |
| 444             | MODEL CBLMS-24-IRJ    | Conveyor Belt                                   |
| 445             | 10-6401-0010-IRJ      | Portable Aircraft Lavatory Service Cart         |
| 446             | NA                    | Crash and Salvage Trolley                       |
| 447             | SPL-2336              | Engine Fuel Pump Removal Cradle                 |
| 448             | MODEL-ECPL-25-IRJ     | Engine Cowl Pylon ladder                        |
| 449             | NA                    | International Deployable Data Management Center |
| 450             | NA                    | Aircraft Tyre Transportation Trolley            |
| <b>Kamov-31</b> |                       |                                                 |
| 451             | 620X180M 3A           | Tyre Main Wheel                                 |
| 452             | 480X200M 14A          | Tyre Nose                                       |
| 453             | 503.9901.0600.000     | Fore Wheels Control Arm                         |
| 454             | 160X60 MODEL 2        | Brake Inner Tube                                |
| 455             | N5810-270             | Non Return Valve                                |
| 456             | NA                    | Tube Main Wheel Tyre                            |
| 457             | NA                    | Tube Nose Wheel Tyre                            |
| 458             | 78029906402           | Bushing 12 MM                                   |
| 459             | 500.5101.5045.000     | Cover                                           |
| 460             | 800.6001              | V/V Charging                                    |
| 461             | KT44-100              | Brake PADP                                      |
| 462             | 25N10-14X1            | Cap                                             |

| Ser No.     | Part No                    | Description                                                           |
|-------------|----------------------------|-----------------------------------------------------------------------|
| 463         | KT44-70                    | Spring                                                                |
| 464         | 19ZH-1028                  | Key                                                                   |
| 465         | KT38-24                    | Lock Nut                                                              |
| 466         | OD38-11                    | Cap                                                                   |
| 467         | KT44-53                    | Cup 1                                                                 |
| 468         | KT44-54                    | Cup 2                                                                 |
| 469         | KT44-40                    | Flanged Connection                                                    |
| 470         | KT96A.031                  | Casing                                                                |
| 471         | KT44-52                    | Ring                                                                  |
| 472         | 500.9940.0000.000          | Systems Charging and Test desk                                        |
| 473         | (3)-6-30-KD OST 1.31103-80 | Bolt                                                                  |
| 474         | OD27-29                    | Rubber Gasket                                                         |
| 475         | 3402A-1-6-10KD             | Washer                                                                |
| 476         | 6KD OST 133059-80          | Nut                                                                   |
| <b>Hawk</b> |                            |                                                                       |
| 477         | 772B35798                  | Kit Inflation/ Charging MK6A Adaptor                                  |
| 478         | S3S20763000                | Sling Engine                                                          |
| 479         | KB132K0846-002             | Kit Rigging Engine Control                                            |
| 480         | S3S2024300                 | Manufacturing of LP/HP Compressor Washing Rig                         |
| 481         | MBSS1-100                  | Manufacturing of Ejection Seat Servicing Stand                        |
| 482         | MBSS141                    | Adapter Ejection seat/ Adapter Arm                                    |
| 483         | KB131K0008-002             | Canopy Cover Hawk                                                     |
| 484         | 10141                      | Gauge                                                                 |
| 485         | 6373-017-410EA             | Indicator                                                             |
| 486         | NA                         | Polarised LCD Film Weapon Control Panel / (Part of 261-0001-01A, WCP) |
| 487         | 501D201885D                | Guard Debris Port                                                     |
| 488         | 501D201886D                | Guard Debris Stbd                                                     |
| 489         | KB131K0004-000             | Blank                                                                 |

| Ser No.         | Part No              | Description                                  |
|-----------------|----------------------|----------------------------------------------|
| 490             | OE-B1101A            | Chock and Tensioner                          |
| 491             | 40-148-001           | Relay Module                                 |
| 492             | 40-615-022-4/20/2-R  | Multiplexer Module                           |
| 493             | 778572-27            | 64x1 Multiplexer Switches                    |
| 494             | 778793-01            | 8x1 High Speed Multiplexer Switches          |
| 495             | 778697-02            | Arbitrary Wave Form Generator                |
| 496             | 780446-04            | PXI Controller                               |
| 497             | TE71860-1            | Test Cable, PDU TE - Rear Data Entry Panel   |
| <b>Kamov-28</b> |                      |                                              |
| 498             | 1-OST1 11045-73      | Manufacturing of Wheel Chocks                |
| 499             | 500.9940.0000.000    | System Testing Kit                           |
| 500             | 500.9955.3500.000    | Appliance for washing and emulsifying Engine |
| 501             | 500.9901.0100.000    | Air Field Tow Bar                            |
| 502             | 500.9901.1600.000    | Nose Wheel Steering Tow Bar                  |
| 503             | 500.9913.0500.000    | Appliance for checking Blade in Track        |
| <b>Dornier</b>  |                      |                                              |
| 504             | JD38999/26WJ35PN     | Connector with Cable                         |
| 505             | JD38999/26WE35SN     | Connector with Cable                         |
| <b>COTS</b>     |                      |                                              |
| 506             | N128347-N-YE-3-1-1NA | Portable Nitrogen Charging Unit              |
| 507             | 700010293-NA         | Digital Ultra Sonic Device (Sona phone)      |
| 508             | DURAAIR002-NA        | Air Void Filling System                      |
| 509             | 4489996NA            | Portable Battery Analyser                    |
| 510             | 4489229NA            | Portable Vibration Meter                     |
| 511             | WMGBMRU12DNA         | Portable Earth Ground Tester                 |
| 512             | WMGBT550NA           | Portable Thermal Imager                      |

| Ser No. | Part No      | Description                                        |
|---------|--------------|----------------------------------------------------|
| 513     | 4962665NA    | Portable Video Borescope                           |
| 514     | TQCK10M300NA | Portable Torque Wrench Tester                      |
| 515     | KRSF12ANA    | Stuck Fastener Removal Tool Kit                    |
| 516     | 5165607NA    | Portable Power Quality Analyser                    |
| 517     | -            | Battery Charging/ Discharging Equipment            |
| 518     | -            | Tow Tug Electric                                   |
| 519     | -            | Scissor Lift with Platform                         |
| 520     | -            | Ground Handling Equipment                          |
| 521     | TC7000NA     | Power Pack Lithium Ion Cell (PESU)                 |
| 522     | -            | Two Channel Handheld Vector Network Analyser       |
| 523     | -            | Grease Gun Cordless Kit 18V                        |
| 524     | -            | Battery Load Tester                                |
| 525     | -            | Fume Extractor                                     |
| 526     | -            | Digital Pitot Static Leak Tester (Digital KPA-PVD) |

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**APPENDIX F**  
(Refers to Para 35 Chap 9)

**ELECTRICAL/ ELECTRONICS PROJECTS BEING INDIGENISED**

| Ser No. | Description                                        | Status                                           | OEM/Vendor                                                                                                                                                   |
|---------|----------------------------------------------------|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | Motors of Various Ratings                          | Completed<br>(Vendor Base Expansion in progress) | M/s Narhari Engg Works, Mumbai<br>M/s CG Power<br>M/s Kirloskar Electric Co Ltd<br>M/s Elmot Alternators Pvt Ltd, Hyderabad<br>M/s Megha Rototech, Ahmedabad |
| 2       | Switchboard with APMS                              | Completed<br>(Vendor Base Expansion in progress) | M/s L&T, Navi Mumbai<br>M/s Marine Electricals, Mumbai<br>M/s Siemens Ltd. New Delhi                                                                         |
| 3       | ATS (Auto Transfer Switch)                         | Completed<br>(Vendor Base Expansion in progress) | M/s Precision Power Products, Aurangabad<br>M/s Marine Electricals(I) Pvt Ltd<br>M/s Sipani Energy System, Bangaluru                                         |
| 4       | Helo Starting Rectifier (HSR)                      | Completed<br>(Vendor Base Expansion in progress) | M/s Static Transformers, Indore<br>M/s Precision Power Products, Aurangabad<br>M/s Marine Electricals, Mumbai                                                |
| 5       | LED Light Fitting Including Magazine Light Fitting | Completed<br>(Vendor Base Expansion in progress) | M/S Ray Enterprises, Ambala<br>M/s McGeoch Marine, Mumbai<br>M/s Sipani Energy System, Bangaluru<br>M/s ZealTech, Mumbai                                     |

| Ser No.                                    | Description                                           | Status                              | OEM/Vendor                                                                  |
|--------------------------------------------|-------------------------------------------------------|-------------------------------------|-----------------------------------------------------------------------------|
| 6                                          | IBS (Integrated Bridge System)                        | Vendor Base Expansion is envisaged  | M/s Marine Electricals (Participation of more vendors is being encouraged). |
| 7                                          | Auto Plotter                                          | Vendor Base Expansion is envisaged. | M/s Elcome Marine                                                           |
| <b>Indigenisation in Progress/ Planned</b> |                                                       |                                     |                                                                             |
| 8                                          | HVLAS                                                 | -                                   | M/s AMA<br>M/s Elcome Marine Integrated Systems                             |
| 9                                          | EM LOG Transducer                                     | -                                   | M/s CDAC                                                                    |
| 10                                         | Development of indigenous Echo Sounder for Submarines | -                                   | M/s Keltron                                                                 |
| 11                                         | Fiber Optic Gyro (FOG) for Ship Application           | -                                   | M/s RCI                                                                     |
| 12                                         | SSPA for AMDR Radars                                  | -                                   | TDF Route through DRDO (M/s AIDIN Technologies)                             |
| 13                                         | Drone Based ELINT System                              | In progress-                        | M/s BEL                                                                     |
| 14                                         | Indigenous Integrated Mast (IIM)                      | -                                   | M/s BEL                                                                     |
| 15                                         | RF Over Fiber Based CAW with Conformal Antenna        | -                                   | M/s BEL & M/s CDAC                                                          |
| 16                                         | Single Chip/ Single Board Radio                       | -                                   | M/s CDAC                                                                    |

| Ser No. | Description                                                     | Status                  | OEM/Vendor                                  |
|---------|-----------------------------------------------------------------|-------------------------|---------------------------------------------|
| 17      | Development of Varuna Lite EW System                            | -                       | M/s BEL                                     |
| 18      | Digital Beam-Forming Based Satellite TV (DB2ST)                 | -                       | M/s Rangsons                                |
| 19      | Helo Deck Communication System (HDCS)                           | -                       | M/s L&T                                     |
| 20      | RF Components for EW systems                                    | -                       | Under TDF scheme through DRDO               |
| 21      | Li-Ion Based AELs and Lead Lamps                                | -                       | M/s Zeal Tech                               |
| 22      | BLI Based 18-40 GHz ESM Sub Unit                                | -                       | M/s BEL                                     |
| 23      | SATCOM Terminals for Submarines (Ku Band)                       | -                       | M/s ECIL<br>M/s BEL                         |
| 24      | Rukmini (C and Ku Band) for Ship Application                    | -                       | M/s BEL                                     |
| 25      | Integrated Communication and Surveillance System for Submarines | -                       | DRDO Project. Being steered by NPOL, Kochi. |
| 26      | Modular ESM Receivers                                           | -                       | M/s BEL                                     |
| 27      | TR Modules for EW Systems                                       | In progress-            | M/s BEL                                     |
| 28      | Software Defined Radio                                          | Completed (Vendor Base) | M/s BEL                                     |

| Ser No. | Description                                           | Status                                         | OEM/Vendor                                                                                                                                                                           |
|---------|-------------------------------------------------------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         |                                                       | expansion in progress)-                        |                                                                                                                                                                                      |
| 29      | Inertial Navigation System for Ship Applications      | -                                              | M/s BEL                                                                                                                                                                              |
| 30      | EW Systems - Shipborne                                | -                                              | M/s BEL                                                                                                                                                                              |
| 31      | Shipborne High Accuracy ELINT System 0.17 to 40MHz    | Completed (Vendor Base expansion in progress)- | M/s BEL                                                                                                                                                                              |
| 32      | SDR for Combat Ships (SDR NC)                         | -                                              | M/s BEL                                                                                                                                                                              |
| 33      | Battery Monitoring System for Submarines              | -                                              | M/s Precision Power Products                                                                                                                                                         |
| 34      | Alternators for Ships (up to 1.5 MW)                  | -                                              | M/s Kirloskar Electric Co Ltd, Bangalore<br>M/s Elmot Alternators Pvt Ltd, Hyderabad<br>M/s BHEL, Bhopal<br>M/s Cummins Generator Technology, Pune<br>M/s TD Power Systems Bangaluru |
| 35      | DC Insulation Measuring Instrument for EKM Submarines | -                                              | M/s Precision Power Products                                                                                                                                                         |
| 36      | Shipborne Main Broadcast System                       | -                                              | M/s Phi Audiocom<br>M/s Linia Engg Services<br>M/s Sipani Defence, Bengaluru                                                                                                         |
| 37      | Data Network for Ships                                | -                                              | M/s BEL                                                                                                                                                                              |

| Ser No. | Description                                                                                                   | Status                                         | OEM/Vendor                          |
|---------|---------------------------------------------------------------------------------------------------------------|------------------------------------------------|-------------------------------------|
| 38      | Ship Borne 1kW High Frequency Trans-Receiver                                                                  | -                                              | M/s Avantel                         |
| 39      | IFF MKXII-S                                                                                                   | -                                              | M/s BEL                             |
| 40      | Link II MOD III for Ships and Submarines                                                                      | -                                              | M/s BEL                             |
| 41      | Radar Finger Print System for ELINT Application                                                               | Completed (Vendor Base expansion in progress)- | M/s BEL                             |
| 42      | Deep Sea Side Towing Winch (DS4TW)                                                                            | -                                              | M/s L&T                             |
| 43      | COMINT (Ship Based)                                                                                           | Completed (Vendor Base expansion in progress)- | M/s BEL                             |
| 44      | Remote Embedded System Support (Remote Control / Monitoring Panels for Electrical/ Machinery) for Naval Ships | -                                              | M/s Yeoman Marine Services Pvt Ltd. |
| 45      | High Data Rate VLF-HF Receivers for Ships                                                                     | -                                              | M/s BEL(Panchkula)                  |
| 46      | IU for AWOS-MNS for INS Vikramaditya                                                                          | -                                              | M/s Keltron                         |

| Ser No. | Description                                         | Status | OEM/Vendor                         |
|---------|-----------------------------------------------------|--------|------------------------------------|
| 47      | Li-Ion Battery for Submarine Application            | -      | M/s HBL                            |
| 48      | BSI Module (RLG Sigma-40)                           | -      | M/s BEL, Chennai/ RCI, Hyd         |
| 49      | Mobile Cable Handling Assembly (MoCHA)              | -      | M/s H & H Precision Pvt Ltd Mumbai |
| 50      | Optical Landing System                              | -      | M/s Celeritas                      |
| 51      | Camera Based Tracking System                        | -      | M/s Celeritas                      |
| 52      | Deck Lighting System for Air Craft Carrier (SATURN) | -      | M/s Elcome                         |
| 53      | Indigenous Development of KTSOD Data Link           | -      | M/s Whirlybird Electronics         |
| 54      | Indigenous Development of Buran Data Link           | -      | M/s Whirlybird Electronics         |

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**APPENDIX G**  
(Refers to Para 2 Chap 10)

**IN PROJECTS UNDER 'MAKE' CATEGORY**

| Ser No. | Project                                                                                         |
|---------|-------------------------------------------------------------------------------------------------|
| 1       | Upper Air Sounding System                                                                       |
| 2       | Digital Beam forming Based Satellite TV                                                         |
| 3       | Three Phase Inverters                                                                           |
| 4       | Expendable Under Water Target                                                                   |
| 5       | Effectors for Anti-torpedo Countermeasure System                                                |
| 6       | Proximity and DA Fuze for 76/62 SRGM with universal capability for 76-127 mm Ammunition         |
| 7       | Limpet Mines (7kg and 15 kg)                                                                    |
| 8       | Marine Grade Aluminum Alloy Plate                                                               |
| 9       | Marine Sewage Treatment Plant                                                                   |
| 10      | High Endurance Autonomous Underwater Vehicle (HEAUV)                                            |
| 11      | Mine Counter Measure – Autonomous Surface Vessel (MCM-ASV)                                      |
| 12      | 5 m <sup>3</sup> /h Oily Water Separator (OWS) System                                           |
| 13      | Integrated Stand by Instrument System                                                           |
| 14      | Buoyancy Glider for enhancing underwater domain awareness                                       |
| 15      | Supersonic Weapon Imitating Flying Target                                                       |
| 16      | Glide SSM                                                                                       |
| 17      | Light Weight High Speed Marine Engine for Naval Boats                                           |
| 18      | Ship Based Rukmini SATCOM Terminals                                                             |
| 19      | Turbocharger for P-75                                                                           |
| 20      | Semi-Submersible Autonomous Vessel for Intelligence, Operations and Reconnaissance (SAVIOR)-ASW |
| 21      | Compact Autonomous Surface Craft All Domain Effects - Anti Submarine Warfare (CASCADE-ASW)      |
| 22      | 16 Core Advanced Hybrid Armoured Fiber Optic Undersea Range Cable                               |
| 23      | Medium Speed Marine Diesel Engine (6 MW – 9 MW)                                                 |
| 24      | URAN SSM Fire Control System                                                                    |
| 25      | Electro Optical IR Search and Track System (EOIRST)                                             |
| 26      | 30 mm Naval Surface Gun                                                                         |

| Ser No. | Project                                                        |
|---------|----------------------------------------------------------------|
| 27      | 76 mm Super Rapid Gun Mount                                    |
| 28      | 12 MW Electric Propulsion for ships                            |
| 29      | 4MW Marine Gas Turbine based Electric Power Generator          |
| 30      | 24-28 MW Marine GT                                             |
| 31      | MANPADS                                                        |
| 32      | Extra Large Autonomous Underwater Vehicle (XLAUV)              |
| 33      | Ship Borne Laser Weapon System (30kW)                          |
| 34      | Lightning Detection System                                     |
| 35      | Infantry Weapon Training Simulator (IWTS)                      |
| 36      | Multipurpose Forklift Truck                                    |
| 37      | Foldable Fibre Glass Mat                                       |
| 38      | APTORS (Automatic Pilot Landing and Take Off Recording System) |
| 39      | Aircraft Recovery Dollies                                      |
| 40      | Aircraft Lifting Slings                                        |
| 41      | Transition Platform with Trailer                               |
| 42      | High Altitude Pseudo Satellite                                 |

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**APPENDIX H**  
(Refers to Para 2 Chap 10)

**/N PROJECTS – INNOVATIONS FOR DEFENCE EXCELLENCE (iDEX)**

| <b>Ser</b> | <b>Project</b>                                                                                                                                |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 1          | Development of 4G/LTE based Tactical LAN                                                                                                      |
| 2          | Secure Hardware based Offline Encryptor Device for Graded Security                                                                            |
| 3          | Unmanned Surface & Underwater Vehicle                                                                                                         |
| 4          | AI based Logistics and Supply Chain Management                                                                                                |
| 5          | Development of Advanced Technology based De-salination Plant and Bilge OWS System                                                             |
| 6          | Stabilised C & KU Band Terminal Antennae                                                                                                      |
| 7          | Low cost Autonomous Underwater Swarms                                                                                                         |
| 8          | Machinery Health Monitoring System                                                                                                            |
| 9          | Enhancing UDA by the use of AI/ML or other Novel Techniques                                                                                   |
| 10         | Development of a Private 5G network for Machine to Machine Communication                                                                      |
| 11         | Development of Inertial Energy Storage System for Naval Applications (IESS)                                                                   |
| 12         | Non-Lethal Devices for Stopping Vessels at Sea                                                                                                |
| 13         | Artificial Intelligence and Augmented Reality Based Virtual Assistant                                                                         |
| 14         | Low Latency Multicast Accelerated File Transfer and Video Streaming over existing SATCOM Links to Remote Platforms/ Sites                     |
| 15         | Below the Noise Floor Modems in S/ C/ Ku band (1 Kbps to 20 Mbps) to Operate within existing out/ in Routes on S, C and Ku Band.              |
| 16         | Portable (Handheld / Manpack) Ku Band Terminal for /N SATCOM Network.                                                                         |
| 17         | Development of On-board Processing and Beam Switching Payload for 'Ku' and 'Ka' Band GEO Satellite for High Throughput Maritime Requirements. |
| 18         | Beam steering Ku band SATCOM Antenna over /N SATCOM Network for MR aircraft.                                                                  |

| Ser | Project                                                                                                                                             |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 19  | Compact, Lightweight, Multiband SATCOM (UHF/ S /C/ Ku / Ka) SDR for Ships Submarines and Aircraft.                                                  |
| 20  | Customised Remote Modem with Ruggedised Field Programmable Gate Array (FPGA) based Platform with Inbuilt Post Quantum Encryption for VSAT Baseband. |
| 21  | Development of an Indigenous Security Information and Event Management (SIEM) Solution based on Open-Source Framework                               |
| 22  | Development of an Advanced Open-Source Framework Sanitisation Tool Facilitating Secure Transfer of Data between Multiple Air-gapped Networks        |
| 23  | AI based Smart Ship Operations                                                                                                                      |
| 24  | Replenishment at Sea (RAS) / Fueling at Sea (FAS)                                                                                                   |
| 25  | Development of Underwater Target Structure (UWTS)                                                                                                   |
| 26  | Naval Imagery and Target Information Network (NITIN)                                                                                                |
| 27  | Undersea Communication                                                                                                                              |
| 28  | Automated Celestial Navigation System                                                                                                               |
| 29  | Development of 11m 'all electric' Work Boat                                                                                                         |
| 30  | AI based Condition-Based Predictive Maintenance (CBPM)                                                                                              |
| 31  | Online Power Quality Module (PQM)                                                                                                                   |
| 32  | Forecasting of Defect/Prediction of useful Life for Critical Machinery                                                                              |
| 33  | Hydraulic Dock Block                                                                                                                                |
| 34  | AI Based Interactive Knowledge Management Module                                                                                                    |
| 35  | Development of Ramjet Engine for Fixed Wing Flying Objects                                                                                          |
| 36  | Close Loop Waste Heat Recovery System                                                                                                               |
| 37  | Fabrication, Integration and Testing of one Prototype AUV as per 'Jalkapi' Design by Indian Navy                                                    |
| 38  | Advancing Under water Object Identification using Aerial Hyperspectral Imaging and AI                                                               |
| 39  | Perpetual Power Plant 1.28 MW (Technology Demonstration only)                                                                                       |
| 40  | Smart Loitering Munition                                                                                                                            |
| 41  | Axial flux BLDC Motors                                                                                                                              |
| 42  | Integrated Maritime Domain Awareness Platform for Detecting Anomalies using AI/ML                                                                   |
| 43  | Monolithic Telescope-based Imaging System                                                                                                           |
| 44  | Disposal of Expired Ammunitions & Bombs into Sea                                                                                                    |
| 45  | Heavy Lift Tethered Aerial Vehicles (HLTAV)                                                                                                         |

| Ser | Project                                                                                                    |
|-----|------------------------------------------------------------------------------------------------------------|
| 46  | Water Mist Fixed Firefighting System                                                                       |
| 47  | Portable, Modular Steel – Box Earth covered Magazine for High Explosive with Blast Door                    |
| 48  | Optic Fiber based Fire and Temperature Detection System for Sea going Platforms                            |
| 49  | Gimbal - Less Seeker                                                                                       |
| 50  | Unmanned Seaplane Zebra                                                                                    |
| 51  | Solid Fuel based Low Temperature Gas Generator                                                             |
| 52  | Skydock Autonomous Launch, Recovery and Charging of Drones                                                 |
| 53  | Long Range Powered Precision Guidance Munition                                                             |
| 54  | Wearable Large UAV for MARCOS                                                                              |
| 55  | Electro Optical IR Search and Tracking                                                                     |
| 56  | Indigenously Design Developed Aircraft/ Helicopter Tow Bar Less Battery-Operated Tow Tug (Remote Operated) |
| 57  | FOD Removal Robot for Aircraft Carrier                                                                     |
| 58  | High Altitude Pseudo-Satellite Mk I (HAPS Mk I)                                                            |
| 59  | Tethered Underwater Communication Buoy                                                                     |
| 60  | Mission Planning, Decision Support and Debrief System for Submarine Operation Planning Organisations       |
| 61  | Virtual Reality based Submarine Escape Training Simulator                                                  |
| 62  | Driven Ammunition with Reduced Time of Flight (DART) for SRGM(U)                                           |
| 63  | Total Blast Containment (Zero Arc and Reduced Arc) Vaults with Unit Risk (Day Carry Boxes)                 |
| 64  | Optical Landing Assistance System for Aircraft Carrier                                                     |
| 65  | Camera Based Optical Landing System                                                                        |
| 66  | Damage Control System                                                                                      |
| 67  | Automation for Loading & Unloading of Signal Flares and Associated Procedures                              |
| 68  | Torpedo Leak Testing                                                                                       |
| 69  | 30 MM Ammunition Disposal                                                                                  |
| 70  | Smart ELINT Exploitation and Dissemination System (SEEDS)                                                  |
| 71  | Nucleonix NX_CBRN1_SC Standoff Chemical and CBRN Solution                                                  |
| 72  | AquaAirx - Autonomous Multi Medium Amphibious Drone                                                        |
| 73  | Automated Celestial Navigation System                                                                      |
| 74  | Autonomous Gunnery & Radar Alignment of Warships                                                           |

| Ser | Project                                                                                                        |
|-----|----------------------------------------------------------------------------------------------------------------|
| 75  | Buran System R-98 MODEM - Ship end Equipment                                                                   |
| 76  | KTSOD Data Link System-Ship end Equipment                                                                      |
| 77  | AFC for Aircraft Carrier (Deck Lighting System)                                                                |
| 78  | AI Based Contactless Motion Amplification and Diagnostic Tool                                                  |
| 79  | Artificial Intelligence based Fire Fighting and Damage Control (FFDC) system                                   |
| 80  | Damage Control Shore System                                                                                    |
| 81  | Electric Davit - Obliviation of Manual Hoisting                                                                |
| 82  | Low-cost Indigenous Pyrotechnic Systems for Naval Applications                                                 |
| 83  | Pass Analysis Solutions for Defence                                                                            |
| 84  | Moisture Wicking Hydrophobic Weapon Cover                                                                      |
| 85  | Underwater Photography Noise Cancellation using Artificial Intelligence and Deep Learning                      |
| 86  | Axial flux motor based lightweight Electric OBM with Optional Fuel Cells                                       |
| 87  | Disposable Light Weight Drone (DLD)                                                                            |
| 88  | Underwater Remotely Operated Vehicle (UWROV) for Underwater Inspection and Repairs                             |
| 89  | Hardware Enforced Solution against Advanced, Persistent and Coordinated Attacks to prevent Kernel Mode Malware |
| 90  | Submarine Voyage Data Recorder (SM-VDR)                                                                        |
| 91  | Development of Submarine Launched Expendable Bathythermograph (SSLXBT)                                         |
| 92  | AI Based FOD (Foreign Object Debris) Detection and Classification System for FOD Management at IN Air Station  |
| 93  | Beamforming ASIC based Radar with Massive MIMO technology                                                      |
| 94  | AI based Collision Avoidance for Unmanned Vessels                                                              |
| 95  | AI enabled Automatic Floatation Device Dispersal Drone                                                         |
| 96  | Development of Hydro Acoustic ASW Vector Sensors which can be used with Drones                                 |
| 97  | Converting Oxygen Torpedoes to UW Targets for ASW Training and Practice Torpedo Firings                        |
| 98  | Blue Green Lasers for Underwater Applications                                                                  |
| 99  | Reusable Off board Missile Decoy                                                                               |
| 100 | Microwave Obscurant Clouds (MOC) which are Programmable based on the Threat                                    |

| Ser | Project                                                                                                                                     |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------|
| 101 | Portable RCS Measuring Device that is capable of Independent Operation and Deployable from Multiple Platforms (Ship, Boat, UAV, etc.)       |
| 102 | Autonomous Weaponised Boat Swarms                                                                                                           |
| 103 | AI based Multi Radar Signal Conversion, Distribution & Multi Target Tracking for <i>IN</i> ships (Particle Filter)                          |
| 104 | Depth Based Positioning System to Navigationally Fixing Position of Submarine                                                               |
| 105 | AI based Ship Recognition Software using Image Processing                                                                                   |
| 106 | Fire Proximity Suit                                                                                                                         |
| 107 | Multi Sensor Real Time Monitoring of Running Machinery On-board Submarine                                                                   |
| 108 | Noise Augmentation Unit for Masking Submarines own Signature Skin Friction of Water                                                         |
| 109 | Smart, Lightweight, Retractable and easily Deployable Cable Gangways for Submarine Shore Supply                                             |
| 110 | Smart Mobile Units for Shore Supply and Charging Cable                                                                                      |
| 111 | Non Hull Penetrating Connectivity Solution for Submarines at Harbour                                                                        |
| 112 | Blue Green Laser Technology based on Light Detection & Ranging (LiDAR) to establish Communication from a Ship or an Aircraft to a Submarine |
| 113 | Development of Super Hydrophobic Paint for Torpedoes to reduce Skin Friction of Water                                                       |
| 114 | 30 mm Proximity Fuze for Gun Mounts                                                                                                         |
| 115 | Long Range Communication Technology for Locating Torpedoes                                                                                  |
| 116 | AI Based Gun Parts Inspection System (Software & Hardware)                                                                                  |
| 117 | AI Based Barrel Crawling Bot Inspection System (Software & Hardware)                                                                        |
| 118 | Personal Locator Device with Fall Detection for Firefighters/ Damage Control Teams On-board Ships                                           |
| 119 | Smart Firefighting Features to the existing Breathing Apparatus                                                                             |
| 120 | Remote Controlled NBC Monitoring Bot                                                                                                        |
| 121 | Development of Low cost, Indigenous Morpene Compound                                                                                        |
| 122 | Axial Motor based Portable Submersible Pumps in order to Sustainability reduce Weight                                                       |

| Ser | Project                                                                                                                                                              |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 123 | Fire Fighting BOT to allow a User to Control a Fire Fighter Robot                                                                                                    |
| 124 | Caged Drone with TIC for Fire Fighting in confined Spaces                                                                                                            |
| 125 | Aerogel based Fire Fighting Proximity Suit for better Efficiency in Fire Fighting                                                                                    |
| 126 | Instant Cooling Vest for Fire Fighters                                                                                                                               |
| 127 | Portable Hydraulic Metal Cutter                                                                                                                                      |
| 128 | Indigenous Aluminised Fire Proximity Suit (AFPS)                                                                                                                     |
| 129 | Portable Rugged, Waterproof and Lightweight Torch for DC/FF Activities including Underwater                                                                          |
| 130 | Lightweight Filtration based Breathing Apparatus                                                                                                                     |
| 131 | Long Range Communication for Tracking and Exchanging Short message between <i>IN</i> Helicopter (Chetak) and the Ship.                                               |
| 132 | Lightweight Integrated Indigenous ELINT/ COMINT System for NSUAS/MULE Class RPA                                                                                      |
| 133 | GNSS based 3-D HELO approach and Landing Aid for <i>IN</i> helicopters for Assistance in approach on Landing in bad Weather/Reduced Visibility/ Night at Sea States. |
| 134 | Underwater Communication for Swarm of AUVs                                                                                                                           |
| 135 | Underwater Navigation System for AUVs                                                                                                                                |
| 136 | 3D Forward Looking Sonar for Surface Platforms and Autonomous Underwater Vehicles (AUVs)                                                                             |
| 137 | AI based Adaptive Noise Cancellation for Sonars of Autonomous Underwater Vehicles (AUVs) and Ship Borne Sonar                                                        |
| 138 | Autonomous Beach Check Survey Device                                                                                                                                 |
| 139 | Electro Optical Infrared sensor system contained in an External Pod composed of a Variety of Sensors                                                                 |
| 140 | Airborne High Performance Multi-Mode Active Electronic Scanned Array (AESA) Radar                                                                                    |
| 141 | Expendable Mobile ASW Training Target (EMATT), capable of Simulating the Sounds and Movement of a Real Submarine                                                     |
| 142 | Airborne High Performance Lightweight COMINT System                                                                                                                  |
| 143 | ASIC Base Beam Forming Antenna for Space Communication                                                                                                               |
| 144 | Digital Radio Frequency memory (DRFM) based Simulator on a Drone for AD Training and Radar Calibration                                                               |
| 145 | AI based Remote Monitoring System to assess Wear down of Outboard Shaft Bearing                                                                                      |

| Ser | Project                                                                                                                                           |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 146 | Autonomous Starting, Running and Shutting down of a Diesel Alternator suitable for Charging Lithium Ion Batteries                                 |
| 147 | Propulsion System of AUVs                                                                                                                         |
| 148 | Portable Under Water Diver Delivery System (PUDDS)                                                                                                |
| 149 | Submersible Boat                                                                                                                                  |
| 150 | Multi Utility Long Endurance (MULE) NSUAS Class RPA                                                                                               |
| 151 | Environmentally Benign Firefighting System for Machinery Spaces                                                                                   |
| 152 | Autonomous Hull Crawler                                                                                                                           |
| 153 | Deep Fat Fryer Gimbaled                                                                                                                           |
| 154 | Submarine Detection Technology                                                                                                                    |
| 155 | Tactical Multi Role Combat Airborne Loitering UAS                                                                                                 |
| 156 | Material Movement Shifting Onboard Ship over Hatch Door Coaming                                                                                   |
| 157 | Labour Saving Devices for Material Shifting Onboard Submarines                                                                                    |
| 158 | Secure AV Communication                                                                                                                           |
| 159 | Nonintrusive, Multistep and Multi-Technology Fusion Intrusion Detection Systems to Secure Defence Establishment                                   |
| 160 | Achieving IR and Ultrasonic Stealth Through Advanced Material Insulation                                                                          |
| 161 | Fast, Reliable and Economic Aerial Transport of Armed Forces – Autonomous Cargo Carrying Aerial Vehicle (ACAV)                                    |
| 162 | Heavy Lift Autonomous Flying Robot for Shipborne Operations - Autonomous Cargo Carrying Aerial Vehicle (ACAV)                                     |
| 163 | Automation of Material Movement between Navy Ship and Jetty                                                                                       |
| 164 | Ultra Endurance Monorotor Drone – ARUN                                                                                                            |
| 165 | Zebra Skyplane                                                                                                                                    |
| 166 | RAS FAS System                                                                                                                                    |
| 167 | Design & Development of Long Range Surveillance and Targeting Drone (LR-STD)                                                                      |
| 168 | Ship Launched Multi-Domain Autonomous Naval Tactical Attack Drone (MANTA -Drone) for ISR and Targeting                                            |
| 169 | Design and Development ship borne Autonomous Aerial Vehicle (AAV) to deploy, recover and re-deploy AS Sensor(s)/ payload(s) from platforms at Sea |
| 170 | Secure indigenised AIS for Platform Identification                                                                                                |
| 171 | Radio Frequency (RF) Emulator for Deception                                                                                                       |

| Ser | Project                                                                                                                                  |
|-----|------------------------------------------------------------------------------------------------------------------------------------------|
| 172 | Development of EMP Payload for C-UAS                                                                                                     |
| 173 | Design and Development of Control and Monitoring unit for MiG-29K aircraft engine                                                        |
| 174 | Design & Development of Sovereign Multi-modal Foundational Model                                                                         |
| 175 | Re-arming by Drone at Sea (Rearm-D)                                                                                                      |
| 176 | Electro Magnetic Launch System for Maritime Operations                                                                                   |
| 177 | Underwater Welding Electrode                                                                                                             |
| 178 | Non-Destructive Test for Weld Joints in Afloat Condition                                                                                 |
| 179 | Specialised Indigenised hardware, AI & storage computing based layer Solution for collating data from ships for Analytic & Deep Learning |
| 180 | Sensing Transformer to Convert Angular Motion to Electrical Signals for MiG 29K Aircraft Engine                                          |
| 181 | Engine Pressure Transmitter for MiG 29K Aircraft Engine                                                                                  |
| 182 | Universal fire sensor for MiG 29K Aircraft Engine                                                                                        |
| 183 | Virtual Walkthrough Model for P-75 Submarines                                                                                            |
| 184 | Safety Round Logging and Monitoring System (SRLMS)                                                                                       |
| 185 | Development of software for P8I Sonobuoy data                                                                                            |
| 186 | Universal digital weight of blow gauge for measuring impact force of firing pin in torpedo tubes and gun mounts                          |
| 187 | New Age DC Repair Kit                                                                                                                    |
| 188 | Inflatable Hatch Sealer                                                                                                                  |
| 189 | Development of Doppler Velocity Log                                                                                                      |
| 190 | Fire Fighting Drone for High Rise Building                                                                                               |
| 191 | Design & Development of Quantum Radar                                                                                                    |
| 192 | Guided Long Range 76 mm Ammunition with Programmable Fuze                                                                                |
| 193 | Development of submarine Fibre Optic cable embedded with Distributed Acoustic Sensing System for Underwater Detection                    |
| 194 | Automatic Ammunition Feeding System for 76 mm Gun                                                                                        |
| 195 | Ballistic Extended Range 76 mm Ammunition with Programmable Fuze                                                                         |

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**APPENDIX J**  
(Refers to Para 2 Chap 10)

**/IN PROJECTS - TECHNOLOGY DEVELOPMENT SCHEME (TDF)**

| Ser No. | Project                                                                                     |
|---------|---------------------------------------------------------------------------------------------|
| 1       | Standalone Miniaturised Telemetry Package (SMTP)                                            |
| 2       | Leveraging Health and Usage Monitoring Systems (HUMS) for Enhancing Aircraft Serviceability |
| 3       | Development of Indigenous Water Jet Propulsion System                                       |
| 4       | VLF Loop Antenna including the below deck interface equipment for Kalvari class submarine   |
| 5       | VLF- HF matrix including the interface equipment for Kalvari class submarines               |
| 6       | Use of Composite Technology for Bottles Storing HP Air and Hydrogen                         |
| 7       | Development of Marine Desalinators for Life Rafts onboard Indian Naval Ships                |
| 8       | Tide Efficient Gangway                                                                      |
| 9       | SSPA State 2 Amplifier for AMDR                                                             |
| 10      | Underwater Launched Unmanned Aerial Vehicle (ULUAV)                                         |
| 11      | Pressure gauge – Hawk                                                                       |
| 12      | Motor for Pump-jet Propulsion                                                               |
| 13      | Wireless Aircraft Flight Data Recorder                                                      |
| 14      | Buoyant Cable Antenna                                                                       |
| 15      | RF Components for EW System                                                                 |
| 16      | Radar Absorption Material                                                                   |
| 17      | Mini EW Systems with Tethered Drone                                                         |
| 18      | Fibre Optic cables with Connectors – RPA                                                    |
| 19      | Optical Torsion Meter                                                                       |
| 20      | Multi-Function Antenna                                                                      |
| 21      | Engine Fire Detection System LRUs – Sea King Aircraft                                       |
| 22      | Submarine Launched Autonomous Underwater Vehicle (SLAUV)                                    |
| 23      | TGR (Terminal Guidance Radar)                                                               |
| 24      | Development of Indigenous Thrusters                                                         |
| 25      | Dynamic Positioning System for Mine Counter Measure Vessel (MCMV)                           |

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**APPENDIX K**  
(Refers to Para 2 Chap 10)

**MISCELLANEOUS PRODUCTS TO BE TAKEN UP FOR  
DEVELOPMENT**

| Ser No. | Projects                                             | Description                                                                                                                                                                       |
|---------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | Active Mounts                                        | Traffic Analysis to filter Data and VoIP traffic based on keywords and IP address over Naval Networks.                                                                            |
| 2       | Advanced Hull Coatings                               | Advanced anechoic hull coatings to reduce low frequency radiated noise as well as absorb incident acoustic energy.                                                                |
| 3       | Radar Absorption Paints                              | Radar absorbent materials/ coatings which are also resistant to immersion in sea water                                                                                            |
| 4       | Low Acoustic Signature Machinery                     | Manufacture of low acoustic signature mechanical machinery such as hydraulic pumps etc.                                                                                           |
| 5       | Hull Material                                        | Development of high tensile density, high yield, corrosion resistant low magnetic signature steel for pressure hull of submarines                                                 |
| 6       | Hull Paints                                          | Long life solvent less epoxy coating for internal as well as external submarine applications                                                                                      |
| 7       | Electric Drive Propulsion for Submarines             | Development of main drive technology for motors.                                                                                                                                  |
| 8       | Solid State Power Electronics Control for Submarines | Sophisticated, solid state power control devices for control of motors (for electric drive and other motors) with an aim to reduce the total power consumption during operations. |
| 9       | Improved Battery Power Systems for Submarines        | Integrated with all sensors of the submarines                                                                                                                                     |
| 10      | Tethered submarine Buoy                              | To enable submarine communications at depth as well as intelligence collection.                                                                                                   |

| Ser No. | Projects                                                                 | Description                                                                                                                            |
|---------|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| 11      | Fuel Cells                                                               | To enhance performance of existing fuel cell as well as R&D of alternate fuel cell technologies like PEM, AFC etc.                     |
| 12      | Carrier Borne Fixed Wing UCAVs with Satellite Link                       | -                                                                                                                                      |
| 13      | Sonobuoys                                                                | DIFAR / DICASS / Bathy                                                                                                                 |
| 14      | Long Range Electro Optical Sensors                                       | For helicopters, UAVs and MR Aircraft                                                                                                  |
| 15      | Fresnel Lens Based Optical Landing System                                | For aircraft carriers and airfields                                                                                                    |
| 16      | UW LED Lights                                                            | Tool for diver to provide lighting underwater. To be miniaturised to fit diving helmet/ mask.                                          |
| 17      | Supersonic Aerial Targets, Remote Controlled Target Boat (RCTB) with DPS | Supersonic targets for practice firing of missiles/ guns and remote controlled unmanned boats as surface targets for practice firings. |
| 18      | Active off Board Decoys                                                  | Decoys to be fired from ship capable of seducing missiles at standoff ranges from the firing platform.                                 |
| 19      | Close-in-Weapon System                                                   | Small calibre multi barrel guns with high rate of fire > 4000 rds/ min                                                                 |
| 20      | Infra-Red/ Thermal Imaging Search and Tracking System (IRST)             | A passive detection system (range > 30km) based on IR/ night vision capability for fitment on ships.                                   |
| 21      | Next Gen NVDs (IR/ Thermal Imaging )                                     | State of art 3 <sup>rd</sup> generation Night Vision Devices.                                                                          |
| 22      | Helmet Mounted NVBs                                                      | Night Vision Binoculars (NVB) helmet mounted, to provide hands free capability.                                                        |
| 23      | Fuses                                                                    | -                                                                                                                                      |
| 24      | Ship Installed Chemical System (SICS)                                    | System capable of detecting Chemical Agents to be installed onboard <i>IN</i> Ships.                                                   |

| Ser No. | Projects                                 | Description                                                                                                                                                                |
|---------|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 25      | Magazine Fire Fighting Systems for Ships | Fire Detection and associated Fire Fighting System (containing different propellant and explosives) for installation in various weapon magazines on board <i>IN</i> ships. |
| 26      | Specialised SV Mount                     | Cradle mounts of Talwar Class ships and Raft mounts of P-28 class ships                                                                                                    |
| 27      | Motor Boat Engines                       | -                                                                                                                                                                          |
| 28      | 5 MW Electric Propulsion Equipment       | Development of indigenous warship grade electric propulsion equipment                                                                                                      |
| 29      | Non-Magnetic Engines                     | -                                                                                                                                                                          |

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**APPENDIX L**  
(Refers to Para 3 Chap 10)

**PROJECTS COMPLETED/IN PROGRESS THROUGH  
DRDO/ PRIVATE INDUSTRY**

| Ser No. | Project                             | Description                                              |
|---------|-------------------------------------|----------------------------------------------------------|
| 1       | Echo Sounder (Multi Frequency Type) | M/s KELTRON                                              |
| 2       | Log EM (Type EML 40)                | M/s KELTRON                                              |
| 3       | Main Switchboard/ EDC/ EDPs         | M/s L&T<br>M/s GE Ltd                                    |
| 4       | Converters, 400 Hz                  | M/s ELMOT Alternators                                    |
| 5       | VCS System (VOIP Based)             | M/s BEL                                                  |
| 6       | C&C Switchboard                     | M/s L&T,<br>M/s Marine Electricals                       |
| 7       | Main Broadcast & SRE System         | M/s Phi AudioCom                                         |
| 8       | SIRS                                | M/s ECIL                                                 |
| 9       | Sound Power Telephones (SPT)        | M/s ELCOME Marine<br>M/s Linea<br>M/s Marine Electricals |
| 10      | LED Light Fittings                  | M/s McGeach Marine<br>Electricals<br>M/s Ray Enterprises |
| 11      | Power Panel for Heavy Loads         | M/s L&T, Mumbai<br>M/s Marine Electricals                |
| 12      | Degaussing Cable                    | M/s Universal Cables<br>Bangalore                        |
| 13      | Emergency Supply System             | M/s Ray Enterprises                                      |
| 14      | Rectifiers                          | M/s Precision Power Ltd                                  |
| 15      | Ship Data Network (SDN)             | M/s BEL, Bangalore                                       |
| 16      | Integrated Bridge System (IBS)      | M/s Navicom                                              |
| 17      | CMS                                 | M/s TPSED Mumbai                                         |
| 18      | Conventional Light Fittings         | M/s Ray Enterprises                                      |
| 19      | AELs                                | M/s Ray Internationals                                   |
| 20      | Power Cables for Main Switchboard   | M/s Nicco Corporation &<br>Radiant Cables                |
| 21      | Lighting Cables                     | M/s Radiant Cables                                       |

| Ser No.                         | Project                                                        | Description                                                                            |
|---------------------------------|----------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 22                              | Cable Ways                                                     | M/s Shakti Engg Works                                                                  |
| 23                              | Air Cooled Transformers (20 kVA)                               | M/s Marine Electricals                                                                 |
| 24                              | Power Panel for Engine and DA Room                             | M/s L&T                                                                                |
| 25                              | Lighting Panel                                                 | M/s Marine Electrical                                                                  |
| 26                              | Control and Monitoring Cable                                   | M/s Radiant cables<br>M/s Siechem Technology<br>M/s Nicco Corporation                  |
| 27                              | COS for Heavy and Machinery LOADS                              | M/s L&T                                                                                |
| 28                              | VLF system                                                     | DRDO/ Industry                                                                         |
| 29                              | INCIS (IN Communication Interoperability System)               | WESEE                                                                                  |
| 30                              | AVLF Modulator/ Demodulators                                   | M/s DEAL/ BEL                                                                          |
| 31                              | Next Generation Helo Harnessing and Traversing System (NGHHTS) | M/s L&T                                                                                |
| 32                              | KH 136 Paint                                                   | DRDO/NMRL                                                                              |
| 33                              | Marine Grade AL Alloy DMR 191A                                 | M/s Hindalco                                                                           |
| 34                              | Marine STP                                                     | M/s Hi Point                                                                           |
| 35                              | Heat Barrier Coating for Vikrant                               | NMRL                                                                                   |
| 36                              | Acid-Resistance Rubber Coating                                 | NMRL                                                                                   |
| 37 Additional Shipborne Systems |                                                                |                                                                                        |
| 38                              | GSHRB                                                          | M/S ECIL                                                                               |
| 39                              | C & C SW BD                                                    | M/S L & T LTD                                                                          |
| 40                              | Emergency DA SWBD                                              | M/S Marine Electricals                                                                 |
| 41                              | 20 kVA Convertor                                               | M/S ELMOT LTD                                                                          |
| 42                              | ACOS                                                           | M/S Marine Electrical                                                                  |
| 43                              | SIRS                                                           | M/S ECIL                                                                               |
| 44                              | ICCP System                                                    | M/S Cathodic Control Ltd                                                               |
| 45                              | Transformer                                                    | M/S Static Transformer                                                                 |
| 46                              | Lighting System                                                | M/S ISAAC Engg<br>M/S Manish Industries<br>M/S Arvin Industries<br>M/S Ray Enterprises |
| 47                              | Emergency Supply System                                        | M/S AIM Engg<br>M/S ISAAC Engg                                                         |
| 48                              | 30 kVA Helo Convertor                                          | M/S Kirloskar Ltd                                                                      |

| Ser No. | Project                                | Description                       |
|---------|----------------------------------------|-----------------------------------|
| 49      | Helo Starting Rectifier                | M/S Static Transformer            |
| 50      | CCS MK-III                             | M/S BEL                           |
| 51      | VCS-28                                 |                                   |
| 52      | SDN-28                                 |                                   |
| 53      | LINK-II MOD-III                        |                                   |
| 54      | LUP-329                                |                                   |
| 55      | 100 W MF Transmitter                   |                                   |
| 56      | EW SANKET                              |                                   |
| 57      | V/UHF COMNIT/ DF System ELK-7036-WB DF |                                   |
| 58      | MB/SRE                                 | M/s Phi Audio Com                 |
| 59      | Intercom System                        |                                   |
| 60      | SATCOM                                 | ISRO                              |
| 61      | SATCOM, PCS                            | M/s DEAL/ DRDO/ BEL               |
| 62      | Network Security Encryptors            | M/s ECIL/BEL                      |
| 63      | EW Ellora/ Ellora Mk II                | M/s DLRL/ BEL                     |
| 64      | EW Varuna                              | M/s DLRL/ BEL                     |
| 65      | CMS-28                                 | M/s BEL                           |
| 66      | ATM Switch for CMS                     |                                   |
| 67      | DDU for RLG                            | M/s Data Patterns Ltd             |
| 68      | Kavach Mod –II                         | M/s Machine Tool                  |
| 69      | 50 kVA Converter                       | M/s PCL Ltd                       |
| 70      | Radar Revathi                          | M/s BEL                           |
| 71      | UWT                                    | M/s Keltron                       |
| 72      | Echo Sounder V-2                       |                                   |
| 73      | AK 630                                 | M/s GSF, M/s Cossipore<br>M/s BEL |
| 74      | SOP for AK 630                         | M/s BEL                           |
| 75      | ITTL                                   | M/s L&T                           |
| 76      | FCS LYNX U1                            | M/s BEL                           |
| 77      | IAC MOD 'C'                            |                                   |
| 78      | SONAR HUMSA NG                         |                                   |
| 79      | IRL                                    | M/s L&T                           |

| Ser No. | Project                                                                       | Description                                                                                                                                |
|---------|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| 80      | Anchor Capstans                                                               | M/s Geeta                                                                                                                                  |
| 81      | Foldable Hangar Door                                                          | M/s L&T                                                                                                                                    |
| 82      | Rail-less Helo Traversing System                                              |                                                                                                                                            |
| 83      | Railed Helo Traversing System                                                 |                                                                                                                                            |
| 84      | Shore Supply Cables<br>(including light weight SS cables)                     | M/s Radiant Cables<br>M/s Siechem Technologies Pvt. Ltd<br>M/s Quadrant Cables<br>M/s Apar Cables<br>M/s Thermo Cables<br>M/s Polycab Ltd. |
| 85      | SFC                                                                           | M/s Precision Power Products<br>M/s Elcome Integrated System<br>M/s Static Transformers                                                    |
| 86      | Boat Davit                                                                    | M/s HH Group,<br>M/s Geeta Engg,<br>M/s Vanson Engg                                                                                        |
| 87      | AC Condenser Cooling Water Pumps                                              | M/s KBL Pumps<br>M/s SPX<br>M/s DESMI                                                                                                      |
| 88      | Auxiliary Cooling Water Pumps                                                 |                                                                                                                                            |
| 89      | Chilled Water Pumps                                                           |                                                                                                                                            |
| 90      | Fresh Water Pumps                                                             |                                                                                                                                            |
| 91      | Economiser Elements for Boilers of INS Vikramaditya                           | M/s Virtue Engineering<br>M/s BHEL                                                                                                         |
| 92      | Valves Fitted in Freshwater, Feed Water, Sea Water and Other Auxiliary System | M/s GDPA, M/s L&T<br>M/s Lender, M/s Meason                                                                                                |
| 93      | Feed Condensate Booster Turbo Driven Pump                                     | M/s TOCOL                                                                                                                                  |
| 94      | Proportioning Pumps for Boiler Dosing                                         |                                                                                                                                            |
| 95      | Motor Driven Fuel Pumps                                                       | M/s DESMI M/s Alektor<br>M/s Allenator                                                                                                     |

| Ser No. | Project                                                                          | Description                                           |
|---------|----------------------------------------------------------------------------------|-------------------------------------------------------|
| 96      | Reducing Stations                                                                | M/s Hale Hamilton Pvt Ltd<br>M/s Elgi                 |
| 97      | Globe Valves                                                                     | M/s GDPA,<br>M/s Meason<br>M/s Lender,<br>M/s L&T     |
| 98      | Diesel Monitoring Equipment                                                      | M/s Symptronic                                        |
| 99      | Coolant Expansion Tanks                                                          | M/s Ship Builder                                      |
| 100     | Electric Bilge Drying Pumps                                                      | M/s SPX,<br>M/s MERU      M/s<br>DESMI                |
| 101     | Refrigerating Plants                                                             | M/s Accel,    M/s KPCL,<br>M/s JCIPL                  |
| 102     | HP Air Compressors – Oil Filter (Submarine)                                      | M/s Burckhardt<br>DRDO/ CVRD<br>M/s Elgi              |
| 103     | IBA (Integrated Broadcast Application)                                           | M/s Data Byte                                         |
| 104     | HP Air Compressors – Air Filter (Submarine Application)                          | M/s NUKON Industries<br>DRDO/ CVRD<br>M/s BEKU/ NUCON |
| 105     | Hydraulic Filters Filter Element (Submarine Application)                         | DRDO/ CVRD                                            |
| 106     | Air + Water Filters Cartridge (Submarine Application)                            |                                                       |
| 107     | Reeled Compressed Air Foam System                                                | M/s Adisan Systems LLP                                |
| 108     | Indopene Foam Compound                                                           |                                                       |
| 109     | Development of Integrated SATCOM Multifunction Antenna (ISMS) for SSK Submarines | M/s Navstar                                           |
| 110     | Axial Flux Motors                                                                | M/s Tressa Energy                                     |
| 111     | Inertial Energy Storage Systems                                                  | M/s ELMOT                                             |
| 112     | SSM Loader                                                                       | M/s Mahindra Defence Systems Ltd                      |
| 113     | Fuel/ Lub Oil Centrifuge                                                         | M/s Alfa Laval                                        |

| Ser No.                                   | Project                                                               | Description                      |
|-------------------------------------------|-----------------------------------------------------------------------|----------------------------------|
| <b>Indigenisation Process in Progress</b> |                                                                       |                                  |
| 114                                       | HDVLF Rx                                                              | M/s DEAL, M/s BEL                |
| 115                                       | HEMP, 1000 Amps Filter                                                | DRDO, M/s Zeonics                |
| 116                                       | Indigenous Secure Router                                              | M/s Nivetty Systems              |
| 117                                       | MDA-DSS (Maritime Domain Awareness – Decision Support Software        | M/s CRL, M/s BEL                 |
| 118                                       | Fin Stabiliser                                                        | M/s L&T                          |
| 119                                       | ONEGA Control System                                                  |                                  |
| 120                                       | Development of Portable & Universal Pump Efficiency Monitoring System | M/s CSIR, CSIO                   |
| 121                                       | TDFL Pump for INS Vikramaditya                                        | M/s Tocol Machine Tools Pvt. Ltd |
| 122                                       | Main Circulating Pump for INS Vikramaditya                            |                                  |
| 123                                       | Thermal Imaging Camera (TIC)                                          | M/s BEL                          |
| 124                                       | 85 kW DC Motor with starter for HP Air Compressor for Submarines      | M/s Elmot Alternator Pvt. Ltd    |

**APPENDIX M**  
(Refers to Para 23 Chap 1)

**LIST OF /IN ITEMS UPLOADED ON SRIJAN DEFENCE PORTAL**

| <b>Ser No.</b> | <b>Product Description</b>                                 | <b>Srijan Portal ID</b> |
|----------------|------------------------------------------------------------|-------------------------|
| 1              | Boiler Tubes                                               | PRO59612                |
| 2              | Pump and Injector Unit                                     | PRO59615                |
| 3              | Heating Battery/ Element                                   | PRO59621                |
| 4              | Manipulator                                                | PRO59625                |
| 5              | 06 types of System Valve                                   | PRO59627                |
| 6              | IR Sensor Switch                                           | PRO59628                |
| 7              | 41 Types of SW/FW System Valve                             | PRO59629                |
| 8              | LSHSD Cargo Pump                                           | PRO59632                |
| 9              | 07 Types Filters                                           | PRO59635                |
| 10             | Window Wiper Assembly                                      | PRO59638                |
| 11             | Guard Rail Stanchion                                       | PRO59640                |
| 12             | Battery Unit                                               | PRO59642                |
| 13             | Modules of Listivista                                      | PRO59646                |
| 14             | Towing Slip                                                | PRO59651                |
| 15             | Sluice Valve                                               | PRO59713                |
| 16             | Ventilation Keys: Fresh Air & Foul Air                     | PRO59716                |
| 17             | 4G/LTE Tactical LAN                                        | PRO60881                |
| 18             | Unmanned Surface/Underwater Vehicles                       | PRO60886                |
| 19             | Development of C & Ku Band Terminal Antenna                | PRO60889                |
| 20             | Upper Air Sounding System                                  | PRO60896                |
| 21             | Three Phase Inverter for Maritime Patrol ELTA Radar        | PRO60898                |
| 22             | Proximity DA Fuze for 76/62 SRGM with Universal capability | PRO60902                |
| 23             | Effectors for Anti-Torpedo Countermeasure System           | PRO60904                |
| 24             | High Endurance Autonomous Underwater Vehicle (HEAUV)       | PRO60906                |
| 25             | Autonomous Surface Vehicle                                 | PRO60908                |
| 26             | AI Based SCM and Logistics                                 | PRO61045                |
| 27             | Desalination/Bilge-Oily Water Separation                   | PRO61046                |

| Ser No. | Product Description                                                             | Srijan Portal ID |
|---------|---------------------------------------------------------------------------------|------------------|
| 28      | Deep Sea Side Scan Sonar Towing Winch                                           | PRO61047         |
| 29      | Digital Beam forming Based Satellite TV System                                  | PRO61048         |
| 30      | Expendable Under Water Target                                                   | PRO61049         |
| 31      | Marine Grade Aluminium Plate 6-30 mm                                            | PRO61051         |
| 32      | Fuel Oil Service Pump (FOSP)                                                    | PRO61052         |
| 33      | Electrically Actuated Valves                                                    | PRO70367         |
| 34      | Flood Warning System                                                            | PRO70368         |
| 35      | Limpet Mines (7kg & 15 kg)                                                      | PRO70369         |
| 36      | Marine Sewage Treatment Plant for Future Platforms                              | PRO70370         |
| 37      | 14 kVA Converter                                                                | PRO70371         |
| 38      | 120 kVA Converter                                                               | PRO70372         |
| 39      | D-86 Main Engine Control System                                                 | PRO70373         |
| 40      | GT Air intake Filters                                                           | PRO70374         |
| 41      | Leaf Spring                                                                     | PRO70375         |
| 42      | 31 Types of Fuses                                                               | PRO70376         |
| 43      | 02 Types of Eductor                                                             | PRO70377         |
| 44      | GTG RPM Measurement & Indication System                                         | PRO70378         |
| 45      | Window Wiper Assembly                                                           | PRO70381         |
| 46      | Window Wiper Assembly                                                           | PRO70382         |
| 47      | Bottle Head Assembly 200 bar                                                    | PRO70383         |
| 48      | Bottle Head Assembly 280 bar                                                    | PRO70384         |
| 49      | Lift Motor, 5.5 kW, 380 V, 3 $\Phi$ , 50 Hz, 915 RPM, Star Winding              | PRO70385         |
| 50      | Hangar Ventilation Motor. 18.5 kW                                               | PRO70386         |
| 51      | Pre Lube Oil Pump Motor. 3.3 kW, 380V, 3 $\Phi$ , 50 Hz, 1685 RPM, Star Winding | PRO70387         |
| 52      | Ventilation Motor, 2.2 kW, 380V, 3 $\Phi$ , 50 Hz, 2895 RPM, Star               | PRO70388         |
| 53      | Ventilation Motor, 3 kW, 380V, 3 $\Phi$ , 50 Hz, 2880 RPM, Star                 | PRO70389         |
| 54      | Ventilation Motor, 7.5 kW, 380V, 3 $\Phi$ , 50 Hz, 2925 RPM, Star               | PRO70390         |
| 55      | Ventilation Motor, 11 kW, 380V, 3 $\Phi$ , 50 Hz, 2880 RPM, Star                | PRO70391         |

| Ser No. | Product Description                                         | Srijan Portal ID |
|---------|-------------------------------------------------------------|------------------|
| 56      | Bilge Pump Motor 8 kW                                       | PRO70392         |
| 57      | Pressure Reducing Station for APZ-028 Reducer               | PRO70393         |
| 58      | Pressure Reducer for RG System                              | PRO70394         |
| 59      | Pressure Reducing Station for Fwd DA Pressure Reducing      | PRO70395         |
| 60      | Pressure Reducing Station for Fwd GT Pressure Reducing      | PRO70396         |
| 61      | 31 Types of Hoses                                           | PRO70400         |
| 62      | 08 Types Hydraulic Hoses                                    | PRO70402         |
| 63      | 23 Type of Generic Instrumentation                          | PRO70403         |
| 64      | TBU Diaphragm                                               | PRO70404         |
| 65      | Converter Unit                                              | PRO70405         |
| 66      | Quick Operating Valve                                       | PRO70406         |
| 67      | 03 Types of OBBM/ OBM Cooler                                | PRO70407         |
| 68      | Load Testing Machine Frame                                  | PRO70408         |
| 69      | Main Vent Flap                                              | PRO70409         |
| 70      | Machinery Health Monitoring System                          | PRO70410         |
| 71      | Rectifiers                                                  | PRO70422         |
| 72      | 40 kVA UPS                                                  | PRO70423         |
| 73      | PLCs Training Kit                                           | PRO70424         |
| 74      | Embedded Software Maintenance Kit                           | PRO70425         |
| 75      | Anchor Windlass Motor                                       | PRO70426         |
| 76      | Helo Starting Converter                                     | PRO70427         |
| 77      | 03 Types of Spares                                          | PRO70428         |
| 78      | 06 Types of RAS/ FAS Hoses                                  | PRO70429         |
| 79      | Low Pressure Air Compressor                                 | PRO70430         |
| 80      | 3.99 m Inflatable Rubber Rib Collar                         | PRO70431         |
| 81      | Halon Fire Suppression System Control Panels                | PRO70432         |
| 82      | Static Frequency Converter (SFC Type1) DC-AC, 127V, 50Hz,   | PRO70433         |
| 83      | Static Frequency Converter (SFC Type 2) DC-AC, 220V, 400Hz, | PRO70434         |
| 84      | Hydraulic System Pump                                       | PRO70435         |
| 85      | PGV Transfer Pump                                           | PRO70436         |

| Ser No. | Product Description                                         | Srijan Portal ID |
|---------|-------------------------------------------------------------|------------------|
| 86      | Hydraulic Pump for Guardrail on Deck 5/ Pump for Ammunition | PRO70437         |
| 87      | Helo Fuel Transfer Pump                                     | PRO70438         |
| 88      | Centrifugal Pumps                                           | PRO70439         |
| 89      | Screw Pumps                                                 | PRO70440         |
| 90      | GT Air Intake Filter Bags for LM 2500 GT                    | PRO70441         |
| 91      | Low Cost Autonomous Under Water Swarms                      | PRO70626         |
| 92      | Secure Hardware Encryption Device                           | PRO70627         |
| 93      | 08 Types of Compensator                                     | PRO70628         |
| 94      | Block B220-3                                                | PRO70926         |
| 95      | PAID CA PCB                                                 | PRO70927         |
| 96      | Y(B)(P)(E) Power Supply Module                              | PRO70929         |
| 97      | Article (TSE) (Z) K(Y)                                      | PRO70930         |
| 98      | Baget                                                       | PRO70932         |
| 99      | Cable Harness                                               | PRO70934         |
| 100     | Waveguide Drier                                             | PRO70935         |
| 101     | Horizontal lifting device                                   | PRO70939         |
| 102     | Front section horizontal lifting device                     | PRO70941         |
| 103     | CM transportation on trolley                                | PRO70942         |
| 104     | Front/ mid transportation on trolley                        | PRO70943         |
| 105     | Amplifier multipiler module of O(P)IM(Z)1-91                | PRO70945         |
| 106     | RFQC test facility                                          | PRO70946         |
| 107     | Power Supply Module M2K3                                    | PRO70947         |
| 108     | Power Supply Module M2K4                                    | PRO70949         |
| 109     | Power Supply Module M2K6                                    | PRO70950         |
| 110     | Ka Band Main Receiver                                       | PRO70952         |
| 111     | RSC 1520 V Board Protection PCB Upper Display               | PRO70953         |
| 112     | Test Station                                                | PRO70954         |
| 113     | Arresting Gear Wire Rope(1100 mtr reel)                     | PRO71092         |
| 114     | Main Circulating Pump                                       | PRO71093         |
| 115     | TDFL Pump                                                   | PRO71094         |
| 116     | 1500 kW TURBO GENERATOR                                     | PRO71095         |
| 117     | Sprayer P(Ts)-2.0                                           | PRO71096         |
| 118     | Sprayer P(Ts)-1.2                                           | PRO71097         |
| 119     | Interface Unit for AWOS MNS                                 | PRO71111         |

| Ser No. | Product Description                                            | Srijan Portal ID |
|---------|----------------------------------------------------------------|------------------|
| 120     | HVLAS                                                          | PRO71112         |
| 121     | SPC(Fregat M2EM Radar)                                         | PRO71113         |
| 122     | TWT (AMDR 2D)                                                  | PRO71114         |
| 123     | Rotary Joint (AMRD 2D)                                         | PRO71116         |
| 124     | BSI Module                                                     | PRO71117         |
| 125     | LCU (AMDR 2D)                                                  | PRO71118         |
| 126     | Rubber O Ring various sizes                                    | PRO73858         |
| 127     | Rubber seal (26 types)                                         | PRO73859         |
| 128     | Diaphragm Sealing Rings, Gaskets and O Rings of various types  | PRO73860         |
| 129     | Cross gauge for submarine                                      | PRO73861         |
| 130     | Smoke Markers and Float smoke                                  | PRO73863         |
| 131     | Shear Bolt and Washer                                          | PRO73864         |
| 132     | Main Fuelling Gun and Vent Gun                                 | PRO73865         |
| 133     | Grease of Various Types                                        | PRO73866         |
| 134     | O-rings (set of 37 Nos)                                        | PRO73867         |
| 135     | Door Plug O-rings                                              | PRO73868         |
| 136     | Missile TLC junction Box O-ring                                | PRO73870         |
| 137     | Cocking Lever, Springs, Extractor of various types             | PRO73871         |
| 138     | Gauge testing blow of striker & striker-eccentricity equipment | PRO73872         |
| 139     | Gauge measuring bore                                           | PRO73874         |
| 140     | Plug bore gauge                                                | PRO73875         |
| 141     | O Ring of various types                                        | PRO73876         |
| 142     | SSE (Green & Red)                                              | PRO73877         |
| 143     | RPM pickup                                                     | PRO73878         |
| 144     | Fasteners (35 types)                                           | PRO73879         |
| 145     | Warhead Refilling                                              | PRO73881         |
| 146     | Oil 4LF                                                        | PRO73882         |
| 147     | 3 (Phi)Grease                                                  | PRO73883         |
| 148     | 192P- 44- 10(Booster Case Washer)                              | PRO73884         |
| 149     | 0501-8 (Locking Washer)                                        | PRO73885         |
| 150     | 17473-72 (Screw secure clamp)                                  | PRO73886         |
| 151     | 300 3A - 1030-4-2-30KP (Bolt 131103-80)                        | PRO73887         |
| 152     | 2-12-48KP-OST (Bolt 1310013-80)                                | PRO73890         |

| Ser No. | Product Description                                                | Srijan Portal ID |
|---------|--------------------------------------------------------------------|------------------|
| 153     | 12-KP-OST (Nut 133048-80)                                          | PRO73891         |
| 154     | Enamels, Solvents, Hardners and Primers of various types           | PRO73895         |
| 155     | Molykote medium 33 silicon low temperature grease                  | PRO73897         |
| 156     | High vaccum silicon grease                                         | PRO73900         |
| 157     | Screws, Lock, Push Rod, Pin and Springs of various types           | PRO73902         |
| 158     | Ball Bearing of various Types                                      | PRO73904         |
| 159     | All Pressure Switch                                                | PRO73906         |
| 160     | Cut Off Valve                                                      | PRO73908         |
| 161     | Poppet Valve                                                       | PRO73911         |
| 162     | Arcanol Grease for Torpedo                                         | PRO73913         |
| 163     | Mobil XHP 221 Grease for Torpedo                                   | PRO73915         |
| 164     | Release Wire for Torpedo                                           | PRO73917         |
| 165     | Scoop Arming Wire for Torpedo                                      | PRO73919         |
| 166     | Coupling Ring for Torpedo                                          | PRO73921         |
| 167     | CRU Battery                                                        | PRO73922         |
| 168     | Molykote HP-870 grease                                             | PRO73924         |
| 169     | Molykote 55 Silicon grease                                         | PRO73926         |
| 170     | Air Charging Gun                                                   | PRO73927         |
| 171     | O tank charging gun                                                | PRO73929         |
| 172     | G tank charging gun                                                | PRO73931         |
| 173     | Silica Indicator                                                   | PRO73932         |
| 174     | Silica Bags                                                        | PRO73934         |
| 175     | Loctite 222, 495,241,242,648 adhesive                              | PRO73936         |
| 176     | Poly sulphide sealing compound MIL-S-81733, MIL-S-8802, PR-1750-A2 | PRO73937         |
| 177     | Explosive bolts for Missiles                                       | PRO73938         |
| 178     | Rubber Comp. (03 Types)                                            | PRO73939         |
| 179     | Electrical Squib Connector                                         | PRO73941         |
| 180     | Plasticiser Sealant                                                | PRO73985         |
| 181     | Sealant and Hardener                                               | PRO73986         |
| 182     | Glue 88(N)(P)                                                      | PRO73987         |
| 183     | Leak-Tec, leak detection liquid (Type 16 OX)                       | PRO73988         |

| Ser No. | Product Description                                      | Srijan Portal ID |
|---------|----------------------------------------------------------|------------------|
| 184     | Anti-seizure paste (OKS-250)                             | PRO73989         |
| 185     | Sealants                                                 | PRO73990         |
| 186     | Accumulator Diaphragm for SSM missile                    | PRO73991         |
| 187     | Rubber Comp. (16 Types)                                  | PRO73992         |
| 188     | Screws, Levers, Springs of various types                 | PRO73993         |
| 189     | Pinion                                                   | PRO73994         |
| 190     | Sector gear                                              | PRO73996         |
| 191     | Seal Packing                                             | PRO73997         |
| 192     | Support                                                  | PRO73998         |
| 193     | Cassette Flares                                          | PRO73999         |
| 194     | Over flow Valve along with Squib                         | PRO74000         |
| 195     | Foldable Butt LMG with swivel mounting and Kevlar shield | PRO74001         |
| 196     | TG Stub                                                  | PRO74002         |
| 197     | End Ring                                                 | PRO74003         |
| 198     | Nefras C4-155/200                                        | PRO74004         |
| 199     | Nefras C4-80/120                                         | PRO74005         |
| 200     | Antistatic additive SIGBOL                               | PRO74006         |
| 201     | Sealing Paste (Y)-(Z)0(I)-5                              | PRO74007         |
| 202     | Vulcanising Paste No. 9                                  | PRO74008         |
| 203     | Product A(G)M-9                                          | PRO74009         |
| 204     | Nitrocellulose Glue AK-20                                | PRO74010         |
| 205     | Varnish AK-113                                           | PRO74011         |
| 206     | Underpaint Putty (I) (P)-0080                            | PRO74012         |
| 207     | Sealing Compound (B)(E)K(S)(E)(N)T                       | PRO74013         |
| 208     | PuttyXB-004(G)O(S)T                                      | PRO74014         |
| 209     | Enamel XB-5169                                           | PRO74015         |
| 210     | Silicone Rubber sealant (RTV-162)                        | PRO74016         |
| 211     | Silicone Rubber sealant (RTV-560)                        | PRO74017         |
| 212     | NIL4                                                     | PRO74018         |
| 213     | Khladon/Mafron 113                                       | PRO74019         |
| 214     | Washer                                                   | PRO74020         |
| 215     | Section 4 charging rig & adaptor                         | PRO74021         |
| 216     | Main Engine Lub Oil Control System                       | PRO74112         |
| 217     | Ejection Seat Cartridge Set (Part No.MBEU92514           | PRO77552         |

| Ser No. | Product Description                                                                         | Srijan Portal ID |
|---------|---------------------------------------------------------------------------------------------|------------------|
| 218     | Command Ejection Cartridge Set (part No.MBEU60228                                           | PRO77553         |
| 219     | Engine fire bottle squib (Right) (Part No.30903871)                                         | PRO77554         |
| 220     | Engine fire bottle squib (Left) (Part No.30903872)                                          | PRO77555         |
| 221     | Exhaust Compensator of BQ System                                                            | PRO78484         |
| 222     | Socket and Washer                                                                           | PRO78485         |
| 223     | MEMS Based Pressure & Temp Sensor with Wireless Communication Scheme                        | PRO78486         |
| 224     | Fin Stabiliser System                                                                       | PRO78487         |
| 225     | MD Fuel Oil Pump Hose                                                                       | PRO78515         |
| 226     | 15 Types of Pressure Gauges                                                                 | PRO78516         |
| 227     | 06 types of Limit Switch                                                                    | PRO78517         |
| 228     | Hose for IDA 59 M, 70 Nos.                                                                  | PRO78519         |
| 229     | Cathelco Anode, 12 Nos.                                                                     | PRO78520         |
| 230     | Portable Smoke Generator-NBCD, 30 Nos.                                                      | PRO78521         |
| 231     | DG Fuel Cooler, 04 Nos.                                                                     | PRO78544         |
| 232     | Indicating Valve, 06 Nos.                                                                   | PRO78545         |
| 233     | Batteries for Forklifts, 10 Nos.                                                            | PRO78546         |
| 234     | Plummer Block Bearings 02 Nos. & Thrust Pads 16 Nos.                                        | PRO78547         |
| 235     | FO Stripping Pump, FO Transfer Pump, FO Feed Pump                                           | PRO78548         |
| 236     | Super D Vibration Mount 17 nos, Metacone Vibration Mount 9 Nos., Metacone Metalastic 9 Nos. | PRO78570         |
| 237     | HP Air Stop Valve                                                                           | PRO78571         |
| 238     | Gland of Fuel Feed Pump                                                                     | PRO78572         |
| 239     | Drinking Water Cooler                                                                       | PRO78573         |
| 240     | Sprayer P(TS)-Dia 4.0, Sprayer P(TS)-Dia 2.8                                                | PRO78574         |
| 241     | Wire Braided Lub Oil Hose (Big) & Wire Braided Lub Oil Hose (small)                         | PRO78575         |
| 242     | Burner Body Assembly/ Injector, Burner Tip/ Sprayer                                         | PRO78603         |

| Ser No. | Product Description                                    | Srijan Portal ID |
|---------|--------------------------------------------------------|------------------|
| 243     | Milliampere Meter / Converter Primary Tachometer       | PRO78604         |
| 244     | Bow Spring Cover Plate                                 | PRO78605         |
| 245     | Half Cover Plate                                       | PRO78606         |
| 246     | Securing Bolt ( Arresting gear )                       | PRO78607         |
| 247     | Load Testing Machine (LTM) Wedges                      | PRO78608         |
| 248     | 23 Types of Fuses                                      | PRO78609         |
| 249     | Screw Pumps                                            | PRO78610         |
| 250     | CGT Cooler                                             | PRO78611         |
| 251     | BGT Cooler                                             | PRO78612         |
| 252     | CRG Cooler                                             | PRO78613         |
| 253     | BRG Cooler                                             | PRO78614         |
| 254     | RG Cooler                                              | PRO78615         |
| 255     | Ship Electric Pan (Shallow fryer)                      | PRO78616         |
| 256     | Burner with Hot Plate                                  | PRO78617         |
| 257     | Chilled Water Cooler                                   | PRO78618         |
| 258     | Battery Lithium type Submarine Indicator Buoy (SIU)    | PRO78619         |
| 259     | 19 Types of Russian / Non- Russian fuses               | PRO78620         |
| 260     | Detonator Percussion N5 Mk II                          | PRO78823         |
| 261     | 09 Types of consumable for signal flares               | PRO78824         |
| 262     | Conformal tank support                                 | PRO78881         |
| 263     | Anchor Cum Mooring Capstan                             | PRO78882         |
| 264     | Stern Windlass                                         | PRO78883         |
| 265     | SSM Loader                                             | PRO78884         |
| 266     | Onega Control System                                   | PRO78886         |
| 267     | Echo Sounder                                           | PRO78887         |
| 268     | Type II Battery (Second Source)                        | PRO78888         |
| 269     | DC Insulation Measuring Unit (Omega)                   | PRO78889         |
| 270     | Helo Deck Communication System                         | PRO78890         |
| 271     | Portable & Universal Pump Efficiency Monitoring System | PRO78891         |
| 272     | Water Pump                                             | PRO78892         |
| 273     | Fuel Duplex Filter                                     | PRO78893         |

| Ser No. | Product Description                                                      | Srijan Portal ID |
|---------|--------------------------------------------------------------------------|------------------|
| 274     | 85 kW DC Motor with starter for HP Air Compressor                        | PRO78894         |
| 275     | Thermal Imaging Camera 81 Nos                                            | PRO78895         |
| 276     | Two types of Universal Variator                                          | PRO78896         |
| 277     | Coalescer Filter                                                         | PRO78908         |
| 278     | Filter Element (Main Engine Fuel Filter )                                | PRO78911         |
| 279     | Indicator Buoy                                                           | PRO79007         |
| 280     | Motor for Accomodation Ladder System                                     | PRO79008         |
| 281     | Motor for Helo Defuelling System                                         | PRO79009         |
| 282     | Motor for Ships Siren                                                    | PRO79010         |
| 283     | Filter Element Fluid (AVCAT Element Filter)                              | PRO79011         |
| 284     | Filter Element Fluid (AVCAT Coalescer Filter)                            | PRO79012         |
| 285     | Buffer Metalastik                                                        | PRO79013         |
| 286     | Element Fuel Oil Filter (DA Fuel Filter)                                 | PRO79014         |
| 287     | Composite Sonar Dome                                                     | PRO79054         |
| 288     | Mounting Device                                                          | PRO79055         |
| 289     | Cradle Support for Canopy                                                | PRO79056         |
| 290     | Radar Mono Block Storage/ Transportation Box                             | PRO79057         |
| 291     | Radar Scanner Storage/ Transportation Box                                | PRO79058         |
| 292     | Installation Trolley for Suspended Fuel Tank                             | PRO79059         |
| 293     | Aircraft Storage Battery                                                 | PRO79060         |
| 294     | Trolley                                                                  | PRO79061         |
| 295     | Cradle Support for Engine Cowls                                          | PRO79062         |
| 296     | Tyre (MLG)                                                               | PRO79063         |
| 297     | Tyre (NLG)                                                               | PRO79064         |
| 298     | Hydraulic Jack                                                           | PRO79065         |
| 299     | Rotor Hub Support                                                        | PRO79066         |
| 300     | Main Gear Stand                                                          | PRO79067         |
| 301     | Deck Mooring Device                                                      | PRO79068         |
| 302     | Tyre Remover                                                             | PRO79069         |
| 303     | Aircraft Wheel Restrainer                                                | PRO79070         |
| 304     | Cables for Kashmir AKIPS Test Bench                                      | PRO79071         |
| 305     | Indigenisation of Lugs of Kashmir Missiles                               | PRO79072         |
| 306     | Ka Band mixer amp, Quad Module Multiplier and Az El Select Interface Mod | PRO79073         |

| Ser No. | Product Description                                                   | Srijan Portal ID |
|---------|-----------------------------------------------------------------------|------------------|
| 307     | Multi Frequency generator Unit, UCHES Unit and S band Pulse Modulator | PRO79074         |
| 308     | Course Receiver Unit, X band target Oscillator and BY Servo Amplifier | PRO79075         |
| 309     | Salt Spacer for MRP mines                                             | PRO79124         |
| 310     | Pyro Squib PP-8                                                       | PRO79125         |
| 311     | Polyurethane Diaphragm                                                | PRO79131         |
| 312     | Pyrocartridge YDP 2-1                                                 | PRO79180         |
| 313     | Ring Packing U-Section                                                | PRO79181         |
| 314     | Washer Joint                                                          | PRO79186         |
| 315     | Ring Packing V-Section                                                | PRO79194         |
| 316     | Washer Joint                                                          | PRO79195         |
| 317     | Ring Packing                                                          | PRO79196         |
| 318     | Rear Clamp Assembly                                                   | PRO79197         |
| 319     | GPS Locator                                                           | PRO79198         |
| 320     | Silicon Oil                                                           | PRO79199         |
| 321     | 07 Types of OBBM Coolers                                              | PRO79511         |
| 322     | Buoyancy Under Water Glider                                           | PRO79660         |
| 323     | Supersonic Weapon Imitating Flying Target (SWIFT)                     | PRO79661         |
| 324     | Integrated Stand Instrument System (ISIS) for MIG 29K                 | PRO79662         |
| 325     | 14 Types of Hoses                                                     | PRO90499         |
| 326     | GT Exhaust Compensator                                                | PRO90500         |
| 327     | 20 Types Russian/non-Russian lamps                                    | PRO90501         |
| 328     | Solenoid valve 02 types                                               | PRO90502         |
| 329     | 03 Types Axial & 35 types centrifugal fans                            | PRO90503         |
| 330     | CAM & Ratchet                                                         | PRO90504         |
| 331     | 76/62 mm SRGM Ammunition                                              | PRO90670         |
| 332     | Automatic Voltage Regulator                                           | PRO90706         |
| 333     | UPS 60 kVA                                                            | PRO90708         |
| 334     | PLCs of Ships Cargo Handling System                                   | PRO90709         |
| 335     | Spring (Camshaft Drive)                                               | PRO90710         |
| 336     | Ring Spring                                                           | PRO90711         |
| 337     | Gasket Copper                                                         | PRO90712         |

| Ser No. | Product Description                     | Srijan Portal ID |
|---------|-----------------------------------------|------------------|
| 338     | Gasket (SR6001D-P(I)471-04-74-26        | PRO90713         |
| 339     | Coupling Unit                           | PRO94058         |
| 340     | Data Acquisition and Processing Unit    | PRO94059         |
| 341     | Control and Monitoring Unit             | PRO94082         |
| 342     | Onboard Oxygen Generation System        | PRO94083         |
| 343     | Optical Mechanical Unit                 | PRO94084         |
| 344     | Unit HF Trans receiver                  | PRO94085         |
| 345     | Aircraft Accessory Gearbox              | PRO94086         |
| 346     | Head Up Display                         | PRO94087         |
| 347     | Antenna Coupler Unit                    | PRO94088         |
| 348     | Multifunctional Display                 | PRO94089         |
| 349     | Short Range Navigation System           | PRO94090         |
| 350     | Air Data Computer                       | PRO94091         |
| 351     | Control Actuator                        | PRO94092         |
| 352     | Control Actuator                        | PRO94093         |
| 353     | Video Data Processor                    | PRO94094         |
| 354     | Specialized Digital Computer            | PRO94095         |
| 355     | Air to Air Receiver                     | PRO94096         |
| 356     | Trans receiver                          | PRO94097         |
| 357     | Generator Drive                         | PRO94098         |
| 358     | Adjuster, Protection and Control Unit   | PRO94099         |
| 359     | Limiting Signal Computer                | PRO94100         |
| 360     | Data Exchange Unit                      | PRO94101         |
| 361     | MLS Receiver                            | PRO94102         |
| 362     | Mission Computer                        | PRO94103         |
| 363     | Integral Sensor Unit                    | PRO94104         |
| 364     | Plunge Pump                             | PRO94105         |
| 365     | DC Generator                            | PRO94106         |
| 366     | Navigation and Landing Unit (NLU)       | PRO94107         |
| 367     | Unit (Radar Exciter)                    | PRO94108         |
| 368     | Unit (Radar Transmitter)                | PRO94109         |
| 369     | Integral Drive Vane                     | PRO94110         |
| 370     | Microwave Landing system (MLS) Receiver | PRO94111         |
| 371     | 20.1" Display                           | PRO94112         |
| 372     | Lift Transducer                         | PRO94113         |

| Ser No. | Product Description                                                                             | Srijan Portal ID |
|---------|-------------------------------------------------------------------------------------------------|------------------|
| 373     | INS-GPS (TNL-16G)                                                                               | PRO94114         |
| 374     | Speed Control Indicator                                                                         | PRO94115         |
| 375     | Hydraulic pump of main hydraulic system                                                         | PRO94116         |
| 376     | Gear Box Oil Cooler                                                                             | PRO94117         |
| 377     | Multi-Functional Display                                                                        | PRO94118         |
| 378     | Air Data Computer                                                                               | PRO 94317        |
| 379     | Medium Speed 6 MW Marine Diesel Engine                                                          | PRO96136         |
| 380     | Electro-Optical IR Search and Track System (EOIRST)                                             | PRO96138         |
| 381     | 127 mm Medium Calibre Gun                                                                       | PRO96184         |
| 382     | 5 m <sup>3</sup> /h Oily Water Separator (OWS) System                                           | PRO96209         |
| 383     | 127 mm Guided Projectile                                                                        | PRO96212         |
| 384     | Ship Based Rukmini SATCOM Terminal                                                              | PRO96213         |
| 385     | Glide SSM                                                                                       | PRO96221         |
| 386     | Light Weight High Speed Marine Engine for Naval Boats                                           | PRO96224         |
| 387     | Turbo Charger for P-75                                                                          | PRO96225         |
| 388     | URAN SSM Complex FCS (KASU)                                                                     | PRO96231         |
| 389     | 30 mm Naval Surface Gun                                                                         | PRO96488         |
| 390     | 30 mm Ammunition for Naval Surface Gun                                                          | PRO96489         |
| 391     | Treatment Panel Conductivity Transmitter                                                        | PRO96551         |
| 392     | 76mm Super Rapid Gun Mount                                                                      | PRO97617         |
| 393     | Next Generation Helo Harnessing and Traversing System                                           | PRO97618         |
| 394     | 76/ 62 SRGM High Explosive (HE) and High Explosive Pre Formed Fragmented (HEPFF) Ammunition'    | PRO97619         |
| 395     | Alternate Emergency De-ballasting System onboard SSK/ P-75 Submarines                           | PRO97621         |
| 396     | Semi-Submersible Autonomous Vessel for Intelligence, Operations and Reconnaissance (SAVIOR)-ASW | PRO100812        |
| 397     | Compact Autonomous Surface Craft All Domain Effects – Anti Submarine Warfare (CASCADE-ASW)      | PRO100813        |

| Ser No. | Product Description                                                                               | Srijan Portal ID |
|---------|---------------------------------------------------------------------------------------------------|------------------|
| 398     | Shore based Guided Rockets (SB-GR) System'                                                        | PRO100814        |
| 399     | 12 MW Electric Propulsion for ships                                                               | PRO100815        |
| 400     | 4 MW Marine Gas Turbine based Electric Power Generator                                            | PRO100816        |
| 401     | Extra Large Unmanned Underwater Vehicle (XLUUV)                                                   | PR0100819        |
| 402     | Ship Born Laser Weapon System (30 kW)                                                             | PRO100821        |
| 403     | Hamilton Valve                                                                                    | PRO100923        |
| 404     | RU Tank Changeover Cock                                                                           | PRO101601        |
| 405     | Valve Pressure Reducing                                                                           | PRO101603        |
| 406     | Auto Release Hook                                                                                 | PRO106217        |
| 407     | Mandatory Overhaul Spares of DE59 GT (SNFs)                                                       | PRO125563        |
| 408     | Ground Handling Equipment (GHE) for Air Loading of <i>IN</i> DSRV System                          | PRO125564        |
| 409     | Integrated SATCOM Multifunction System (ISMS) (Multifunctional Antenna AT-4125 for P-75 Submarine | PRO125565        |
| 410     | Standalone Miniatured Telemetry Package (SMTP                                                     | PRO125566        |
| 411     | Leveraging Health and usage Monitoring Systems (HUMS)                                             | PRO125567        |
| 412     | Composite WT/GT doors and Hatches for <i>IN</i> Ships                                             | PRO125568        |
| 413     | Indigenous Water jet Propulsion Systems for Ships                                                 | PRO125569        |
| 414     | Composite Material Sea Water Pumps (40TPH & 125 TPH)                                              | PRO125570        |
| 415     | VLF Loop Antenna including the below Deck Interface equipment for Kalvari class                   | PRO125571        |
| 416     | VLF-HF Matrix including the interface equipment for Kalvari class of submarine                    | PRO125572        |
| 417     | Use of Composite Technology for Bottles Storing Hydrogen and HP Air for Submarine                 | PRO125573        |
| 418     | Marine Declinators for Life Rafts onboard for Ships                                               | PRO125574        |
| 419     | Tide Efficient Gangway                                                                            | PRO125575        |

| Ser No. | Product Description                                                      | Srijan Portal ID |
|---------|--------------------------------------------------------------------------|------------------|
| 420     | SSPA State 2 Amplifier for AMDR                                          | PRO125576        |
| 421     | Underwater Launched Unmanned Aerial Vehicle (ULUAV)                      | PRO125577        |
| 422     | Motor for Pump-jet Propulsion                                            | PRO125676        |
| 423     | RF Components of EW System Components                                    | PRO125679        |
| 424     | Buoyant Cable Antenna for P-75                                           | PRO125684        |
| 425     | Wireless Aircraft Flight Data Recorder                                   | PRO125687        |
| 426     | Quantum Encryption Modules for Secure Satellite Communication            | PRO125732        |
| 427     | 16 Core Advanced Hybrid Armoured Fiber Optic Undersea Range Cable        | PRO125733        |
| 428     | Naval Aerial Robotic System                                              | PRO125734        |
| 429     | Economiser Coils (Elements) for INS Vikramaditya                         | PRO125736        |
| 430     | Battery Fan and Boat Fan with DC Motor                                   | PRO125751        |
| 431     | KAC 1-14 Card for Burya Control System                                   | PRO125752        |
| 432     | Deck Rim                                                                 | PRO125753        |
| 433     | Pilot Register & Servo Driven Register                                   | PRO125754        |
| 434     | MPU & MK-300 Cards                                                       | PRO125755        |
| 435     | Forward DG Sets incident Level Detector                                  | PRO125756        |
| 436     | Ultrasonic Level Detector on NP16 Flange (High & Low Level Sensor)       | PRO125757        |
| 437     | Ultrasonic Level Detector for bilge with clamp (High & Low Level Sensor) | PRO125758        |
| 438     | Fuel Tank Inlet Motorised Valve (Actuator)                               | PRO125759        |
| 439     | Motor of Fule Valve (Actuator)                                           | PRO125760        |
| 440     | Magnetised Float Level Detector                                          | PRO125761        |
| 441     | Flowmeter ND40 on Fresh Water Circuits                                   | PRO125762        |
| 442     | ND80 Flowmeter on Fresh Water Circuits                                   | PRO125763        |
| 443     | Flowmeter ND80 on Fresh Water Circuits                                   | PRO125846        |
| 444     | Lithium Battery 28 V                                                     | PRO125847        |
| 445     | Lithium Battery 28.8 V, 13Ah                                             | PRO125848        |
| 446     | Lithium Cell Assembly                                                    | PRO125849        |
| 447     | Ni-Cd Battery 12 V, 1.8Ah                                                | PRO125850        |
| 448     | Water Tight Battery 24V, 2A, LR 20 Alkaline                              | PRO125851        |

| Ser No. | Product Description                                                             | Srijan Portal ID |
|---------|---------------------------------------------------------------------------------|------------------|
| 449     | Ni-Cd Battery 3.6 V, 0.9A                                                       | PRO125852        |
| 450     | Flow Indicator                                                                  | PRO125853        |
| 451     | Shaft Cooling S/W Flow Detector                                                 | PRO125854        |
| 452     | Flow Indicator                                                                  | PRO125855        |
| 453     | Turbo Condensate Pump Motor 7.5 kW, 380V, 3Φ, 50Hz, 2895 RPM Star winding       | PRO125856        |
| 454     | Boiler Chemical Cleaning Pump Motor 4 kW, 380V, 3Φ, 50Hz, 2880 rpm Star winding | PRO125866        |
| 455     | Stripping Pump Motor 4 kW, 380V, 3Φ, 50Hz, 2895 RPM Star winding                | PRO125867        |
| 456     | Feed Water Transfer Pump Motor 4 kW, 380V, 3Φ, 50Hz, 2880 rpm Star winding      | PRO125868        |
| 457     | Boat Davit Motor 37 kW, 380V, 3Φ, 50Hz, 1310 RPM Star winding                   | PRO125869        |
| 458     | 02 Types of Butterfly Valves                                                    | PRO125870        |
| 459     | 02 Types of SDNR Valves                                                         | PRO125871        |
| 460     | Butterfly Valve for Suction                                                     | PRO125872        |
| 461     | Butterfly Valve Dia 125mm                                                       | PRO125873        |
| 462     | Ring Sealing/ Packing of Indicator Valve on the Block                           | PRO125874        |
| 463     | Fixture for Rolling Out Shell and Inserts                                       | PRO125875        |
| 464     | Pumping Unit With Hydraulic Drive AGN 25/25                                     | PRO125876        |
| 465     | High Pressure Fuel Supply Line                                                  | PRO125877        |
| 466     | Protector (F) 1301-75                                                           | PRO125878        |
| 467     | Oil Pump for Co2 Compressor                                                     | PRO125879        |
| 468     | Hot & Cold Water Pressure Reducer                                               | PRO125880        |
| 469     | Pressure Air Ejector                                                            | PRO125881        |
| 470     | Periscope Lower Cup Seal                                                        | PRO125887        |
| 471     | Periscope Upper Cup Seal                                                        | PRO125888        |
| 472     | Packing                                                                         | PRO125889        |
| 473     | Hand Pump Cup Seal                                                              | PRO125890        |
| 474     | 6 Cargo LSHD Hose, L-4.5 Mtr                                                    | PRO125891        |
| 475     | 6 Cargo LSHD Hose, L-9 Mtr                                                      | PRO125892        |
| 476     | 4 Cargo AVCAT Hose, L-4.5 Mtr                                                   | PRO125893        |
| 477     | 4 Cargo AVCAT Hose, L-1 Mtr                                                     | PRO125894        |

| Ser No. | Product Description                                                                                                                  | Srijan Portal ID |
|---------|--------------------------------------------------------------------------------------------------------------------------------------|------------------|
| 478     | 2.5 Cargo F1ry Hose, L-4.5 Mtr                                                                                                       | PRO125895        |
| 479     | 2.5 Cargo FW Hose, L-9 Mtr                                                                                                           | PRO125896        |
| 480     | Valve Starting Packing Ring in Cylinder Head                                                                                         | PRO125897        |
| 481     | Bottle Head Assembly Unit with Charging/ Discharge & gauge Relief Valve                                                              | PRO125898        |
| 482     | MD Turning Reducer                                                                                                                   | PRO125899        |
| 483     | Bilge Drying Pump (1B1 Pump) Without Motor                                                                                           | PRO125900        |
| 484     | Valve Shut off Angular Bronze                                                                                                        | PRO125901        |
| 485     | integrated standby Indicator System                                                                                                  | PRO126092        |
| 486     | Coupling Unit                                                                                                                        | PRO126093        |
| 487     | 03 Types of Heat Exchangers (Type: 150 kW, 178 kW and 182 kW DM Water SW Cooler)                                                     | PRO126193        |
| 488     | Bow Fresh Water Circulate pump and Aft Battery Cooling DM circulate pump. (Type MU 12-d4)                                            | PRO126194        |
| 489     | Forward and Aft Seawater Cooling Circuit Pump along with Motor assembly. Type MU 12-d4. (Centrifugal, capacity 40 m <sup>3</sup> /h) | PRO126195        |
| 490     | Hydrophore Group Electric Pump, Type: MU-12C (RN 12ED000C0044)                                                                       | PRO126196        |
| 491     | Water Pump Assembly                                                                                                                  | PRO126197        |
| 492     | Pulse Temperature Regulator                                                                                                          | PRO126198        |
| 493     | 28 V Emergency Network System                                                                                                        | PRO126199        |
| 494     | 06 Types of Underwter Valves                                                                                                         | PRO126825        |
| 495     | Out Board Communication Cable (03 Types)                                                                                             | PRO126827        |
| 496     | HF Control Cable                                                                                                                     | PRO126830        |
| 497     | HF-RF Cable                                                                                                                          | PRO126831        |
| 498     | Boiler Fuel Flowmeter                                                                                                                | PRO126832        |
| 499     | Appliance for Fighting Suspension Nut with 2-Pin Lubricant                                                                           | PRO127452        |
| 500     | Arresting Gear Feedback Wire Mechanism                                                                                               | PRO127639        |
| 501     | Appliance for Press in and out turbo compressor bearing                                                                              | PRO127640        |
| 502     | Kit Inflation/ Charging MK6A Adaptor                                                                                                 | PRO127739        |
| 503     | Appliance for Press the Reduction Gear Driving Shaft Bearing                                                                         | PRO127740        |

| Ser No. | Product Description                                                                      | Srijan Portal ID |
|---------|------------------------------------------------------------------------------------------|------------------|
| 504     | Appliance for Lifting Cylinder Liner                                                     | PRO127741        |
| 505     | Appliance for Pressing and Lifting Cylinder Head                                         | PRO127742        |
| 506     | Appliance for Removal of Vibration Damper                                                | PRO127743        |
| 507     | Appliance for Pressing ON/OFF Compressor Impeller & Inducer                              | PRO127744        |
| 508     | Appliance for Washing the Filtering Element                                              | PRO127745        |
| 509     | Appliance to Drain Oil out of Hydraulic Pusher                                           | PRO127746        |
| 510     | Element Filter Cleaner                                                                   | PRO127747        |
| 511     | Appliance to press the Gear on the Camshaft Cone                                         | PRO127748        |
| 512     | Appliance for Lifting Intake Valve Drive Levers                                          | PRO127749        |
| 513     | Engine Sling                                                                             | PRO127750        |
| 514     | Engine Rigging Control Kit                                                               | PRO127751        |
| 515     | LP/ HP Compressor Washing Rig                                                            | PRO127752        |
| 516     | Stand Ejection Seat                                                                      | PRO127753        |
| 517     | Adapter Ejection Seat/ Adapter Arm                                                       | PRO127754        |
| 518     | Cover Cockpit                                                                            | PRO127755        |
| 519     | Wheel Chock                                                                              | PRO127756        |
| 520     | Expansion Bellow T/C Outlet (ND 700)                                                     | PRO128058        |
| 521     | Expansion Bellow T/C Outlet (ND 1000)                                                    | PRO128059        |
| 522     | Expansion Bellow (Silencer Inlet)                                                        | PRO128060        |
| 523     | Development of Inertial Energy Storage System for Naval Applications (IESS)              | PRO128061        |
| 524     | Non-Lethal Device for Stopping Vessala at Sea                                            | PRO128062        |
| 525     | Axial Flux BLDC Motors                                                                   | PRO128063        |
| 526     | Integrated Maritime Domain Awareness Platform for Detecting Anomalies using AI/ML        | PRO128064        |
| 527     | Disposal of Expired Ammunition and Bombs into Sea                                        | PRO128065        |
| 528     | Portable, Modular Steel - Box Earth Covered Magazine for High Explosives with Blast Door | PRO128067        |
| 529     | Optic Faber Based Fire and Temperature detection system for sea going platforms          | PRO128069        |
| 530     | Air Inlet Expansion Bellow                                                               | PRO128103        |
| 531     | Expansion Bellow T/C Air Inlet                                                           | PRO128105        |

| Ser No. | Product Description                                                 | Srijan Portal ID |
|---------|---------------------------------------------------------------------|------------------|
| 532     | Expansion Bellow Exhaust T/C Inlet                                  | PRO128106        |
| 533     | Fabric Air Intake Bellow                                            | PRO128107        |
| 534     | Bellpw DN 100 Type No. ERVG-100 (100 NBX150mm OAL)                  | PRO128145        |
| 535     | Compressor Condenser XB4.3-1 OM5                                    | PRO128146        |
| 536     | Block Pt No. SR6001D-C2H(I)-01-51-250                               | PRO128147        |
| 537     | Block, Pt No. SR6001D-C2H(I)-01-51-250-01                           | PRO128376        |
| 538     | Block, Pt No. SR6001D-C2H(I)-01-51-250-03                           | PRO128377        |
| 539     | Block, Pt No. SR6001D-C2H(I)-01-51-250-02                           | PRO128378        |
| 540     | Disc Type Turning Gate with Pneumatic Drive & Limit Indicator       | PRO128379        |
| 541     | FWD Vent Valve                                                      | PRO128380        |
| 542     | Hydraulic Bypass Manipulator                                        | PRO128381        |
| 543     | Stop Ball Straight Way Valve with Double Acting Pneumatic AC DN 50  | PRO128382        |
| 544     | Stop Ball Straight Way Valve with Double Acting Pneumatic AC DN 65  | PRO128383        |
| 545     | Stop Ball Straight Way Valve with Double Acting Pneumatic AC DN 100 | PRO128387        |
| 546     | Pneumatic Valve (Turning/Blowing Solenoid)                          | PRO128388        |
| 547     | Sea Water Bellow 80NB(80 NBX350MM OAL)                              | PRO138382        |
| 548     | Insertor to Lower Down the Piston Coupled with Ring                 | PRO138383        |
| 549     | Puller to Press the Bushing out of Cam Shaft Drive Bracket          | PRO138384        |
| 550     | Puller to Remove the Ball Bearing from the Governor Drive           | PRO138385        |
| 551     | Pump Water Sealing Ring Grinder                                     | PRO138386        |
| 552     | Remover for Camshaft Drive Elastic Gear                             | PRO138387        |
| 553     | Remover for Impeller of Pump Water                                  | PRO138388        |
| 554     | Remover Ring Piston and Insertor                                    | PRO138389        |
| 555     | Spanner/Wrench for Angle Pipe Plug for Pump and Inject Fuel         | PRO138390        |
| 556     | Spanner/ Wrench for Connecting Rod Bolt & Nut                       | PRO138391        |
| 557     | Spanner / Wrench for Round Nut of Screw Pumps                       | PRO138392        |

| Ser No. | Product Description                                                       | Srijan Portal ID |
|---------|---------------------------------------------------------------------------|------------------|
| 558     | Spanner/ Wrench for Securing Cylinder Head                                | PRO138393        |
| 559     | Spanner/ Wrench for tighten up the Nut that hold the Cylinder             | PRO138394        |
| 560     | Spanner/ Wrench Head Torque Indicating for Securing Cylinder              | PRO138395        |
| 561     | Suspension Lowering & Lifting Fixture                                     | PRO138396        |
| 562     | Valve Seat for Exhaust Grinder                                            | PRO138397        |
| 563     | Lining Bushing                                                            | PRO138398        |
| 564     | Lower Supporting Bushing                                                  | PRO138399        |
| 565     | Mid Supporting Bushing-                                                   | PRO138400        |
| 566     | Upper Supporting Bushing                                                  | PRO138401        |
| 567     | Lub Oil Cooler                                                            | PRO138402        |
| 568     | SW/FW Tubular Heat Exchanger                                              | PRO138403        |
| 569     | Navigational Light Panel                                                  | PRO138404        |
| 570     | Refrigeration Plant Condenser                                             | PRO138405        |
| 571     | FZAA-31-6 Fan(Without Motor)-                                             | PRO138423        |
| 572     | FZAA-100-6 Fan (Without Motor)/Impeller                                   | PRO138424        |
| 573     | FZAB-90-6 Fan (Without Motor)/Axial Flow Fans FZAB-31-6 TO FZAB-90-6      | PRO138425        |
| 574     | FZAA-100-6 Fan (Without Motor)/Impeller                                   | PRO138426        |
| 575     | HCBB-10-28 Fan (Without Motor)                                            | PRO138427        |
| 576     | HCBB-10-33 Fan (Without Motor)/Impeller Type HCBB-10-33-H(ZRP) (F/S-71)   | PRO138428        |
| 577     | HCBB-10-36 Fan (Without Motor)                                            | PRO138429        |
| 578     | HCBB-12-35 Fan (Without Motor)/Impeller Type HCBB-12-35-H(ZRP) (F/S-80)   | PRO138430        |
| 579     | HCBB-25-35 Fan (Without Motor)/IMPELLER TYPE HCBB-25-35-V(ZRP) (F/S-80)   | PRO138431        |
| 580     | HCBB-40-63 Fan (Without Motor)/Impeller Type HCBB-40-63-H(ZRP) (F/S-112M) | PRO138432        |
| 581     | Plummer Block 3(G)(I)-260-                                                | PRO138433        |
| 582     | Valve Indicating                                                          | PRO138434        |
| 583     | Thrust Pad                                                                | PRO138444        |
| 584     | Fuel Feed Pump                                                            | PRO138461        |
| 585     | Fuel Oil Drain Pump                                                       | PRO138462        |

| Ser No. | Product Description                                           | Srijan Portal ID |
|---------|---------------------------------------------------------------|------------------|
| 586     | Fuel Oil Transfer Pump                                        | PRO138463        |
| 587     | Plummer Block 3(G)(I)-260-Talwar, Pt No. SR6001D-3(G)(I)-260  | PRO138464        |
| 588     | Braided Hose                                                  | PRO138465        |
| 589     | Wire Braided Lub Oil Hose (Big                                | PRO138466        |
| 590     | Wire Braided Lub Oil Hose (Small)                             | PRO138467        |
| 591     | Propeller Track Check Stand                                   | PRO138652        |
| 592     | System Charging and Test Desk                                 | PRO138772        |
| 593     | ELTA Antenna Trolley                                          | PRO138773        |
| 594     | KSA 33M (AAGB Stand)                                          | PRO138810        |
| 595     | Tyre 300x125 Model 5A (for trolley A1320M-000)                | PRO138932        |
| 596     | Maintenance Stand (Part no A3819-0000)                        | PRO138933        |
| 597     | Maintenance Stand (Part no A3819-0000)                        | PRO138934        |
| 598     | Wheel Remover (Part no A1326-0000)                            | PRO138942        |
| 599     | Zhuk-ME Monoblock Lifting Slings (5.17.9915.1300.00)          | PRO138943        |
| 600     | Zhuk-ME Monoblock Lifting Slings (5.17.9915.1300.00)          | PRO138944        |
| 601     | Dial wrench (G103-2)                                          | PRO138945        |
| 602     | Dial wrench (G103-2)                                          | PRO138946        |
| 603     | Dial wrench (G103-1)                                          | PRO138947        |
| 604     | Appliance for removing inspection hole blank                  | PRO138948        |
| 605     | Appliance for removing inspection hole blank                  | PRO138949        |
| 606     | Mountings for Wings                                           | PRO138959        |
| 607     | Sling for Mounting and Canting (5.41.9850.1400.00)            | PRO138960        |
| 608     | Blanking for air intake                                       | PRO138961        |
| 609     | Blanking for air intake                                       | PRO138962        |
| 610     | Hot Section Wash Nozzle                                       | PRO138963        |
| 611     | Transmission Fluid Fill Unit                                  | PRO138964        |
| 612     | Nitrogen Servicing Unit                                       | PRO138965        |
| 613     | 3.99 Mtr Rib Collar                                           | PRO138978        |
| 614     | Adapter Union, Teflon Bolt, Collar (Cup) and Packing (Gasket) | PRO138979        |
| 615     | Automatic Voltage Regulator                                   | PRO138981        |

| Ser No. | Product Description                      | Srijan Portal ID |
|---------|------------------------------------------|------------------|
| 616     | Halon Fire System Annunciation Panel     | PRO138982        |
| 617     | Halon Fire System Remote Release Panel   | PRO138983        |
| 618     | Bottle Head Assembly 200 Bar             | PRO138985        |
| 619     | Bottle Head Assembly 280 Bar             | PRO138986        |
| 620     | Cargo LSHSD system Pump suction Strainer | PRO138987        |
| 621     | Filtering Element for DA                 | PRO138988        |
| 622     | Aircraft Engine Preoiler                 | PRO139000        |
| 623     | Dispenser Water Wash                     | PRO139008        |
| 624     | Jack Aircraft Axle, 5 Ton                | PRO139010        |
| 625     | Servicing Unit Hydraulic                 | PRO139014        |
| 626     | Drain Attachment                         | PRO139016        |
| 627     | Accumulator Damper Service Line T3       | PRO139017        |
| 628     | TLT Cable                                | PRO139267        |
| 629     | Oil Cooler Cover                         | PRO156560        |
| 630     | Strap Assy, Main Rotor Pylon             | PRO156561        |
| 631     | Strap Assy, Main Rotor Pylon             | PRO156562        |
| 632     | Strap Assy, Main Rotor Pylon             | PRO156563        |
| 633     | Strap Assy, Main Rotor Pylon             | PRO156564        |
| 634     | Strap Assy, Main Rotor Pylon             | PRO156565        |
| 635     | Strap Assy, Main Rotor Pylon             | PRO156566        |
| 636     | Hose Assy, Sump Drain, Fuel Tank         | PRO156665        |
| 637     | Locking Collar TLG                       | PRO156666        |
| 638     | Restraint Set main Rotor Blades          | PRO156667        |
| 639     | Bar Assembly Steering                    | PRO156668        |
| 640     | Tow Bar 24 ALBAR                         | PRO156669        |
| 641     | Helicopter                               | PRO156671        |
| 642     | Chock Land Based                         | PRO156672        |
| 643     | ESM Antenna Cover                        | PRO156673        |
| 644     | Engine Cover                             | PRO156674        |
| 645     | Pin Safety CMDS                          | PRO156675        |
| 646     | Plug Assembly                            | PRO156676        |
| 647     | Plug Assembly                            | PRO156677        |
| 648     | Plug Assy                                | PRO156678        |
| 649     | Helium Bottle                            | PRO156716        |
| 650     | Plug Exhaust Fan-So Cooling              | PRO156732        |

| Ser No. | Product Description                                             | Srijan Portal ID |
|---------|-----------------------------------------------------------------|------------------|
| 651     | Plug APU Exhaust                                                | PRO156733        |
| 652     | Plug Engine Inlet                                               | PRO156779        |
| 653     | Plug Engine Exhaust                                             | PRO156780        |
| 654     | Cover Pitot Tube                                                | PRO156781        |
| 655     | MMR R/T SLED                                                    | PRO156782        |
| 656     | Cover Inlet Engine                                              | PRO156783        |
| 657     | Cover Multiple Purpose T-700 Engine                             | PRO156784        |
| 658     | Universal Lifting Sling Assembly                                | PRO156785        |
| 659     | Chilled Water Cooler (Top & Middle)                             | PRO156871        |
| 660     | 10 Types of Pressure Relay KP(D)                                | PRO156930        |
| 661     | 02 Types of Signal Lights                                       | PRO156984        |
| 662     | 18 Types of Fuse                                                | PRO156998        |
| 663     | VSM Central Tube                                                | PRO157044        |
| 664     | TLT Cable                                                       | PRO157045        |
| 665     | Shaft Sleeves and Bushes                                        | PRO157069        |
| 666     | IR Seeker                                                       | PRO157155        |
| 667     | Radar Fusze                                                     | PRO157244        |
| 668     | Active Radar Homing Head (ARHH)                                 | PRO157245        |
| 669     | Inertial Control System (ICS)                                   | PRO157246        |
| 670     | Active Radar Homing Head (ARHH)                                 | PRO157247        |
| 671     | Radio Altimeter                                                 | PRO157249        |
| 672     | Bushing (Pt. No. SR6001 D-(I)EA(SH)-365319-419E )               | PRO157392        |
| 673     | Hydraulic Regime Selector Panel                                 | PRO157393        |
| 674     | Air Distributor RH                                              | PRO157406        |
| 675     | DUAL SPEED AC MOTOR 440V,30,60H2, Pt No. JU9100V- 6105010270674 | PRO157407        |
| 676     | Bonded Seal 14.0x21.8, Pt No.SAXIT C I 1 31 17 5 I 1 4.0x21.8   | PRO157534        |
| 677     | Bonded Seal 17.0x24.0, Pt No SAX/TC/1 3 1 /75I 17 .0x24.O       | PRO157549        |
| 678     | Bonded Seal 24.0x32.0, Pt. No.SAVTC/1 31 I/ 5/24.Ox32.o         | PRO157551        |
| 679     | Bonded Seal 27.0x35.0, Pt. No.SAXII C I 1 31 17 5127.0x3s.0     | PRO157553        |

| Ser No. | Product Description                                                          | Srijan Portal ID |
|---------|------------------------------------------------------------------------------|------------------|
| 680     | Bonded Seal 31.0x38.0,<br>Pt No.SAVTC/1 31/75131.0x38.0                      | PRO157556        |
| 681     | Bonded Seal 34.0x43.0,<br>Pt. No.SAX/TC/1 31 /75134.0x43.0201A               | PRO174352        |
| 682     | Bonded Seal 39.0x48.0,<br>Pt. No SAXIT CI I 31 17 5139.0x48.0                | PRO174354        |
| 683     | Bonded Seal 49.0x59.0,<br>Pt. No.SAXrl d 1 31 17 51 49.0x59.0                | PRO174356        |
| 684     | Bonded Seal 50.0x64.0,<br>Pt. No.SAXIT CI 1 31 17 5150.0x64.0                | PRO174357        |
| 685     | Bonded Seal 67.0x79.0,<br>Pt. No.SAXTC/1 31/75/67.0x79.0                     | PRO174358        |
| 686     | Bonded Seal 175.0x86.0,<br>Pt. No. SAXrf C n 31 n 5175.0x86.0                | PRO174359        |
| 687     | Spring loaded Oil seal 35x58x10,<br>Pt.No. SR6001 D-ICA-35-58-1 0-1 1 36     | PRO174360        |
| 688     | Spring loaded Oil seal 35x60x12,<br>Pt No. SR6001 D-ICA-35-60-12-1 136       | PRO174361        |
| 689     | SHIM Anti Flap 70105-28006-101                                               | PRO174363        |
| 690     | Spring loaded Oil seal 50x70x10,<br>Pt No. SR6001 D-ICA-s0-70-10-1 1 36      | PRO174367        |
| 691     | Spring loaded Oil seal 55x80x12,<br>Pt.No. SR6001 D-ICA-55-80-'1 2-1 1 36    | PRO174369        |
| 692     | Spring loaded Oil seal 120x150x12,<br>Pt. No. SR6001 D-ICA-120-1 50-12-1 136 | PRO174377        |
| 693     | Spring loaded Oil seal 280x320x18,<br>Pt. No. SR6001 D-ICA-280-320-1 8-1 136 | PRO174380        |
| 694     | Gland Cup Seal (Special) C-25x40x6,<br>Pt. No. SR6001 D -C-25-40-6-301 2     | PRO174381        |
| 695     | Gland Cup Seal (Special) C-30x45x6,<br>Pt. No. SR6001 D-C(CH)-1 03-1 01 -328 | PRO174382        |
| 696     | Gland Cup Seal (Special) C-30x50x8,<br>Pt. No. SR600 1 D-C-30-50-8-301 2     | PRO174383        |
| 697     | Gland seal (Special) 25x40x7 .5,<br>Pl.No. SR600'1 D-S-25x40x7 .5-301 2      | PRO174384        |

| Ser No. | Product Description                                                                        | Srijan Portal ID |
|---------|--------------------------------------------------------------------------------------------|------------------|
| 698     | Bonded Seal 25x40x4.4, Pt. No.SR6OO 1 D-S-25x40x4.4-3012                                   | PRO174385        |
| 699     | SHIM,70102-28025-102                                                                       | PRO174389        |
| 700     | Washer, NAS1149E0663P                                                                      | PRO174395        |
| 701     | Washer, NAS1149E0616P                                                                      | PRO174396        |
| 702     | Bonded Seal 22.0x29.0, Pt. No. SAXnd131175122                                              | PRO174411        |
| 703     | PORTABLE CONTROL STATION OF LIFE BOAT DAVIT (RCS)-ROR.H.3, Pt No. EAI 096V-01 02MN1 45E0'1 | PRO174611        |
| 704     | STOCKJACKET, Pt. NO. SRGOO1D-(r)EA(SH)-36531 e-41 1(E) 2018 0.825 6.96                     | PRO174616        |
| 705     | Auto Change Over Switch Starter                                                            | PRO174781        |
| 706     | Pedestal Cover Cable Reeling Machine, Pt no:- 3218AS770                                    | PRO175004        |
| 707     | Water Jet Eductor BE(ZH)-10                                                                | PRO 175062       |
| 708     | Ejector BE(ZH)-25TM(469-34-065)                                                            | PRO 175075       |
| 709     | Non return valves                                                                          | PRO 175083       |
| 710     | Cock valves                                                                                | PRO 175091       |
| 711     | Sleeve FWD stern tube                                                                      | PRO 175123       |
| 712     | Sleeve A bracket                                                                           | PRO 175133       |
| 713     | Sleeve AFT stern tube                                                                      | PRO 175135       |

**APPENDIX N**  
(Refers to Para 4 Chap 10)

**COORDINATING DIRECTORATES AT NAVAL HEADQUARTERS**

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**DIRECTORATE OF INDIGENISATION  
NAVAL HEADQUARTERS  
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