हर काम देश के नाम

स्वावलंबन 4.0
Swavlamban
स्वदेशीकरण योजना
INDIGENISATION PLAN

MAKE IN INDIA

DIRECTORATE OF INDIGENISATION
NAVAL HEADQUARTERS
MINISTRY OF DEFENCE

PREFACE

1. The 3rd edition of ***IN's*** Swavlamban document 'Swavlamban 3.0' was released by the Hon'ble Raksha Mantri on 29 Oct 2024 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 innovation, a commitment to excellence, and a belief that India can lead not just in manufacturing, but 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 4.0' is more than a document—it is a declaration of intent. It outlines Indian Navy's vision to deepen collaboration with Indian industry, academia, and 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 intend 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 4.0' document would contribute towards nurturing a defence ecosystem that is responsive to the needs of Indian Navy and is aligned with the long-term vision of Indian Navy. Swavlamban 4.0 is a blueprint for this transformation and serves as a strategic reference for the Navy's indigenisation roadmap. The 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.

Admiral Dinesh K Tripathi
PVSM, AVSM, NM
Chief of the Naval Staff

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MESSAGE

1. Maritime power is the confluence of ships and systems, of ports and shipyards, and of industry and intellect, realised through the *collective resolve* of a nation to *design, innovate and build for itself.* In an era where technology defines strategic strength, *Atmanirbharta* is both, our moral compass and a strategic necessity. The Indian Navy's journey towards self-reliance reflects the spirit of a confident and capable nation, determined to chart its own technological destiny.

2. The Hon'ble Prime Minister's call for *Atmanirbharta* during his address to the nation on Independence Day 2025, underscored and reaffirmed our enduring national commitment to self-reliance. For the Indian Navy, this commitment is embodied in our concerted focus towards becoming a **Fully *Atmanirbhar* Force by 2047**, through indigenisation and innovation at all levels, from major systems to smallest sub-components. By strengthening our collaboration with domestic industry, start-ups, academia, and research institutions, we aim to transform the Indian Navy's Indigenisation Plan into a living, evolving framework that strengthens the nation's maritime posture.

3. Building on the success of its previous editions, ***Swavlamban 4.0*** embodies this strategic resolve. Designed as a comprehensive roadmap, it calls for co-innovation, co-development, and co-creation of technologies that will define India's maritime prowess in the decades ahead. Presenting an operationally driven Indigenisation Plan that links user requirements directly to development pathways and production readiness, the document seeks to provide the industry with clarity on our priorities, granularity on our capability requirements, and pathways for partnership at scale.

4. I am confident that Swavlamban 4.0 will invigorate our collective efforts and inspire every stakeholder towards achieving our national vision of *Atmanirbharta.*

Sam No Varunah!

Jai Hind!

(Dinesh K Tripathi)
Admiral
Chief of the Naval Staff

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MESSAGE

1. The Indian Navy is entering a new era that is being defined by multi-domain operations, rapid technological shifts and the need for strategic flexibility. Our ability to respond to emerging threats will depend not just on the platforms we deploy, but on the systems and solutions we develop indigenously. As we look ahead, our ability to innovate at speed and scale will be central to maintaining operational superiority across domains.

2. In this context, the defence ecosystem must evolve from being reactive to being anticipatory. The Navy's future will be shaped by how well we embed innovation into our doctrine, our design philosophy and our operational mindset.

3. 'Swavlamban 4.0' is a strategic enabler that identifies areas where indigenous solutions can make a decisive impact. It is designed to foster deeper engagement with Indian industry, MSMEs, and academic institutions, encouraging them to move from being suppliers to strategic partners in capability development. This edition reflects our shift towards a capability-centric approach, where long-term sustainability and rapid adaptability are paramount.

(Sanjay Vatsayan)
Vice Admiral

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MESSAGE

1. The operational readiness of a modern navy is inseparable from the robustness of its technological and industrial backbone. As the Indian Navy continues to modernise, our focus is on building a self-sustaining ecosystem that can support advanced systems through their entire lifecycle—from design to deployment and beyond. The material readiness of the Indian Navy is undergoing a profound transformation. As we move towards greater technological independence, our focus is shifting from acquisition to lifecycle assurance—from assembling systems to engineering solutions that endure and evolve.

2. Ultimately, our goal is to build a defence industrial base that is not only capable but confident—one that can anticipate future needs, respond with agility, and sustain our naval assets with precision and pride.

3. 'Swavlamban 4.0' serves as a comprehensive guide for our partners in industry and academia. It outlines specific areas where indigenous development can directly enhance our capabilities, with a particular focus on propulsion systems, sensors, and integrated platforms. We see immense potential in India's scientific and industrial community to co-create solutions that are not only technically sound but strategically aligned. Let us work together to build a future where our naval systems reflect the ingenuity and excellence of our nation.

(B Sivakumar)
Vice Admiral
Chief of Materiel

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PART – I

INTRODUCTION

CHAPTER 1

INTRODUCTION TO INDIAN NAVAL INDIGENISATION PLAN

1. The release of first 'Swavlamban' document in Aug 2020 and its revised version 'Swavlamban 2.0' in Oct 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 3.0' document has been updated to make it more 'industry friendly'. 'Swavlamban 4.0' 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 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, fall much below par and need 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 Medium, Small and Micro 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 where the exact indigenisation requirements in various categories are listed out, the Point of Contact for further discussion/information are also clearly listed.

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

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

(b) **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, AC & Refrigeration plants, Compressors, Switchboards, Communication equipment, Firefighting Systems etc.

(c) **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 Operation Missions by MARCOs.

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

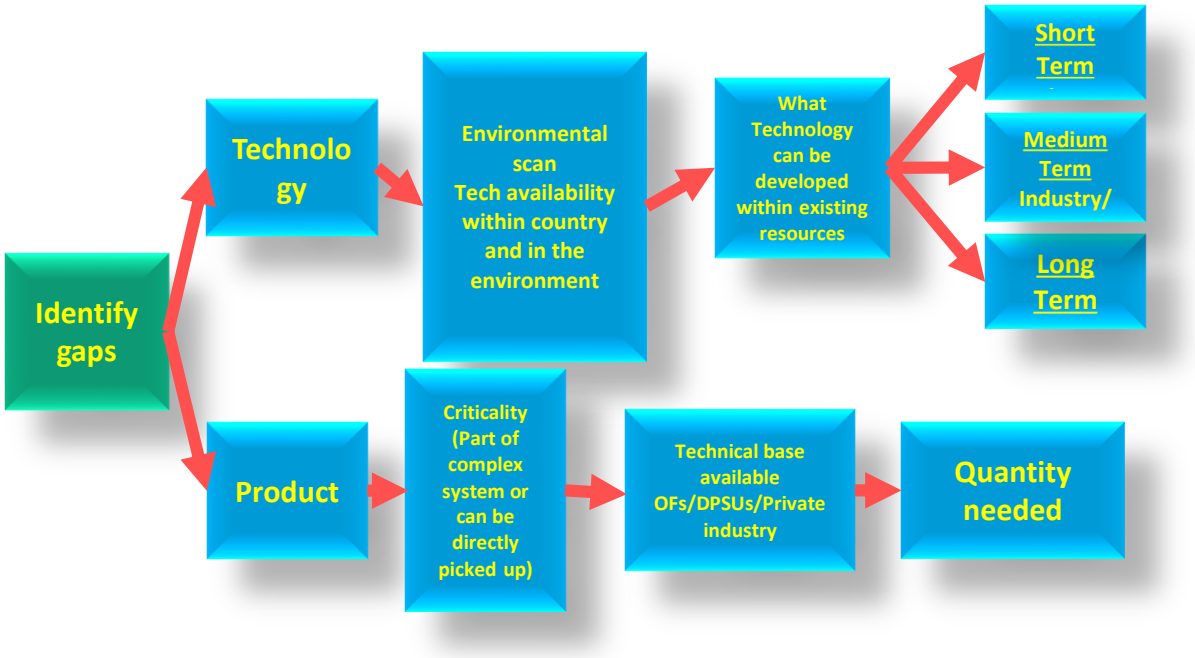
(a) **System Level**. This level includes system as a whole and is primarily based on Naval Staff Qualitative Requirements (NSQR). Due to requirement of ab-initio development and inherent complexity, systems have typically been developed by DRDO till date. However in the recent past, efforts to develop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

(b) **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.

(c) **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 recent past, indigenisation was focused on import substitution through reverse engineering and was limited to components/ subsystem. This method, though helpful in management of existing inventories, 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.



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 developmental 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: -

(a) Directorate of Indigenisation: Ship systems.

(b) Directorate of Air Projects and Plans: Aviation systems.

(c) Directorate of Armament Production and Indigenisation: Armament systems.

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

(a) **Float Category**.

Ser	Type of Equipment
(i)	Underwater Electrodes (for Ship repair)
(ii)	Underwater NDT (for Ship repair)
(iii)	High Grade Composites for Fabrication of items such as Doors, Hatches, Ventilation flap etc.
(iv)	High Grade Carbon Fiber Reinforced Plastic (CFRP) Composites for Mast & Super Structure

(b) **Move Category**.

Ser	Type of Equipment
(i)	Gas Turbines
(ii)	Main Propulsion Diesel Engines
(iii)	Complex Marine Gearboxes
(iv)	Shafting
(v)	Propellers – Both Fixed & Controllable Pitch
(vi)	CFC Free Fire Fighting Systems for Magazines & Machinery Spaces
(vii)	Arrestor Wires for Flight Operations on Aircraft Carriers
(viii)	Aircraft Lifts

(c) **Fight Category**.

Ser	Type of Equipment
(i)	Surface to Air Missile
(ii)	Surface Surveillance Radar [Buy & Make (Indian) in progress]
(iii)	Air Early Warning Radar [Buy & Make (Indian) in progress]
(iv)	Satellite Communication System (SATCOM)
(v)	Aviation Control Suites
(vi)	Fire Control Systems
(vii)	Integrated Mast & Control System for Submarines
(viii)	Mine Hunting and Diver Detection Sonars
(ix)	Light and Heavy Weight Torpedoes
(x)	Towed Array Sonars
(xi)	Unmanned Aerial Vehicles for Surveillance and Delivery of Ordnance/ Autonomous Underwater Vehicles
(xii)	Global Positioning Systems, Inertial Navigation Systems
(xiii)	Super Rapid Gun Mounts (SRGMs)

Methodology/ Indigenisation Routes

15. The procedure followed for indigenisation of stores/systems is as per Chapter 15 of DPM-2009 (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:-

(a) **Revenue Scheme**. This route is exercised through funds allotted to IHQ-MoD(N) under Minor Heads 110(p) – Indigenous Development and 110(q) – Research & Development.

(b) **Make Schemes**. Make Schemes are sub-divided into three categories; Make-I, Make-II & Make III and are elaborated in succeeding para 17.

(c) **Technology Development Fund (TDF) Scheme**. The Technology Development Fund (TDF) operated by DRDO was setup 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 Person are eligible for this scheme. Each project is capped at 50 Crore with a development period of two to four years (https://tdf.drdo.gov.in).

(d) **iDEX**. The iDEX (Innovations for Defence Excellence) initiative was launched by the Hon'ble PM in Apr 18 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. Defence India Start-up Challenge (DISC) is being launched since then with Problem Statements (PS) from Armed Forces and DPSUs. iDEX has provision of providing funding to shortlisted vendors upto 25 Cr under various schemes (https://idex.gov.in).

(e) **DRDO Projects**. The indigenisation of Naval Armament stores is also progressed through DRDO. DGNAI is the Co-Chairman for the IN-DRDO Synergy - Armament Combat & Engineering (ACE) Cluster.

Indigenisation Methodology at Indigenisation Units

16. Following methodology would be followed for indigenisation:-

(a) **Development Procedures**. The procedure followed for indigenisation of stores are as per Chapter 15 of DPM-2009 (through Indian industries) or Chapter IV of DAP-20.

(b) **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 IHQ-MoD(N).

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

(d) **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 development agencies (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 Units. 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 (https://www.makeinindiadefence.gov.in).

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/Agencies (DA/DAs), through the 'Buy (Indian-IDDM)' category with indigenous design and development and a minimum of 50% 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:-

(a) **Make-I (Government Funded)**. Projects under 'Make-I' sub-category will involve Government funding upto 70%, of prototype development cost or maximum 250 crores per Development Agency 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).

(b) **Projects under Make II and Make III**. 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 envisaged for prototype development but there is an **assurance of orders** on successful development and trials of the prototype. Projects under the Make categories, with procurement not exceeding Rs 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 programme earmarked for them, the same shall be opened up for all.

(i) **Make-II (Industry Funded)**. This category essentially pertain to products involving indigenous design, development and manufacturing. To enable Indian industry to leap frog to higher 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 Development Agency(ies) (DA/DAs), through the 'Buy (Indian-IDDM)' category with indigenous Design & Development and a minimum of 50% IC on cost basis of base contract price.

(ii) **Make-III (Industry Funded)**. The procedure 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. In 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:-

(a) Advance Planning & Consultations, and Feasibility Study.

(b) Formulation of Preliminary Staff Qualitative Requirements (PSQR).

(c) Constitution of Project Facilitation Team (PFT).

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

(e) Issue of Expression of Interest (EoI).

(f) Evaluation of EoI responses.

(g) Award of Project Sanction Order.

(h) Design and Development of Prototype.

(j) Conversion of PSQRs into SQRs.

(k) Solicitation of Commercial Offer.

(l) Single Stage Composite Trials/ User Trials by SHQ.

(m) Staff Evaluation.

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

(p) 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.ddpmod.gov.in/defence-acquisition-procedure-2020).

23. **Srijan Defence Portal**. Pursuant to Atmanirbhar Bharat, MoD/DDP launched an Indigenisation Portal on 14 Aug 20, named '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 500 items of *IN* have been uploaded in the portal. Major items uploaded on the portal which are still pending for indigenisation are included in this document 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 has 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 reasonable in second category, there is a large shortfall in the third category.

Major Systems Indigenised

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

(a) **Float**.

Ser	Equipment/ Material	Indigenising Organisation
(i)	Hull Construction Materials	DRDO / SAIL/ Industry
(ii)	Hangar Doors and Shutters	Industry
(iii)	Anchor Capstans / Windlass	Shipyards/ Industry
(iv)	Davits and Boats/ Rigid Inflatable Boats (RIBs)	Industry
(v)	General Service Life Jackets/ Hazardous Duty Life Jackets	Industry
(vi)	Silicon Rubber Seals	Industry
(vii)	HTS	Industry
(viii)	NGHHTS	Industry
(ix)	Paints	DRDO/ Industry
(x)	STP	Industry
(xi)	ATUs/HEs	Industry

(b) **Move**.

Ser	Equipment/ Material	Indigenising Organisation
(i)	Steam Turbine	M/s BHEL
(ii)	Boilers	Naval Dockyard, Mumbai, M/s Thermax
(iii)	RO Plants	M/s Rochem, M/s Technoprocess
(iv)	Pumps	M/s Best & Crompton, M/s Alekton, M/s BE Pumps
(v)	HP Air and AC Compressors	M/s ELGI Compressors, M/s ACCEL
(vi)	AC and Ref Plants	M/s Voltas, M/s KPCL, M/s ACCEL
(vii)	Stabiliser System	M/s Veljan Hydrair, M/s L&T
(viii)	Gas Turbine Generator (GTG) Control System	M/s BEL
(ix)	Gas Turbine (GT) /GTG Starting Rectifier	M/s Precision Power
(x)	Steering Gear	M/s Veljan Hydrair
(xi)	Motors and Power Generation & Distribution Equipment	M/s Narhari Motors, M/s Marine Electricals
(xii)	Submarine Batteries	M/s Exide, M/s HBL
(xiii)	Inertial Navigation System	DRDO/ RCI
(xiv)	Switchboard and APMS	M/s GE Ltd
(xv)	ATS (Auto Transfer Switch)	M/s Marine Electricals
(xvi)	HSR (Helo Starting Rectifier)	M/s Static Transformer
(xvii)	Echo sounder for Submarines	M/s Keltron

(c) **Fight**.

Ser	Equipment/ Material	Indigenising Organisation
(i)	Electro Optical Director for GMs - SOP	M/s BEL
(ii)	Electronic Warfare Systems	M/s BEL
(iii)	Electro Optical Director for GMs - EON	M/s BEL
(iv)	Gun Fire Control System – Lynx U2	M/s BEL
(v)	Anti-Submarine Warfare Fire Control System (ASW FCS)	M/s BEL
(vi)	Supersonic Missile System	M/s BAPL
(vii)	AK630 and Super Rapid Gun Mount	M/s OFBs/ BHEL
(viii)	Torpedo Tube Launchers	M/s L&T, M/s MDS
(ix)	Combat Management System	M/s WESEE, M/s BEL
(x)	Data Link & Net Centric Operation (NCO) Equipment	M/s BEL
(xi)	Weapon Systems Integration	M/s WESEE
(xii)	Composite Sonar Dome	DRDO
(xiii)	Helo Traversing System	M/s L&T, M/s GRSE
(xiv)	Chaff Launchers	M/s OFB/ MTPF
(xv)	CCS/ VCS	M/s BEL
(xvi)	HF/ VLF Receivers	M/s BEL
(xvii)	HF Transmitters	M/s BEL, M/s HAL
(xviii)	V/UHF sets	M/s BEL & M/s ECIL
(xix)	Main Broadcast/ Sound Reproduction Equipment	M/s Phi Audicom, M/s Linea Engg
(xx)	Rocket Launcher	M/s L&T
(xxi)	Torpedoes	M/s BDL/NSTL

(xxii)	Mines	M/s ARPPL/ NSTL
(xxiii)	ILMEN-GUVK (system for transfer alignment of Ship borne Gyro parameters to Kamov helicopters) for 1135.6 Ships).	M/s Whirlybird
(xxiv)	Helo Deck Communication System (HDCS).	M/s L&T
(xxv)	Integrated SATCOM Multifunction Antenna (ISMS) for SSK Submarines.	M/s Navstar
(xxvi)	Sonar USHUS /USHUS II/ TUSHAR	M/s BEL
(xxvii)	Indigenous Cavitation Meter	M/s BEL
(xxviii)	Sonar HUMSA and Variants	M/s BEL
(xxix)	IAC MOD C	M/s BEL
(xxx)	ATDS Mareech	M/s BEL
(xxxi)	IADS	M/s MDS
(xxxii)	Torpedo Batteries	M/s HEB, M/s HBL
(xxxiii)	30mm Ammunition	M/s EEL
(xxxiv)	Submarine Flare Launcher Basket	M/s Vijay Engineers
(xxxv)	30mm AO-18 Gun Cluster	M/s AWEIL (GSF)
(xxxvi)	Scoop Bulk Head for Torpedo	M/s Sri Vamshee Industrial products
(xxxvii)	Medium Range Microwave Obscurant Chaff	DLJ
(xxxviii)	PF shell for 30mm ammunition	ARDE
(xxxix)	HEDA Ammunition for 76mm Gun	M/s MIL (OFK)
(xl)	Chaff Payloads	DLJ
(xli)	Insensitive Munition	HEMRL

3. **<u>Other Equipment & Systems Developed</u>**.

(a) Retractable Stabiliser Systems

(b) Digital GTG Control System

(c) Gas Turbine (GT)/ Gas Turbine Generator (GTG) Starting Rectifier

(d) Deck Hydraulic Systems.

(e) Steering Gear Systems

(f) Stern Windlass

(g) Fin Stabiliser

(h) DC Insulation Measuring Unit

(j) Extraction Trolley and cross piece for Missiles

(k) **<u>Indigenisation by IUs</u>**. 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**.** **<u>Oceanology & Meteorology</u>**. With an endeavor to contribute towards strengthening the spirit of Atmanirbharta, Directorate of Naval Oceanology & Meteorology (DNOM) has steered INDRA Projects which will provide Met & Oceanology support to aid the decision makers in planning and understanding evolutions. The details of the projects are mentioned below: -

(a) 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 app. App has been launched for Tri Services and ICG use by Hon'ble Raksha Mantri at JCC (Lucknow) on 05 Sep 24.

(b) The app is DCyA certified and comprises of several new features like for NAVAREA VIII warnings, Tsunami & Earthquake alerts, location based adverse weather warnings, Tidal data, Ocean state forecast and etc.

(c) Training on usage of app and user management has been provided to sister services (IA and 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.

PART – II

SHIP SYSTEMS

CHAPTER 3

MARINE ENGINEERING

1. Over past few years there has been considerable success in indigenising major systems like steering gear, stabiliser systems, Reduction Gear (lower power range), deck machinery etc. as replacement for imported ship fits, as well as for major ship/ submarine building programme for Navy. It has infused confidence and will lead to further boost the *IN*-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: -

(a) Assured performance in the presence of six degrees of ship motion, significant of which are roll and pitch.

(b) Ability to withstand shock loads.

(c) Appropriate material and metallurgical composition to withstand corrosion and erosion.

(d) Assured performance when submerged /partially submerged and subjected to harsh marine environment.

(e) Wide temperature variation in machinery spaces.

(f) Attenuation of airborne and structural borne noise by appropriate vibration mountings and acoustic enclosures.

(g) Modularity in design to assure high level of maintainability in heavily congested machinery spaces.

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

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

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

(a) Main Propulsion Equipment (Gas Turbines, Diesel Engines, Nuclear/ Steam/ Electric Propulsion).

(b) Prime Movers for Power Generation Equipment.

(c) Auxiliary Equipment (Pumps, AC & Refrigeration Plants, Steering Gear and Stabilisers, HP & LP Air Compressors, Hydraulics & other ship systems).

(d) Machinery Control Systems/ Equipment.

(e) Miscellaneous Equipment (Lifts, Firefighting Systems).

Main Propulsion Equipment

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

(a) Capability of high maximum speed as well as low speeds for loitering and patrolling.

(b) Good endurance and fuel efficient over a wide operating range.

(c) High availability and maintainability (High MTBF).

(d) Reversing capability.

(e) High power to weight ratio.

(f) Compact and modular construction.

(g) 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 manufacture / development of high power diesel engines to Naval specifications will greatly reduce our dependence on imports. In addition, the following specific requirements also exist:-

(a) **Motor Boat Engines**. The Survey Motor Boats (SMB) and the Rigid Inflatable Boats (RIBs) including for Special Operations, are powered by diesel engines in the power range of 100-250 HP. These engines are to be of lightweight and rugged in design with high Mean Time Between Overhaul/ Failure (MTBO/ MTBF). The survey motorboats are operated at sea for 8 to 10 hours continuously.

(b) **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:-

(a) Higher hardness of pinion and gear materials with attendant higher gear tooth loadings.

(b) High efficiency and reliability.

(c) Long life.

(d) Low noise levels.

(e) 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, wherein, 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) 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 (Diesel Engine/ Gas Turbine/ Steam Turbine or combination of these), 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 programme, 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* is also exploring AIP solutions 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 still lacking or is at a very nascent stage and is required to be built up to the range of 225 to 250 KW for retro-fitment on the existing submarines/ incorporation in the new designs.

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 (50KW - 1500KW) and Steam Turbines (500KW - 1000KW) 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 to attain self-sufficiency and preclude dependence on the foreign firms 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, 'B' class and Viraat 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:-

(a) Identification of indigenous equivalents/ sources for Russian origin and Customer Nominated Equipment (CNE) and POLs.

(b) Identification of indigenous equivalents/ sources for 18 chemicals and consumables.

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

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

Indigenisation Envisaged

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

(a) Turbo Driven steam auxiliaries

(i) Turbo-driven Fuel Pumps

(ii) Turbo Blower Units

(iii) Feed Condensate Booster Turbo – driven Pumps

(iv) Turbo-driven Main Circulating Pumps

(v) Turbo-driven Oil Pumps

(vi) Turbo-drive of AC Plants

(b) Feed Water Pumps

(i) Automatic Working Water Pumps

(ii) LPSG Feed Pump

(iii) Condensate Feed Pump

(iv) Pump for Boiler Chemical Treatment

(v) Hand Pump for Boiler Dosing

(vi) Proportioning Pump for Boiler Dosing

(vii) Condensate Feed Pump for TA

(c) Lub Oil and Fresh Water/Feed Water Heat Exchangers which are fitted in various equipment/systems.

(d) Fuel Pumps

(i) Fuel Transfer Pumps

(ii) Stripping Pumps

(iii) Manual Pumps for Aviation Fuel (AVCAT)

(e) Lub Oil Pumps

(i) Transfer Pumps

(ii) Hand Pumps

(f) Sea Water Pumps

(i) AC Condenser Sea Water Cooling Pumps

(ii) Seawater Circulating Pumps

(iii) Fire Pumps

(g) Fresh Water Pumps

(i) Pumps for De-Mineralised water system

(ii) Pump for Technical Fresh water

(h) Desalination Plant Pumps

(j) Bilge system Pumps

(i) Main Drainage Pumps

(ii) Portable Pumps

(k) Hydraulic Pumps

(i) Transfer Pumps

(ii) Manual Pump

(iii) Variable Discharge Pumps

(iv) Hydraulic Pumps for Aircraft Arresting Gear and Lifts

(l) Shafting Components viz. Plummer Bearings, Thrust Pads etc.

(m) Lub Oil Coolers, Condensers and Evaporators of Motor Driven AC Plants and Turbo Driven AC Plant.

(n) Components of Boiler and Turbine Aggregates Control Systems.

(p) Filters of Lube Oil System.

20. The following equipment/ system are also required to be indigenised: -

(a) Boiler Mounting for K(B)(G)-3(D) Boilers and 1500KW Turbo Generator.

(b) Waterjet Propulsion System (being progressed as part of TDF scheme).

(c) Composite Material Air Bottles (being progressed as part of TDF scheme).

(d) Composite Material Sea Water Pump (being progressed as part of iDEX scheme)

(e) Specialised SV Mount.

21. Similarly, the maintenance of hull equipment onboard *IN* Ships also needs to be looked at in the short/ long term perspective as given in succeeding paragraphs.

22. **INDIGENOUS DEVELOPMENT OF 0.6 MW Water Jet Propulsion System WJPS - TDF**

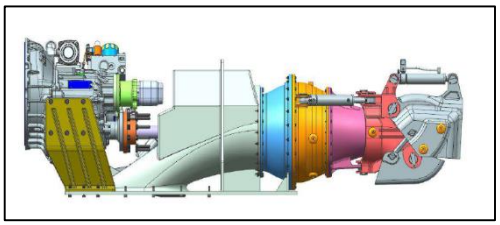
(a) **Background**. In order to augment self-reliance in line with 'Atmanirbhar Bharat' vision of GoI, development of indigenous WJPS (Water Jet Propulsion System) was initiated under Technology Demonstration Fund (TDF). The contract was concluded with M/s L&T with a development time of 24 months. The cardinal dates are tabulated below.

Ser	Activity	Timelines/ Status
(i)	AIP	Jul 2021
(ii)	Contract Signed	Jul 2022
(iii)	Design of prototype	Aug 2023
(iv)	Manufacturing of prototype	Completed, 07 Jun 24
(v)	FATs at L&T (Talegaon)	Completed, 02 Aug 24
(vi)	Fitment of Prototypes	Completed, 04 Feb 25
(vii)	**HATs**	**Completed, 14 Feb 25**
(viii)	**SATs**	**Completed, 17 May 25**

(b) **Present Status**. Two prototypes have been manufactured under the project and retrofitted onboard *IN*FIC T-233 based in Goa. HATs and SATs of the WJPS were completed on 17 May 25. The final trial report from MTU (Goa), nodal agency for trials, is expected by 26 May 25. Notwithstanding, all observations of trials are being liquidated progressively.

(c) Further, it is planned to exploit the M/s L&T WJPS for a duration of six months to establish efficacy of the indigenised WJPS system. Onboard training, highlighting varaiance in SOPs from original fit Castoldi WJPS have been imparted to SPB (Goa) crew. A PMMG review was convened on 29 - 30 May 25 for formal completion of the project at Goa wherein Phase II, i.e conversion of T - 233 for autonomous operations, was also discussed.

(d) **Future Plan.** Post successful sea trials (04 - 06 months), M/s L&T would be considered for inclusion in the prospective vendor list for forthcoming 120 x NGFIC project requiring 240 WJPS. **The forthcoming 120 FICs project can thus feature an indigenous Shafting configuration consisting of both indigenous Waterjet and high-speed aluminium gearbox**. The scaling up of WJPS prototype to 4 MW in order to meet ***IN*** requirements in forthcoming projects will be explored. Further, indigenous 0.6 MW Waterjet can be considered for replacement on commissioned ships during maintenance period, if required.



CAD Design Model of WJPS

Prototype Fitted on T - 233

NBCD Equipment

23. 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

24. A list of requirement 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:-

(a) Hydraulic oil accumulators

(b) Fuel flow meters

(c) System filters

(d) Pumps

(e) Cables

(f) Batteries

(g) Heat Exchangers

(h) Instrumentation Components viz. Transducers and Parameter Indication Devices

(j) Diesel Engine Monitoring System

(k) Anechoic Tiles, Submarine Acoustic Coating and other types of Submarine Acoustic Coatings such as Vibro-damping Coatings and Silencers.

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

(a) High Density Valve Regulated Lead Acid Batteries for Submarines.

(b) Compact High Capacity Turbines.

(c) Main Motor Generators.

(d) Propulsion Motors.

(e) Non Hull Penetrating Submarines Masts.

(f) Optics for Submarine Masts.

(g) Integrated Sonars.

(h) Control and Monitoring Systems Based on Versa Module Europa (VME) / Programmable Logic Controllers (PLCs) with Fibre Optic Backbone.

(j) Inner and Outer Exhaust Flap Assemblies.

(k) Wet Deck Shelters for Special Operations Missions.

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

(a) Phosphoric Acid Fuel Cell Technology for Air Independent Propulsion system.

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

(i) Raft Mounting System for Propulsion System and Auxiliaries.

(ii) Tuned Mass Dampers & Pneumatic Shock Mounts for < 200 kgs Equipment.

(iii) Enhanced Shelf Life Rubber Shock Mounts.

Project -75/ 75(I) Submarines

5. The construction of submarines under the Scorpene project is progressing at 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:-

(a) Steering Gear

(b) Shafting

(c) Reduction Gear

(d) AC Plants.

(e) Ref Plant

(f) Compressors

(g) Pumps

(h) De-Mineralised Water (DM) Plant

(j) Accumulators

(k) Various Types of Filters

(l) System Valves

(m) 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'**.

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CHAPTER 5

AIRCRAFT HANDLING EQUIPMENT

1. With the induction of 2nd 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:-

(a) Ship Based Hoisting and Lifting Equipment (Aircraft / Vehicle Lifts and Cranes)

(b) Automatic Aircraft Landing System (Microwave / Electronic ACLS) for indigenous fixed wing Aircraft

(c) Carrier Based Fixed Wing Aircraft Arrester Wire Recovery System

(d) Aircraft Catapult Launch System

(e) Flight Deck & Hangar Fixed Fire Fighting System

(f) 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 OPS. 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 numbers and also have a limited shelf life. Considering these aspects, the following equipment have been identified for indigenous development and production:-

(a) Thermal Night Vision devices with advanced optics and user defined sizes based on application ie worn by human, weapon mounted sight etc.

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

(i) Software Defined Radios

(ii) Satellite Communication Sets

(iii) Remotely Deployable Command and Control System

(c) **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*.

(d) 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.

(e) Man-Portable Unmanned Aerial Vehicle with following capabilities:-

(i) Ordnance delivery

(ii) Day/night aerial surveillance of enemy targets

(iii) Relay of information between deployed teams and commend post

(iv) Capability of being launched and recovered from a mobile platform eg RHIB, rubber dinghy and surface vehicle

(f) Under Water 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. Since the data is used for making navigational charts, ENCs, products and publications used by international shipping and wide range of users in maritime domain, the data collected by hydrographic equipment is required to comply with quality standards promulgated by International Hydrographic Organisation (IHO). The equipment is COTS in nature, however there are very few users of the equipment in India (including few scientific organisations). Following equipment have been identified for indigenous development and production: -

(a) Long endurance survey grade drones with capability to land/ take off from ship's helicopter deck

(b) Autonomous Survey Craft along with Launch & Recovery System for development from ship equipped with Multi-beam Echo- Sounder for surveying in coastal waters.

(c) Water level Meter for remote observation of tidal data.

(d) Sound Velocity Profilers and Conductivity- Temperature-Depth Probe.

(e) Current meters for measuring currents in coastal waters.

PART – III

NAVAL ARMAMENT, WEAPONS AND SENSORS

CHAPTER 7

ARMAMENT, WEAPONS AND SENSORS

1. **Background**. At independence, India's defence-industrial production was mainly coming from the existing Ordnance Factories. The *IN* in the early 80s embarked on indigenisation of fast moving components. Of late, NA 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:-

(a) Missiles (Air-to-Air, Air to Surface, Surface to Air, Surface to Surface and Shoulder launched).

(b) Torpedoes (Air, Ship and Submarine launched).

(c) Mines.

(d) Bombs and Mortars.

(e) Depth Charges.

(f) Underwater Rockets and Launchers.

(g) Guns and Ammunitions.

(h) Small Arms and Ammunitions.

(j) Countermeasures (Decoys and Deceivers) and launchers.

(k) Pyrotechnics stores.

(l) Demolition Charges.

(m) Special Arms and Ammunition for MARCOS.

(n) Power Cartridges.

3. India has one of the largest defence industrial complexes in the developing world. It consists of sixteen Defence Public Sector Undertakings (DPSUs), and an emerging vibrant private sector. Vital value addition to the effort of this conglomerate is provided by 52

Defence Research and Development (R&D) laboratories under the umbrella Defence Research and Development Organisation (DRDO).

4. State of the art ships and submarines are under construction at Indian shipyards, both public and private. Indigenisation of armament will not only propel the *IN* to be self-reliant but also cut down costs and reduce dependence on foreign vendors.

5. **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 NA Stores paved way for meeting the operational requirements of seagoing platforms through indigenous means.

6. Indigenisation of armament for Kavach chaff system (launcher & rockets), AK 100 ammunition, AK 630 ammunition, 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 Ctge, re-filling of warheads of missile, torpedo, depth charge, bomb, etc. have been developed. However, despite all this, we have achieved only about 50% indigenisation in the 'Fight Category'. Development of 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 etc. have been developed recently.

7. A multipronged approach for development of shipborne weapons/ armaments is being taken; 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 this areas.

Underwater Systems

8. Underwater systems mainly consist of torpedoes, decoys, rockets and underwater mines. Over the years there has been

considerable amount of indigenisation in terms of primary and secondary batteries of torpedoes, torpedo launchers and ASW rockets launchers, explosive filling of depth charges etc.

9. Presently *IN* holds a large number of torpedoes imported from western origin countries and of eastern origin. There is a huge opportunity for the private industries to contribute in indigenous development of the following sub-systems of torpedoes: -

(a) **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.

(b) **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 torpedoes. There is a need to indigenously develop the payload, casing, fuze and safety & arming device(SAD)/ exploders.

(c) **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 from private industries. However, there exists a need for indigenous development of recorders, actuators, compressed air bottles, electro explosive devices, smoke markers, noise makers etc.

(d) **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 in nature. The batteries which are used in the IN are usually of AgO-Zn or sea

water activated batteries (Mg-AgCl). In light of recent advancement of Lithium Ion battery technology worldwide, there is a requirement to indigenously develop long lasting and higher endurance batteries in order 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.

(e) **Control System**. The control system of the torpedo caters for regulating the course, depth and roll of the torpedo. Currently, the entire control system of the torpedo are of foreign origin. Indigenous development of course gyro mechanisms, servo actuators for rudders etc is required.

(f) **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 the large variety of these sealing mechanisms and 'O' rings could be taken up for development by Indian manufacturers.

10. *IN* has indigenised underwater rockets, Depth charges, limpet mines, Processor based ground mines, which are primarily used for combat role against submerged submarines and incoming torpedoes.

11. Other underwater NA stores like anti torpedo countermeasure system 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.

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

(a) Homing Heads of Torpedoes of Eastern and Western Origin Countries.

(b) Warheads and Exploders.

(c) Exercise Heads and its Components.

(d) Rubber Floats and Recovery Aids of Torpedoes.

(e) Elastomers used as Sealants in Propulsion Systems and Propellers.

(f) Anti Torpedo Countermeasures.

Ordnance/ Gun Systems

13. The ordnance/ gun systems held in the *IN* inventory are predominantly of eastern origin, inducted and procured from Original Equipment Manufacturers (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 Navy enough confidence in the Indian Industry and displayed that such complex technologies can be evolved with concerted participation of the various lead stakeholders.

14. 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.

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

(a) Barrels and Liners for Various Guns.

(b) Proximity Cut-off Devices for Gun Systems.

(c) Bore Gauges for Checking Condition of Barrels.

(d) Various Elastomers for Gun Systems.

(e) Mechanical Components such as Springs, Levers and Screws of Various Gun Systems.

(f) Hydraulic Buffers and Recuperators of Various Gun Systems.

(g) Proximity fuze for 30 mm and 76mm ammunition.

(h) Steel cartridge case for 76mm ammunition.

(j) MOC dispersal mechanism.

Missile Systems

16. The missile systems held in the *IN* inventory and those which are being inducted are procured from Original Equipment Manufacturers (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-art missiles with better capabilities at all times.

17. *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.

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

(a) Homing Heads of Missiles.

(b) Warheads, Rocket Motors and Exploders.

(c) Airframes, Control Surfaces and Actuators of Missiles.

(d) Sealants.

(e) Enamels and Paints.

(f) Various Elastomers and Rubber Components.

(g) Weapon Health Monitoring System.

Electrical/ Electronic Systems

19. The electrical/ electronic systems in NA stores play a very important role be it within the NA store or the test equipment being used. Most of the electrical/ electronic systems held in the *IN* inventory are predominantly procured from Original Equipment Manufacturers (OEMs). The electrical/ electronic systems primarily include: -

(a) Test Equipment for Missile and Torpedo Preparation.

(b) Simulators.

(c) PCBs of Various Missiles Sections and Torpedoes.

20. Optimum self-reliance in these systems is of vital importance for both strategic and economic reasons. There is a requirement to enhance the participation of Private industry in indigenisation of various electronic/ electrical sub-assemblies of NA stores.

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

(a) Muzzle Velocity and Discharge Pressure Measuring Device.

(b) Torpedo Simulators.

(c) Invertors, Converters and Frequency Stabilisers for Torpedoes.

(d) PCBs of Various Missiles and Torpedoes.

(e) Motors, Actuators, Power Amplifiers and Sensors of Torpedoes and Missiles.

(f) Portable and Ship Borne Presetters.

Framework and Organisation

22. DAPI was established at IHQ-MoD(Navy) in Apr 2017. The role and responsibility of indigenisation of NA stores has been entrusted to DAPI since its inception. Subsequently, following Indigenisation Cells (ICs) were created at:-

(a) Controllerate of Naval Armament Inspection(West), Mumbai/ CNAI(W)

(b) Controllerate of Naval Armament Inspection(East), Vishakhapatnam/ CNAI(E)

(c) Controllerate of Naval Armament Inspection(South), Alwaye/ CNAI(S)

(d) Controllerate of Naval Armament (Ordnance Factories), Pune/ CNA(OF)

(e) Controllerate of Naval Armament (Defence Production), Hyderabad/ CNA(DP)

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

(a) NAI Cell at HEMRL, Pune

(b) NAI Cell at ARDE, Pune

(c) NAI Cell at NSTL, Vishakhapatnam

24. Naval Armament Stores being Indigenised under MAKE – II are as follows:-

Ser	Naval Armament Store
(a)	Universal Proximity and DA fuze for 76/62 SRGM with Electronic Adaptable to 76-127mm Ammunition
(b)	5” Mobile Target Emulators for C303/S Countermeasure System
(c)	Limpet Mines Mk 414(7kg) and Mk 430(15Kg)

25. Some of the Naval Armament Stores proposed for Indigenisation under various indigenisation routes are as follows:-

Missiles	
(a)	Missile Balwanka
(b)	Missile Mockup
(c)	Lightweight Supersonic Target
Torpedoes	
(d)	Exploders for Torpedoes
(e)	Consumables for Torpedo and Decoy
(f)	Torpedo Simulator
Ammunition	
(g)	Signal Flares
(h)	Flare Launchers
(j)	SSE Ejector
(k)	Insensitive Energetics
(l)	Homing System for Underwater Rockets
Decoys	
(m)	Passive Off-Board Decoys including Inflatable Decoys
(n)	Active Off-Board Decoys
(p)	Ship Launched IR and Smoke Decoys
(q)	A/c Launched IR Flares and Chaff
(r)	Anti-Sonar Decoys (Submarines)
Test and Handling Equipment	
(s)	Torpedo and Missile Loading Gears
(t)	Decoy Loading Gears

Indigenisation Through Academia

26. Naval Armament Stores proposed for Indigenisation through Academia are as follows: -

Ser	NA store	Institute
(a)	Advanced Artillery Smart Shell Design – SUDARSHAN	IIT Kanpur
(b)	Finite Element Analysis of SRGM Barrel	IIT Kanpur
(c)	Design and Development of Polymer/ Composite Based Driving Band for Gun Ammunition.	IIT Delhi
(d)	Identification of Molecules for Making Insensitive Explosives	IIT Chennai

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

Ser	Naval Armament Store
(a)	Light Weight and Heavy Weight Torpedoes
(b)	Light Weight and Heavy Weight Torpedo Test Equipment
(c)	Torpedo Countermeasure Systems
(d)	Surface to Air Missiles and Surface to Surface Missiles
(e)	Missile Test Equipment
(f)	Small Calibre Ammunition for Negev, Tavor, Galil, Dragonov Rifles
(g)	Proximity and Direct Action Fuzes
(h)	Chaff Payloads
(j)	Flare Countermeasures

28. 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.

29. 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.

30. The entire industrial might of the country, whether it is the Public Sector Undertakings, Defence Public Sector Units, Large private industries or Medium, Small and Micro Enterprises (MSMEs), need to partner to achieve the goal of self-reliance of the Indian Navy.

Indigenisation Requirements

31. 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'**.

32. Through this, it is evident that there are enormous opportunities available for Indian industries in various domains to participate in the Navy's indigenisation plan towards sustaining existing imported armaments and eventually replacing them with Indian armaments.

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PART – IV

NAVAL AVIATION

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:-

(a) Micro - Obsolescence Management and Import Substitution.

(b) Macro - Reduce dependence on foreign OEM, Enhance Capability.

(c) 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 "PINAS" Procedure for Indigenisation of Air Stores" 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 05 years period, a revised Naval Aviation Indigenisation Roadmap for the period 2022-2027 was published on 30 Mar 22. Indigenisation of airborne stores is mainly based on its classification as flight critical / non-flight critical.

(a) **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 Centre for Military

Airworthiness and Certification (CEMILAC) through respective Regional Centres for Military Airworthiness (RCMA).

(b) **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) and 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 the 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 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-functional 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

(a) **Micro**. Obsolescence management of and sustenance of legacy platforms such as KV 28 ASW helos of Russian origin and Western Origin platforms such as seeking ASW HELO. 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

by type spares have been indigenised till date and over 300 are in the pipeline.

(b) **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 in country Deep Repair Facilities (DRF) in partnership with Indian Industry is being actively pursued.

(c) **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 in 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

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), 1MW Generators, Command and Control Systems, Multi-Function Displays, ATM based data bus, Control System for Remote Control Target Boat (RCTB), Rotary and Static Converters/ Inverters etc. have been indigenised by industry and are used onboard *IN* ships.

2. Greater participation of the industry for development and production of the under mentioned Electrical/ Electronic equipment, merits consideration.

Navigational Aid Equipment

3. **Gyros**. Indigenous Ring Laser / Fibre Optic Gyro.

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 is being progressed as import substitution of high value items.

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.

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 and 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 as 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**. VLAS is a visual landing aid system installed onboard *IN* ships for providing visual indications to the pilot of a Helicopter, who is coming onboard a ship for recovery. The present equipment fit in the *IN* is of foreign origin which is being supplied by the firm's Indian rep. Design and development of an indigenous Visual Landing aid system by participation of the industry, is considered essential to achieve self-reliance in the domain.

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.

(a) **Luna**. Optical landing aid helps pilot to navigate aircraft for final approach path. Indigenisation of the system is in progress by M/s is being progressed through iDEX route.

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

(c) **Rezistor-E**. Rezistor-E is an instrumental landing system comprising of six sub systems viz RB, SR, FMSC, ACS and MLS. The system is being indigenised under Design and Development route.

Communication Equipment

12. **Rukmani**. A case for indigenous development of Rukmani (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**. A proposal for development of SATCOM terminals (Ku Band) for Submarine application is also being deliberated, as the present equipment fit is supplied by foreign OEMs. Participation of the private industry in the project is recommended as it envisages development of in-board equipment, outboard Antenna head units, and necessary ancillaries.

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/ services through ToT through PSUs like HAL, BEL and ECIL etc. 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 EOI was hosted on MoD website post accord of AoN by SCAPCC on 06 Dec 18. Post receipt of budgetary offers, the Project Sanction Order was issued. However, limited success has been achieved till date. Participation of more firms in the project is recommended for materialising the project.

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). *IN* requirements for the proposed IIM envisages integration of ELINT, COMINT, CAW and Data Link antenna on a single mast without Radome. Private industry may propose suitable solutions in the domain, especially development of frequency selectable radome for consideration by *IN*.

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 in technology, there is 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. **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.

22. **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.

23. **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

24. **Induction of Lithium Ion Batteries**. Case for Li-Ion batteries for submarine and ship application is being progressed by the *IN*. Further, towards inducting Lithium Ion Batteries for ship borne applications, development in potential application areas such as AELs, LED based lamps and UPS is being progressed. Involvement of private industry in development of Li-Ion batteries for these already identified applications, and future applications (as and when finalised by the *IN*) is deemed to be essential.

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

(a) Automated Power Management System (APMS) and Main Switchboard.

(b) Alternators.

(c) Motors.

(d) Helo Starting Rectifiers.

(e) LED Luminaries.

(f) Ruggedised UPS and ATS.

26. **Axial Flux Motors**. Conventional Induction motors used onboard ships are Radial Flux Machines where in 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:-

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

(b) **Permanent Magnet Material**. Use of permanent magnets would yield the performance results from Axial Flux machines.

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

27. **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:-

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

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

(c) **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/ C3 Equipment and their Integration

28. **Navigational Radars**. These radars are generally extremely low power CW radars with complex signal processing and capable of detecting targets without being picked up by EW systems. These are being supplied as COTS items by multiple Indian vendors.

29. **Air Surveillance Radars**. Early Warning radars have traditionally been sourced from M/s Bharat Electronics 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. Further, the private sector is also participating in the development of radars with M/s TASL supplying the 3D ASR for the new construction platforms. As part of the future requirements, development of an indigenous 3D-AMDR is being progressed by DRDO. Involvement of the private sector is being further encouraged as replacement of foreign origin ASRs is also likely to be undertaken with suitable indigenous substitutes in the future.

30. **Command Control & Communication System**. Command, Control and Communication (C3) 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 C3 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. C3 systems are required to be developed to incorporate following areas in support of commanders engaged in command and control:-

(a) Reconnaissance and Surveillance

(b) Environmental Observation and Forecasting

(c) Intelligence Analysis

(d) Electronic warfare

(e) Navigation

(f) Strategic and Tactical Weapons Deployment

31. **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.

32. **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.

33. 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

34. 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. Proposals for projects envisaged to be taken up under 'MAKE' category, Projects under 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

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:-

(a) Advanced Electronics and Computation.

(b) Sensors (Photonics, Laser, MEMS).

(c) Advanced Weapons.

(d) C^4ISR and Network Centric Operations.

(e) Advanced Propulsion, Energy Storage and Power Systems.

(f) Warship Design.

(g) Stealth.

(h) Advanced Materials.

(j) Autonomous Systems and Robotics.

(k) Artificial Intelligence.

(l) Software Defined Radio.

(m) 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. **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:-

(a) Development of Multifunction Phased Array Radars.

(b) Development of Synthetic Aperture Radars (SARs).

(c) Development of Low Probability of Intercept (LPI) Radars.

(d) Development of Millimetre Wave Radars (MWR).

16. **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.

17. **QUINS (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.

18. **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}` 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.

19. **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.

20. **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.

21. **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.

22. **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.

23. **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.

24. **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

25. 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.

26. 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.

27. 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 electronics-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.

28. 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 market.

29. 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).

30. 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.

31. **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, the 'Directed Energy Weapons (DEW)'.

32. **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.

33. **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.

34. **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.

35. **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.

36. 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.

37. **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 per sec and, therefore, the ranges that can be achieved are limited.

38. 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.

39. **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 per second. It is projected that hypersonic velocities of up to 6 km per second 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.

40. **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:-

(a) **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.

(b) **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.

41. **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 and Network Centric Operations - C^4ISR and NCO

42. 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. 'Network Centric Operations' 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.

43. **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.

44. **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.

45. **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.

46. 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.

47. **Technology Status and Trends**. Advances in C4ISR 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:-

(a) **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, Defence Space Agency.

(b) **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.

(c) **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 developmental agency DLRL and production partner BEL(Hyd), most capable EW system available worldwide. An Advanced Integrated EW system incorporating future technologies need to be progressed to meet the current and future challenges.

48. **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-manoeuvre 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 disseminated to the relevant units. This would require high speed modems and reliable, high-bandwidth communication backbone.

49. **Network Centric Warfare**. A C4ISR 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.

50. **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 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.

51. **Common Information Grid**. Since the C4 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.

52. **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.

53. **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.

54. **Network Security**. Protection of C4ISR 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.

55. **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

56. **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.

57. **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.

58. **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.

59. **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:-

(a) **Proton Exchange Membrane Fuel Cells (PEMFC)**. The electrolyte in the PEM fuel cell is a thin polymer membrane (such as poly perfluorosulphonic acid, NafionTM, 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 volt, 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 per cent 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.

(b) **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 (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°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.

(c) **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.

(d) **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°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 carbon

monoxide 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 per cent efficiency and this could potentially rise to 80 per cent if the waste heat is 106anomete. Development work needs to be undertaken to improve their efficiency, as these hold good promise for naval applications.

(e) **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 per cent carbon monoxide and a few ppm of 106anomet 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.

(f) **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.

(g) **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 107anometer107 with yttrium oxide, instead of a liquid. These cells can reach efficiencies of around 60%. Energy is generated by the migration of oxygen anions 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 107anomete 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.

60. **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.

61. 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.

62. **Electrical Propulsion**. Electrical 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.

63. 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 electrical propulsion option more attractive.

64. **Marine Engineering Systems**.

(a) **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.

(b) **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.

(c) **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 kts. 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.

65. **Production and Design Technology**.

(a) It is essential to develop technology for use of air-lubricated bearings for use 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.

(b) 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:-

(i) Analytical tools, viz., Bond graphs for machine design.

(ii) Advanced machining technologies for manufacturing components.

(iii) Computer-aided production, planning & control relevant to warship aspects.

(iv) Investment casting technology.

Warship Design

66. **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.

67. **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.

68. **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.

69. **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.

70. **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.

71. **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.

72. **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.

73. **Other Hull forms**. Various other newer hull forms like Delta hulls, Planing Hulls, M Hull forms and Hybrid Hull Forms are also under extensive investigation by other advanced navies.

Stealth

74. 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.

75. **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.

76. **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 < 200Hz need to be further explored.

77. **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 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.

78. **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

79. 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.

80. **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.

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

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

(a) Fabricating items such as doors, hatches, ventilation flaps, hanger shutters etc.

(b) 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.

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

(d) Suitable composite armour materials also need to be identified / developed to provide protection for personnel against small and medium 115anomet arm 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.

83. **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.

84. **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.

85. **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 built up.

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

87. **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:

(a) Superconducting magnets for electrical motors and ship propulsion.

(b) Superconducting magnetic sensors for mine detection.

(c) Superconducting magnetic systems that store energy for burst power.

(d) High-Q cavities for high-resolution radar system.

(e) Low-power analog and digital circuits.

88. 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.

89. **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 TiAlNb with Silicon Carbon (SiC) fibres, may be useful for compressors. Static engine components will require high-modulus inter-metallic compounds such as g-TiAl. The high-temperature capability of super-alloys based on Ni-Al is expected to meet the 2,000°C requirement.

90. **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.

91. **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.

92. **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.

93. **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.

94. **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, 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.

95. **Nano-Phase Materials**. A new emphasis in material science centres on the nanometer (10^{-9} metre) 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 behaviour 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.

96. The capacity to carry out high-resolution lithography capable of manufacturing devices with critical dimensions on the order of a 118 anometer 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.

97. **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 aluminium oxides 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 power generation 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.

98. **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 fibre 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.

99. **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.

100. **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.

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

102. **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.

103. **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

104. 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.

105. Some of the illustrative applications are:-

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

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

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

(d) Generating physical mass in the battlespace through resilient swarms of low-cost systems.

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

(f) Supporting an active military presence in areas where it would not traditionally be possible.

106. **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.

107. **Autonomous Surface Vehicle**. Autonomous surface vehicles have a diverse employability for the *IN.* These range from benign missions eg collection of MET data, Tsunami warning to an offensive role eg swarm attack, *Kamikaze* attacks on opportune afloat/ashore targets, ISR etc.

108. **Autonomous Underwater Vehicles (AUVs)**. These vehicles would enhance operational capabilities of naval forces in underwater warfare, reconnaissance and surveillance. Potential AUV missions include shallow-water mine reconnaissance and counter proliferations in harbours. The US Navy has already acquired a Long-term Mine Reconnaissance System (LMRS), which is a submarine launched and submarine recovered counter-mine system. Future capabilities of UUVs would also include ability to carry a limited range of weapons for attacking detected targets. In the future, surface ships operating in littoral waters can be expected to encounter novel threats like intelligent sleeping mines, frogman, miniature submarines, intelligent torpedoes, etc. Counter-measures already being progressed to include artificial, remote-controlled 'fish', equipped with explosive loads that can be activated through acoustic means.

Artificial Intelligence

109. Technological advancements in Artificial Intelligence (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 Artificial Intelligence/ Machine Learning (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:-

(a) Automated computer-network defence – real time anomaly detection and patching of vulnerabilities.

(b) Logistics – improved and automated stock management and resupply.

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

(d) 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.

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

(f) Streamlining administrative back office functions such as HR and finance.

Appendix 'A'
(Refers to Para 26 Chap 3)

INDIGENISATION REQUIREMENT OF EQUIPMENT AND SYSTEMS
MARINE ENGINEERING

Ser	Description
Main Propulsion Equipment	
1.	Marine Diesel Engine (Capacity: 3-10 MW)
2.	Gas Turbine Engines (Capacity: 20-30 MW)
3.	Electric Propulsion System (Capacity: 6-10 MW)
4.	Shafting System-Plummer Blocks and Shaft (with capability to design and integrate)
5.	Fixed Pitch and Controllable Pitch Propeller for Frigate and Destroyer Class of Ships
6.	Waterjet Propulsion System
7.	Boiler Control System-INS Vikramaditya
8.	Hydrogen Based Engine (1-3 MW)
9.	Marine Diesel Engine with Stern Drive (330 HP)
10.	Reduction Gears (1-50 MW)
11.	Main Propulsion Control System for Gas Turbine
Power Generators	
12.	Gas Turbine Generators (Capacity: 1-4 MW)
13.	Steam Turbo Generators (Capacity: 1-2 MW)
Auxiliary Equipment	
14.	Magnetic Bearing Compressor for AC Plant
15.	Bilge Oily Water Separator
16.	Variable Stroke Gear (VSG) Pump for Steering and Stabiliser System
17.	Magnetic Bearing Pumps
18.	Fuel Transfer Pump with Motor (400 TPH)
19.	AVCAT Transfer Pump
20.	Advanced Motion Control Systems/Motion Interceptors for Roll and Pitch Stabilisation
21.	Turbo Blower Unit-INS Vikramaditya

Ser	Description
22.	Turbo Driven Forced Lubrication Pump-INS Vikramaditya
23.	Turbo Driven Circulator Pump-INS Vikramaditya
24.	Composite Material Sea Water Pump 125 TPH
25.	Composite Material HP Air Bottles
Miscellaneous Item	
26.	Bow Thrusters

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Appendix 'B'
(Refers to Para 6 Chap 4)

INDIGENISATION REQUIREMENT OF EQUIPMENT AND SYSTEMS OF SUBMARINES

Ser	Description
1.	Telescopic Hangers
2.	Integrated Platform Management System (IPMS)
3.	Hoistable Mast
4.	De-Mineralised Water (DM) Plant
5.	System Valves (Hull and Doubler)
6.	HP Air Compressor
7.	MU12 Volumetric Pump
8.	MU12 B Hydraulic Pump
9.	MU12 D1 De-Mineralised Pump
10.	MU12 D2 Self Priming Pump
11.	MU12 D3 Centrifugal Pump
12.	Diesel Exhaust Valves
13.	Turbo Charger-1.1 MW Diesel Engine
14.	Emergency De-Ballasting System
15.	Rosa 42 System for EKM Submarines
16.	Diesel Governor for EKM Diesel Engine
17.	Steering Console
18.	LoX Tank for Air Independent Propulsion

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Telephone: 011-23010802, 23010622
Email: dme@navy.gov.in

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Appendix 'C'
(Refers to Para 2 Chap 5)

INDIGENISATION REQUIREMENT OF AIRCRAFT HANDLING EQUIPMENT

er	Description	Point of Contact
1.	Ship Based Hoisting and Lifting Equipment (Aircraft / Vehicle/ Lifts and Cranes)	Directorate of Marine Engineering NHQ/ MoD, 129/A, Sena Bhawan, New Delhi 110 011 Telephone: 011-23010802 Email: dme@navy.gov.in
2.	Arresting and Restraining Gear	
3.	Carrier Based Fixed Wing Aircraft Arrester Wire Recovery System	
4.	Aircraft Catapult Launch System	
5.	Dynamic Positioning System	
6.	Flight Deck & Hangar Fixed Fire Fighting System	Directorate of NBCD NHQ/ MoD, 2ND Floor, 'D' Block, Defence Offices Complex, Africa Avenue, New Delhi -110023 Telephone: 011-26771564 Email: dnbcd@navy.gov.in

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Appendix 'D'
(Refers to Para 31 Chapter 7)

INDIGENISATION REQUIREMENT OF NAVAL ARMAMENT STORES

Ser	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 & Indigenisation, Naval Headquarters West Block -V, Wing No. 5 (FF) RK Puram, New Delhi – 110 066 Tele: 01126194691 Email: 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 -T	Air Armament	
16.	Ignition Cartridge K-716-1 (У-418) (for ignition of Booster Engine Igniter)		
17.	Igniter B-287 (for ignition of solid propellant charge of booster engine)		
18.	Safety & Actuating Mechanism (9E129/ PIM 9E129)		

Ser	Item Description	End Use	Point of Contact
19.	SRGM Ordnance	Gun	Directorate of Armament Production & Indigenisation, Naval Headquarters West Block -V, Wing No. 5 (FF) RK Puram, New Delhi – 110 066 Tele: 01126194691 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	
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 Packag	Missiles	

Ser	Item Description	End Use	Point of Contact
33.	Breaking disc	Underwater Article	Controllerate of Naval Armament Inspection (West) Naval Dockyard, Gun Gate, Mumbai 400023 Tele: 022-22751977 Email: wnccnaimb@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		
46.	Inclinometer N215000100		
47.	SRP Bag W036494		
48.	Diode & piles box		
49.	Shaft propeller assembly WMP 32440009		
50.	Steering control assembly W WMP 324400392		
51.	Electromechanical assembly W018370		
52.	Hydraulic Pump with Reduction Unit 2517.011.0000-01		
53.	Tail Unit 2517.020.0000		
54.	Steering Engine (829.25.03)		
55.	Steering Engine (810.11.10)		
56.	Starting Device - 2517.038.0000		

Ser	Item Description	End Use	Point of Contact
57.	Towed Reel БК4.769.010-01		Controllerate of Naval Armament Inspection (West) Naval Dockyard, Gun Gate, Mumbai 400023 Tele: 022-22751977 Email: wnccnaimb@navy.gov.in
58.	A- spool kw 20 279.648 683		
59.	Exercise Section I EF6037G049		
60.	Exploder(Exploder DM1 9A1 279.601 027		
61.	Ignition Amplifier (Ignition Amplifier DM16) 279.994 340		
62.	Safety & Actuating Mechanism	Air Armament	
63.	Solid Propellant Rocket Motor		
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		
81.	Memory Box	Missile Mockup	
82.	Laser Guided Bombs along with accessories	Air Armament	
83.	Imitator-R	Simulator for underwater article	

Ser	Item Description	End Use	Point of Contact
84.	Sea trial kit	Under water article	Controllerate of Naval Armament Inspection (East) PO: Naval Armament Depot, Vishakhapatnam 530009 Tele: 0891-2571143 Email: enccnaiv@navy.gov.in
85.	Steering Engine КЯ2-503-026		
86.	Steering Engine 243.08.000-01Э		
87.	Steering Engine 810.10.11-01		
88.	SFE and Barrel 243.59.000		
89.	Horizontal Rudder Independent Control Mechanism 243.19.022		
90.	Cassette – ACAKC-HB (CHE-IE) 468332.071		
91.	CGM КЯ2.300.019 ПС		
92.	UID 825.52.000 T		
93.	Converter 253.58.000-I МЭ		
94.	Nozzle Box 243.40.000 МЭ		
95.	UID M825.01.000		
96.	Starting Valve 243.10.000		
97.	Combustion Flask 243.12.000		
98.	Depth and Heel Corrector 243.58.000		
99.	Stop Valve unit 243.14.000		
100.	Valve Unit 243.06.003-I		
101.	Hydraulic pump 2517.011.0300		
102.	Relay unit рэ-7 2517.053.0500		
103.	Homing Head 778248.001		
104.	Pack 2517.040.0050-01		
105.	AIE (Mod) 778211.002		
106.	Torpedo Reel		
107.	Distance Gear - 2526.010.000		
108.	Forward Propellers A666.393.030-01		
109.	Aft Propellers A666.393.031-01		
110.	Pack 2517.040.0050		
111.	Pack 2517.040.0300-1		
112.	Pack 2517.040.0300		
113.	Stern Bush 260.019.0102		

Ser	Item Description	End Use	Point of Contact
114.	Forward Propeller 260.021.010	Under water article	Controllerate of Naval Armament Inspection (East) PO: Naval Armament Depot, Vishakhapatnam 530009 Tele: 0891-2571143 Email: enccnaiv@navy.gov.in
115.	After Propeller 260.021.011		
116.	Converter and Frequency Stabilizer ПТО-1000 & БР42Н		
117.	ADKPC 260.07.001		
118.	Electronic Pack 2517-040-0300		
119.	Relay unit рэ-7 2517.058.0000-01		
120.	Relay unit рэ-10 2517.054.0050		
121.	Motor Ап-19Y1		
122.	Long Storage Battery		
123.	Start Battery 26 НКМ-5 (ЙПВЕ.563511.011)		
124.	Towed Reel		
125.	Torpedo Reel		
126.	Tail Section (2556.020.000)		
127.	On Board Computer Complex (OBCC) БЦВМЗАРЯ-43	Air Armament	
128.	3M54E W/H		
129.	3M54TE W/H		
130.	Radar Homing Head У554-5		
131.	Thermal Battery (Part No. 6277205)	Under water Article	
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	

Ser	Item Description	End Use	Point of Contact
139.	TGPSU (Turbo Generator Power Supply Unit)	Air Armament	Controllerate of Naval Armament Inspection (East) PO: Naval Armament Depot, Vishakhapatnam 530009 Tele: 0891-2571143 Email: enccnaiv@navy.gov.in
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 (Seperable Type Only)	Mock up Missile article	
149.	Missile Mockup 3M14ETBM and 3M54ETBM		
150.	Actuating Gear 1392253-100012	Underwater Article	Controllerate of Naval Armament (S) PO:NAD Alwaye 683563 0484-2838384 Email: sncnaia@navy.gov.in
151.	Sealing Paste Y-30Э-5	Air Article	
152.	Refilling of A244S War head	Underwater Article	The Controllerate of Naval Armament (Ordnance Factories) Ammunition Factory Khadki Pune – 411003
153.	Mk 1 Mod 3 Squib (Motor disconnector) for A244S		
154.	Ejection Safety System	Air Armament	
155.	SRGG (ГТТ-95)		
156.	KH-35 Explosive Bolts		
157.	TGPSU (Turbo Generator Power Supply Unit)		
158.	Rocket Motor		
159.	Safety and Actuating Mechanism alongwith Detonator, Squib & Pellet		

Ser	Item Description	End Use	Point of Contact
160.	TVC Explosive Bolts		Tele: 020-25922760 Email: naipune@navy.gov.in
161.	Thermal Battery squib and Ignition Tape	Air Armament	
162.	Igniter SquibS-4753 with P/N R01S0010A		
163.	Limpet Mine 7kgs and 15kgs	Mines	
164.	P-50T Bomb	Bomb	
165.	SBP for 100mm Ammn	100mm Ammn	
166.	ACOUSTIC HEAD FOR MOD 3 TORPEDO WMP324400429	Underwater Article	The Controller of Naval Armament Controllerate of Naval Armament (Defence Production) Naval Armament Inspectorate PO – Kanchanbagh Hyderabad – 500 059 Tele: 040-24342595 Email: naihyderabad@navy.gov.in
167.	AG 2000 RACK WMP324400277		
168.	SCAN BOARD WM 9940119900		
169.	I/O BOARD WM 9940120600		
170.	DSP BOARD WM 9940120700		
171.	PPC BOARD WM 9940133200		
172.	DC/DC CONVERTER WTP 324400206		
173.	A244/s MOD 3 D& P TORPEDO with container WMP324400046		
174.	Transmitting Load DM16 M1298		
175.	DM16 for SUT Torpedo		
176.	VSM Rocket Motor	Air Armament	
177.	AM Rocket Motor		
178.	Igniter of AM Rocket Motor (Booster)		
179.	Gas Generator (GGEMA)		
180.	Jet Deflector thermal Battery		
181.	Pyrotechnic thermal battery		
182.	Ancillary thermal battery		
183.	Homing head thermal battery		
184.	Missile thermal battery		
185.	Homing head		
186.	Locking Pad Gas Generator		
187.	Ignition Cartridge (ДП4-3)		

Ser	Item Description	End Use	Point of Contact
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 Controllerate of Naval Armament (Defence Production) Naval Armament Inspectorate PO – Kanchanbagh Hyderabad – 500 059 Tele: 040-2434 2595 Email: naihyderabad@navy.gov.in
189.	Igniter Squibs (ПС-95ТМО)		
190.	Igniter Squibs (ПС-95ТМ) (Qty -02) (for relighting in case of SE flame out) (Used along with Electric Igniter эВП-19)		
191.	Auto-pilot БУ-10		
192.	Section No.4 9М381э.0401.000-01		
193.	Radar Homing Head (RHH) 9э501э		
194.	Section 1 Assembly 9М317.0100.000-05		
195.	Section 4 Assembly 9М317.0400.000-02		
196.	Thermal battery	Mockup Missile Article	
197.	Ship-Borne Close-in Weapon Systems	Miscellaneous	Directorate of Weapons Equipment NHQ/ MoD, 6th Floor, 'D' Block, Defence Offices Complex, Africa Avenue, New Delhi - 110023 Tel:011-26771356
198.	Anti-Submarine Rocket Launchers		
199.	Ship-Borne Medium Range Gun		
200.	Torpedo Tube Launcher for Light Weight Torpedoes		
201.	Ship-Borne Sonars for Large Ships		
202.	Hull Mounted Submarine Sonar		
203.	Expandable Aerial Targets		
204.	Anti Torpedo Decoy		
205.	Ship-Borne Surface Surveillance Radar		

Ser	Item Description	End Use	Point of Contact
206.	Portable Diver Detection Sonar	Miscellaneous	Email: dwe@navy.gov.in
207.	Composite Sonar Dome for Ships		
208.	Upgraded 76 mm SRGM		
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		Directorate of Weapons Equipment NHQ/ MoD, 6th Floor, 'D' Block, Defence Offices Complex, Africa Avenue, New Delhi - 110023 Tel:011-26771356 Email: dwe@navy.gov.in
214.	Anti-Submarine Warfare Sonar for shallow water		
215.	Ship Based Vertical Launched Short Range Surface to Air Missile System		
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

DETAILS OF ITEMS FOR INDIGENISATION – NAVAL AVIATION		
Ser	**Part No**	**Description**
MiG 29K		
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

Ser	Part No	Description
22	5.41.6100.1140.00	Telescopic assembly
23	5.15.6100.0280.00	Telescopic unit
24	KT211M.060	Rotor plate
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	SPTA FOR SU30.97.CABLE LOOM (RTC CABLE LOOM)	Radar Test Cable Loom (11 by type)
39	5.41.9920.1300.00	Eqpt for pressure check shock strut
40	051.08.0500	AAGB Box
41	KN35.007	Valve Body
42	5.41.2210.1007.09	Bolt
43	781-2-E	Small Sized Avionics Clock
44	247663	Washer
45	257755	Sealing Ring
46	TK-7849-4270-03	BKDU-130 Hose (V)
47	TK-7849-5100-01	Oxygen hose
48	TK-7849-5120-470	Hose
49	TK-7849-4270-01	Hose
50	TK-7849-5120-520	Hose
51	TK7849-5120-03	Oxygen hose
52	TK-7849-5120-600	Hose
53	TK-7849-5300	Hose
54	5.41.5313.8440.00	Clamping block
55	5.41.5313.8410.00	Clamping block
56	5.41.5313.8425.00	Clamping block

Ser	Part No	Description
57	5.41.5313.8450.00	Clamping block
58	20407198020	Shim
59	5.41.5313.8460.00	Clamping block
60	TK 7849-5120-550	Oxygen Hose
61	15 M	Air Hose
62	2-1000	Hose
63	3-1500	Hose
64	TK 7849-5120-450	Oxygen Hose
65	TK-7849-5120-01	Oxygen Hose
66	TK-7849-5300-01	Hose
67	8D0.447.005-01-28	Fluoroplastic sleeve
68	8D0.447.005-20-28	Fluoroplastic sleeve
69	8D0.447.005-20-41	Fluoroplastic sleeve
70	8D0.447.005-20-46	Fluoroplastic sleeve
71	8D0.447.018-20-47	Fluoroplastic sleeve
72	8D0.447.024-30-35	Fluoroplastic sleeve
73	8D0.447.005-30-47	Fluoroplastic sleeve
74	5125A-86-2	Ring
75	007-01019-2-043 ost 1 00980-80	Ring
76	2267A-517-2	Sealing ring
77	5125A-83-2	Ring
78	5.15.6407.8001.98	Screw
79	8.21.0100.0131.98	Screw
80	TKS2010DL	Contactor
81	M5-6Yekh 16.109.30kh GSA.029 GOST 10336-80	Instrument Panel Screw
82	5.47.7701.0600.00	Screw
83	5.47.7701.0500.00	Screw
84	3-8-khim pas-OST 131544-80	Screw
85	3-10 khim pas-OST 131544-80	Screw
86	5.01.7110.0130.00	Static Discharger
87	5.41.0430.0441.09	Rivet
88	5.41.0430.0444.09	Washer
89	009-013-25-1-112	Sealing Ring
90	021-025-25-1-112	Sealing Ring
91	020-024-25-1-112	Sealing Ring
92	5.41.0106.0005.98	Bolt
93	5.41.4200.1200.09	Rubber Bar

Ser	Part No	Description
94	5.31.4701.0030.00	Buffer
95	5.41.0430.0080.00	Piano Hinge Rod
96	8.21.0100.0131.98	Screw
97	5.41.0100.0033.09	Screw
98	BA8.0920.021-12	Bolt
99	BA8.920.021-07	Bolt
100	FAZ.811.001 (YUSP-3)	HUD Alignment Tool
101	052-058-36-1-035-A-OST1 00980-80	Ring
102	021720051	Flange
103	027-031-25-2-OST 100980-80	Ring
104	5-20-KHIM.PAS.OST1 31504-80	Screw
105	903-7200-1400	AIT Battery for Ejection Seat / Self contained power source
106	5.41.9850.1400.00	Sling for mounting and Canting
107	5.15.9927.0070.91	Blanking for Air Intake (LH & RH)
108	5.15.9927.0070.92	Blanking for Air Intake (LH & RH)
109	5.41.9915.7500.00	Mounter for wings
110	G15	Appliance for removing insp. hole blank
111	G22	Appliance for removing insp. hole blank
112	A3819-0000	Maintenance Stand
113	1320-0000	Tyre 300 x 125 Model 5A (For Trolley A1320M-0000)
114	5.17.9915.1300.00	ZHUK-ME Monoblock Lifting Slings
115	A1326-0000	Wheel Remover
116	G103-1	Dial
117	G103-2	Wrench
118	5.41.9915.3500.00	KSA-33M Support

Ser	Part No	Description
119	561032900	Safety blank for HPT graphitic sealing
120	561034300	Engine bench (for vetical mounting of engine)
121	561035900	Fan ring
122	561844970	Device for fan mounting (mounting shaft)
123	561056800	Retainer for 1 support nut tightening
124	564953070	Device for LPT dismantling witout fan
125	561036400	Turbine compressor lifting ring
126	561046200	Wrench with retainer for LPT nut with torque upto 45 kgf.m
127	942860100	Support for LPT rotor
128	988812000	Rig for engine assembly (tilting device)
129	988891400	Support for block 08
130	591811900	Rack for fan storing
131	565051500	Extension for rod 561031900
132	561031900	Rod for checking coaxiality for lp nozzle guide vanes relative to fan rotor pivot pin
133	D7.9911-0	Appliance (Tool for PKU 58 Test Bench)
134	1-2-OST1 10108-85	Device (Brake Bleeding Kit)
135	TK-7849-4290	De-Nitrification Kit (for BKDU)
MH 60R		
136	M83248/1-022	Packing
137	M83248/1-031	Packing
138	M83248/1-141	Packing

Ser	Part No	Description
139	M83248/1-238	Packing
140	M83248/1-910	Packing
141	M83248/2-908	Packing
142	M83248-1-026	Packing
143	M83248-1-128	Packing
144	MS29513-211	Packing Preformed
145	MS29512-06	Packing Preformed
146	MS29512-12	Packing Preformed
147	MS20995C32	Safety Wire
148	MS20995C47	Safety Wire
149	MS21094-4004	Bolt Self Locking
150	MS21094-4006	Bolt,Self Locking
151	SS5211-4H10	Bolt, Shear
152	SS5211-4H12	Bolt, Shear
153	MS28778-10	Packing Preformed
154	M39029/4-110	Pin Contact
155	M7928/1-42	Lug, Terminal (Pwr)
156	M7928/1-41	Lug, Terminal (Gnd)
157	70400-38159-102	Bolt Machine
158	70400-38159-103	Bolt Machine
159	70400-38159-104	Bolt Machine
160	MS20995CY20	Shear Wire
161	MS20995NC20	Safety Wire
162	MS20995NC32	Safety Wire
163	NAS847	Protective Caps and Plugs
164	3609044-1	Oil Filter Element
165	3882693-1	Filter Assy
166	3B940-TC, LS14500	Battery, Lithum ivhmu
167	9010A038	Locknut, Self Locking
168	ASTM D 5486	Tape, Pressure Sensitive
169	Formit-18-Fan	Spray Extension Tube, 18 Long
170	M83461/1-011	Packing Preformed
171	M83461/1-018	Packing, Preformed
172	01-118-5543	Tyre Assy MLG
173	01-480-5161	Tyre Assy NLG
174	M81757/14-1	Aircraft Main Battery
175	AG768000-04	Gasket

Ser	Part No	Description
176	MS35650-302	Nut
177	MS21044C5	Nut (APU)
178	SS4424-04	Gasket
179	70400-08119-108	Insulator
180	AN3-14	Bolt
181	MS17826-3	Nut Self Locking
182	MS24694C59	Screw
183	SB5303-103	Self Aligning Bearing
184	M7444-1-11(m7444-1-1-1)	Polyurethane Tubing
185	NAS1523C12B	Washer
186	2491153	Bolt
187	MS24665-334	Cotter Pin
188	NAS1305-68D	Bolt
189	MS28775-011	Packing
190	79698-820	Insert, Screw
191	37362-1	O-Ring
192	70105-28006-101	Shim
193	70102-28025-102	Shim
194	NAS1149E0663P	Washer
195	NAS1149E0616P	Washer
196	NAS1149C1232R	Washer
197	65104-11022-102	Shim
198	2012A96	Shim Laminated
199	NAS1149D0416K	Washer Flat
200	NAS76B3-027P	Bushing
201	SS5112-316	Bolt Self Locking
202	SS5092-3	Nut Plain
203	MS16624-4125	Ring, Retaining
204	NAS1149D0516J	Washer
205	NAS1149F0563P	Washer
206	NAS1304-16H	Bolt
207	3501614-3	Quill Shaft
208	18D8532-1	Hot Section Wash Nozzle
209	H538A-3	Drain Attachment
210	21C7088P01	Cover, Multiple Purpose, T-700 Engine
211	21C7396P01	Cover, Inlet Engine
212	3218AS760-1	MMR R/T Sled

Ser	Part No	Description
213	70700-20460-041	Cover, Pitot Tube
214	70700-20500-043	Plug Engine Exhaust
215	70700-77106-044	Plug Engine Inlet
216	70700-20502-043	Plug APU Exhaust
217	70700-77108-042	Plug Exhaust Fan-SO Cooling
218	71700-77500-041	Plug Assy
219	71700-77500-042	Plug Assy
220	71700-77501-041	Plug Assy
221	135947-0001	Pins Safety CMDS
222	89SDSCC-D-0162-1	Engine Cover
223	89SDSCC-D-0162-2	Engine Cover
224	TPSESM001	ESM Antenna Cover
225	1509AS300-1	Chock Land Based
226	1610AS100-2	Grounding System Helicopter
227	1479AS400-1	Tow Bar 24 ALBAR
228	70700-77112-041	Bar Assembly Steering
229	3218AS171-1	Hose Assy, Sump Drain, Fuel Tank
230	70073-85000-013	Universal Lifting Sling Assy
231	70700-77515-043	Restraint Set Main Rotor Blades
232	70700-77499-041	Locking Collar TLG
233	3218AS538-1	Accumulator Damper Service Line T3
234	9824	Servicing Unit Hydraulic
235	061477-100	Transmission Fluid Fill Unit
236	53D22020	Jack Aircraft Axle, 5 Ton
237	21C7298G01	Dispenser Water Wash
238	061475-100	Engine Fluid Servicing Unit
239	1317AS100-2	Nitrogen Servicing Unit
240	07180A01	Tool Set, Bridge Removal

Ser	Part No	Description
241	1428AS100	Cylinder Assy- Nitrogen Portable
242	1480AS100-1	Trailer, Engine Transportation
243	18C2268-1	Spline Socket-PAS
244	18C2268-2	Spline Socket- LDS
245	21C7324G02	Stand Shipboard
246	21C7445G01	Hose, Preservation, Fuel System
247	2L8636	Kit, Desiccant Breather
248	3218AS501-1	Wedge, 20 Degree
249	3218AS502-1	Wedge, 30 Degree
250	3218AS503-1	Wedge, 10 Degree
251	3218AS674-1	Tool, Taper Pin Removal
252	3218AS999-1	Tool, Monk Rigging
253	3909AS1400-1	Reeling Machine Bracket, ALFS
254	3909AS1425-1	Wrench, Oil Line Nut
255	3909AS1670-1	Cable Tension Adapter Assy
256	6509861-1	Acoustic Attenuator
257	70700-20324-047	Blade Clamp Assembly
258	70700-20403-045	Positioner Assy Strainer
259	70700-77116-041	MRB/ TRB Adapter Storage and Transport
260	70700-77200-041	Cart Adapter
261	70700-77205-041	Rig Set, Flight Control
262	70700-77383-041	Bushing, I.D. Wearing Tool
263	70700-77408-046	Lifting Bar Assembly, engine/ Components
264	70700-77669-041	Check/ Fill Unit, Nitrogen
265	70700-77684-041	Pin, Rigging
266	915-11515-1	Trim Tab Bending Tool Set
267	M85352/1	Inflator Assembly
268	70700-77342-041	Elastomeric Bearing Suppressor

Ser	Part No	Description
269	3218AS780-1	Cable Reel Lift Table
270	CJ69J1270	Jack Tripod, 12 Ton, Model T12-1FH
271	70400-08171-101	Bridge Retaining Zee
272	70700-77332-041	Tool, Inspection
273	3218AS770-1	Pedestal Cover, Cable Reeling Machine
274	57L414	Hydraulic Fluid Contamination Analysis Kit
275	3218AS790-1	SONAR Accessory Kit (AN/AQS-22)
276	65700-10072-041	Valve assy, Bleed
277	70700-77306-043	Remover/ Installer, Damper bearing
278	D730L	Drain hose assy
279	3218AS505-1	Adapter cable, test set
280	3218AS633-1	Wrench, TLG shock strut
281	3218AS100-1	Adapter set, Pitot-static
282	NIV	Adapter, HP Air/ Nitrogen
283	NIV	Adapter, Cylinder assy-Nitrogen portable
284	NIV	Adapter, Dispenser water wash
285	NIV	Adapter nitrogen service unit
286	NIV	Adapter, Parker nozzle
Seaking		
287	S1525-50514	Washer
288	566286-2	Stud
289	MS28777-8	Ring Backup
290	MS28777-12	Ring Backup
291	MS28777-16	Ring Backup
292	MS28777-6	Ring Backup
293	AN6290-10	Seal
294	BAS160-6-5-24-16	Sleeve Connecting
295	BAS160-6-5-32-16	Sleeve

Ser	Part No	Description
296	S6130-80009-2	Bolt
297	575311	Pin Cotter
298	BL-5497-1	Tube Swivel Hook Keeper Retaining
299	624AG5HD	Nut Generator Mount
300	567080	Washer, Cup Bullet Starter
301	2752-054RET	Retainer Nut
302	NK4-11A	Bolt
303	AN381-3-18	Pin Cotter
304	A103CT	Nut
305	AS3492-01	Gasket
306	577327	Gasket
307	SS4021-5-16B	Seal
308	N13219	Washer Sealing
309	AN6236-1	Element Filter
310	S6130-80110	Nut
311	N6595	Nut Lock
312	N12935	Tab Washer
313	S6110-21085-5	Element Lock
314	WD01-60-90005-17	Tube Assy
315	WD01-60-90005-19	Tube Assy
316	WD01-60-90005-21	Tube Assy
317	WD01-60-90005-35	Tube Assy
318	WD01-73-90141-1	Hose Assy
319	WD01-73-90141-2	Hose Assy ALT
320	S6165-20531-77	Tube Assy
321	S6165-20531-129	Tube Assy
322	S6130-80415-1	Hose Assy
323	WD01-57-90060-69	Tube Assy
324	WD01-73-90060-105	Tube Assy
325	S6165-20531-23	Tube Assy
326	S6165-20531-125	Tube Assy
327	WD01-73-90140-22	Hose Assy
328	S6165-20531-59	Tube Assy
329	S6165-20531-9	Tube Assy
330	WD01-73-90060-109	Tube Assy
331	S6165-62070-868	Tube Assy

Ser	Part No	Description
332	S6165-20531-85	Tube Assy
333	S6165-62070-285	Tube Assy
334	272-982051-IKV	Sleeve Adaptor
335	2837-003E	Filter
336	2837-002E	Seal
337	WD01-81-51119	Clip
338	2622	Gasket
339	S6110-26032-1	Boot
340	SS7016-1	Wire Ground
341	D660	Connector
342	D2370-120	Element, Sensing
343	X5-49348	Fastener
344	601002-12D0362	Hose Assy
345	S6135-20842-1	Bush Assy
346	NE1258275	Packing
347	5007205	Lining Brake
348	BL-4	Clip
349	4582	Filament Lamp
350	4580	Filament Incandescent
351	WD4282-13040-041	Mic/Tel Connector Assy. (External)
352	WD4282-13040-045	Mic/Tel Connector Assy. (Pilot/ Co-Pilot)
353	WD4282-13040-047	Mic/Tel Connector Assy. (Tacco/Senso)
P8i		
354	42424-02	EO/IR Purging kit
355	F70199-52	Tyre inflation Tool (TIT)
356	R/C-AOAC-2	Aircraft Angle of Attack Vane Cover
357	0061BN1	Aircraft Ice Detector Probe Cover
358	MC960002-4	Wing Pylon Lifting Assy
359	F70200-18	Strut Inflation Tool (SIT)
360	APS06030	Main Wheel Tyre
361	275K22-1	Nose wheel tyre

Ser	Part No	Description
362	1072288P-5	Flat panel monitor
363	MODEL CTT-24-IRJ	Chock Transportation Trolley
364	MODEL K2922-IRJ	Lavatory Service Cart Adapter
365	MODEL ARRHT-24-IRJ	Aft Radar Radome Handling Trolley
366	MODEL ETRF-24-IRJ	EOIR TDU Removal/ Fitment GSE
367	MODEL MC960006-57-IRJ	Wing Pylon Inspection Trolley
368	MODEL CBLMS-24-IRJ	Conveyor Belt
369	10-6401-0010-IRJ	Portable Aircraft Lavatory Service Cart
370	NA	Crash and Salvage Trolley
371	SPL-2336	Engine Fuel Pump Removal Cradle
372	MODEL-ECPL-25-IRJ	Engine Cowl Pylon ladder
KM-31		
373	620X180M 3A	Tyre Main Wheel
374	480X200M 14A	Tyre Nose
375	503.9901.0600.000	Fore Wheels Control Arm
376	160X60 MODEL 2	Brake Inner Tube
377	N5810-270	Non Return Valve
378	NA	Tube Main Wheel Tyre
379	NA	Tube Nose Wheel Tyre
380	78029906402	Bushing 12 MM
381	500.5101.5045.000	Cover
382	800.6001	V/V Charging
383	KT44-100	Brake PADP
384	25N10-14X1	Cap
385	KT44-70	Spring
386	19ZH-1028	Key
387	KT38-24	Lock Nut
389	OD38-11	Cap
390	KT44-53	Cup 1
391	KT44-54	Cup 2

Ser	Part No	Description
392	KT44-40	Flanged Connection
393	KT96A.031	Casing
394	KT44-52	Ring
395	500.9940.0000.000	Systems Charging and Test desk
	HAWK	
396	772B35798	Kit Inflation/ Charging MK6A Adaptor
397	S3S20763000	Sling Engine
398	KB132K0846-002	Kit Rigging Engine Control
399	S3S2024300	Manufacturing of LP/HP Compressor Washing Rig
400	MBSS1-100	Manufacturing of Ejection Seat Servicing Stand
401	MBSS141	Adapter Ejection seat/ Adapter Arm
402	KB131K0008-002	Canopy Cover Hawk
403	10141	Gauge
404	6373-017-410EA	Indicator
405	NA	Polarised LCD Film Weapon Control Panel / (Part of 261-0001-01A, WCP)
406	501D201885D	Guard Debris Port
407	501D201886D	Guard Debris Stbd
408	KB131K0004-000	Blank
409	OE-B1101A	Chock and Tensioner
410	40-148-001	Relay Module
411	40-615-022-4/20/2-R	Multiplexer Module
412	778572-27	64x1 Multiplexer Switches
413	778793-01	8x1 High Speed Multiplexer Switches
414	778697-02	Arbitrary Wave Form Generator
415	780446-04	PXI Controller

Ser	Part No	Description
KV-28		
416	1-OST1 11045-73	Manufacturing of Wheel Chocks
417	500.9940.0000.000	System Testing Kit
418	500.9955.3500.000	Appliance for washing and emulsifying Engine
DOR		
419	JD38999/26WJ35PN	Connector with Cable
420	JD38999/26WE35SN	Connector with Cable
CTK		
421	3160-92-00-240 ICGMBY	Modified Steering Arm

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Appendix 'F'
(Refers to Para 34 Chap 9)

ELECTRICAL/ ELECTRONIC PROJECTS UNDER PROCESS/ INDIGENISATION REQUIREMENT

Ser	Description	Status	OEM/Vendor
1.	Motors of Various Ratings	Completed (Vendor Base Expansion in progress)	M/s Narhari Engg Works M/s Poly Phase Motors M/s Ketaki Engg Pvt. Ltd M/s Laxmi Hydraulics Pvt Ltd, M/s KEC M/s Megha Rototech
2.	Switchboard with APMS	Completed (Vendor Base Expansion in progress)	M/s L&T M/s Marine Electrical M/s Siemens Ltd M/s Precision Power Products M/s Symtronics
3.	ATS (Auto Transfer Switch)	Completed (Vendor Base Expansion in progress)	M/s Precision Power Products M/s Marine Electrical, Mumbai M/s Sipani Defence, Bengaluru
4.	Helo Starting Rectifier (HSR)	Completed (Vendor Base Expansion in progress)	M/s Static Transformers M/s Precision Power Products M/s L&T

Ser	Description	Status	OEM/Vendor
5.	LED Light Fitting Including Magazine Light Fitting	Completed (Vendor Base Expansion in progress)	M/s Ray Enterprises M/s Mcgeoch Marine M/s Zeal Tech M/s Sipani Energy Ltd.
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
Indigenisation in Progress/ Planned			
8.	HVLAS	-	M/s AMA 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	-	M/s BEL
14.	Indigenous Integrated Mast (IIM)	-	M/s ATLA, Japan & 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
17.	Development of Varuna Lite EW System	-	M/s BEL
18.	Digital Beam-Forming Based Satellite TV (DB2ST)	-	M/s Rangsons

Ser	Description	Status	OEM/Vendor
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 M/s BEL
24.	Rukmani (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	-	M/s BEL
28.	Software Defined Radio	-	M/s BEL
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	-	M/s BEL
32.	SDR for Combat Ships (SDR NC)	-	M/s BEL
33.	Battery Monitoring System for Submarines	-	M/s Precision Power Products

Ser	Description	Status	OEM/Vendor
34.	Alternators for Ships (up to 1.5 MW)	-	M/s Kirloskar Electric Co Ltd M/s Cummings Generator Technology M/s Elmot Alternators Pvt Ltd M/s TDPS M/s BHEL
35.	DC Insulation Measuring Instrument for EKM Submarines	-	M/s Precision Power Products
36.	Shipborne Main Broadcast System	-	M/s Elcome Integrated System, Mumbai M/s Linia Engineering Services M/s Phi Audiocom
37.	Data Network for Ships	-	M/s BEL
38.	Ship Borne 1KW High Frequency Trans-Receiver	-	M/s Avantel
39.	IFF MKXII-S	-	M/s BEL
40.	Intercom System for Ship and Submarines	-	M/s Linia Engineering Services
41.	Link II MOD III for Ships and Submarines	-	M/s BEL
42.	Radar Finger Print System for ELINT Application	-	M/s BEL
43.	Deep Sea Side Towing Winch (DS4TW)	-	M/s L&T
44.	COMINT (Ship Based)	-	M/s BEL
45.	Remote Embedded System Support (Remote Control/ Monitoring Panels for Electrical/Machinery) for Naval Ships	-	M/s Info Allies M/s Yeoman Marine Services Pvt Ltd.

Ser	Description	Status	OEM/Vendor
46.	High Data Rate VLF-HF Receivers for Ships	-	M/s BEL(Panchkula)
47.	IU for AWOS-MNS for VKD	-	M/s Keltron
48.	Li-Ion Battery for Submarine Application	-	-
49.	LCU (AMDR 2D)	-	-
50.	Rotary Joint (AMDR 2D)	-	-
51.	TWT (AMDR 2D)	-	-
52.	BSI Module (RLG Sigma-40)	-	-
53.	SPC (Fregate M2EM)	-	-
54.	Mobile Cable Handling Assembly (MoCHA)	-	-
55.	LED Based Taxy, Landing and Navigation Lights	-	-
56.	Optical Landing System	-	M/s Celeritas
57.	Camera Based Tracking System	-	M/s Celeritas
58.	Deck Lighting System for Air Craft Carrier (SATURN)	-	M/s Elcome
59.	Indigenous Development of KTSOD Data Link	-	M/s Whirly Bird
60.	Indigenous Development of Buran Data Link	-	M/s Whirly Bird

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Appendix 'G'
(Refers to Para 2 Chap 10)

PROJECTS UNDER 'MAKE' CATEGORY

Ser	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 m3/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 Rukmani SATCOM Terminals
19.	Turbocharger for P-75
20.	127 mm Guided Projectile
21.	30 mm Ammunition for Naval Surface Gun
22.	Next Generation Helo Harnessing and Traversing System (ASIST)
23.	Semi-Submersible Autonomous Vessel for Intelligence, Operations and Reconnaissance (SAVIOR)-ASW
24.	Compact Autonomous Surface Craft All Domain Effects - Anti Submarine Warfare (CASCADE-ASW)
25.	Shore based Guided Rockets (SB-GR) System
26.	Quantum Encryption Modules for secure Satellite Communication

Ser	Project
27.	16 Core Advanced Hybrid Armoured Fiber Optic Undersea Range Cable
28.	Naval Aerial Robotic System
29.	Emergency De-Ballasting System for SSKs/ P-75
30.	76/ 62 SRGM High Explosive (HE) and High Explosive Pre-Formed Fragmented (HEPFF) Ammunition'
31.	Medium Speed Marine Diesel Engine (6 MW – 9 MW)
32.	URAN SSM Fire Control System
33.	Electro Optical IR Search and Track System (EOIRST)
34.	127 mm Medium Calibre Gun
35.	30 mm Naval Surface Gun
36.	76 mm Super Rapid Gun Mount
37.	12 MW Electric Propulsion for ships
38.	4MW Marine Gas Turbine based Electric Power Generator
39.	Extra Large Autonomous Underwater Vehicle (XLAUV)
40.	Ship Borne Laser Weapon System (30KW)
41.	Lightning Detection System
42.	Infantry Weapon Training Simulator (IWTS)
43.	Multipurpose Forklift Truck
44.	Foldable Fibre Glass Mat
45.	APTORS (Automatic Pilot Landing and Take Off Recording System)
46.	Aircraft Recovery Dollies
47.	Aircraft Lifting Slings
48.	Transition Platform with Trailer
49.	High Altitude Pseudo Satellite
50.	Airborne Multi-constellation GNNS Receiver and Converter
51.	R-73
52.	HSLD MK II (Rampage)

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Appendix 'H'
(Refers to Para 2 Chap 10)

PROJECTS UNDER INNOVATIONS FOR DEFENCE EXCELLENCE (iDEX) SCHEME

Ser	Project
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 IN SATCOM Network.
17.	Development of On-board Processing and Beam Switching Payload for 'Ku' and 'Ka' Band GEO Satellite for High Throughput Maritime Requirements.

Ser	Project
18.	Beam steering Ku band SATCOM Antenna over IN SATCOM Network for MR aircraft.
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

Ser	Project
43.	Monolithic Telescope-based Imaging System
44.	Disposal of Expired Ammunitions & Bombs into Sea
45.	Heavy Lift Tethered Aerial Vehicles (HLTAV)
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.	ALMERIO Environmentally-Shielded Modular Portable Proof/Practice Chamber for Small Arms/Ammunition (up to 12.7mm) and 100 m Length (can be extended up to 300 m) ESMPPC-SAA
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)

Ser	Project
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
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

Ser	Project
99.	Reusable Off board Missile Decoy
100.	Microwave Obscurant Clouds (MOC) which are Programmable based on the Threat
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 IN 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 Suppressant Material that can Suppress Fire in the Initial Stage only
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

Ser	Project
121.	Development of Low cost, Indigenous Morpene Compound
122.	Axial Motor based Portable Submersible Pumps in order to Sustainability reduce Weight
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 IN 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 IN 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

Ser	Project
145.	AI based Remote Monitoring System to assess Wear down of Outboard Shaft Bearing
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.	Vegazel - Very High Speed Data Transfer
155.	Encore - Video Streaming Solution to Relay UAV Footage in Real Time
156.	Submarine Detection Technology
157.	Tactical Multi Role Combat Airborne Loitering UAS
158.	Material Movement Shifting Onboard Ship over Hatch Door Coaming
159.	Labour Saving Devices for Material Shifting Onboard Submarines
160.	Secure AV Communication
161.	Nonintrusive, Multistep and Multi-Technology Fusion Intrusion Detection Systems to Secure Defence Establishment
162.	Achieving IR and Ultrasonic Stealth Through Advanced Material Insulation
163.	Fast, Reliable and Economic Aerial Transport of Armed Forces – Autonomous Cargo Carrying Aerial Vehicle (ACAV)
164.	Heavy Lift Autonomous Flying Robot for Shipborne Operations - Autonomous Cargo Carrying Aerial Vehicle (ACAV)

Ser	Project
165.	Automation of Material Movement between Navy Ship and Jetty
166.	Ultra Endurance Monorotor Drone – ARUN
167.	Zebra Skyplane

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Appendix 'J'
(Refers to Para 2 Chap 10)

PROJECTS UNDER 'TECHNOLOGY DEVELOPMENT SCHEME'

Ser	Project
1	Standalone Miniaturised Telemetry Package (SMTP)
2	Composite WT/GT doors and Hatches for IN ships
3	Leveraging Health and Usage Monitoring Systems (HUMS) for Enhancing Aircraft Serviceability
4	Development of Indigenous Water Jet Propulsion System
5	VLF Loop Antenna including the below deck interface equipment for Kalvari class submarine
6	VLF- HF matrix including the interface equipment for Kalvari class submarines
7	Use of Composite Technology for Bottles Storing HP Air and Hydrogen
8	Development of Marine Desalinators for Life Rafts onboard IndianNaval Ships
9	Tide Efficient Gangway
10	SSPA State 2 Amplifier for AMDR
11	Underwater Launched Unmanned Aerial Vehicle (ULUAV)
12	Pressure gauge – Hawk
13	Motor for Pump-jet Propulsion
14	Wireless Aircraft Flight Data Recorder
15	Buoyant Cable Antenna
16	RF Components for EW System

Ser	Project
17	Radar Absorption Material
18	Mini EW Systems with Tethered Drone
19	Fibre Optic cables with Connectors – RPA
20	Optical Torsion Meter
21	Multi-Function Antenna
22	Engine Fire Detection System LRUs – Sea King Aircraft
23	Submarine Launched Autonomous Underwater Vehicle (SLAUV)
24	TGR (Terminal Guidance Radar)
25	Development of Indigenous Thrusters
26	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	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.

Ser	Projects	Description
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.
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 rd/ 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 3rd generation Night Vision Devices.
22.	Helmet Mounted NVBs	Night Vision Binoculars (NVB) helmet mounted, to provide hands free capability.

Ser	Projects	Description
23.	Fuses	-
24.	Ship Installed Chemical System (SICS)	System capable of detecting Chemical Agents to be installed onboard IN Ships.
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 IN ships.
26.	Specialised SV Mount	Cradle mounts of Talwar Class ships and Raft mounts of P-28 class ships
27.	Motor Boat Engines	-
28.	5MW 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.	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 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, 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 M/s Linea M/s Marine Electricals
10.	LED Light Fittings	M/s McGeoach Marine Electricals M/s Ray Enterprises
11.	Power Panel for Heavy Loads	M/s L&T, Mumbai M/s Marine Electricals
12.	Degaussing Cable	M/s Universal Cables 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 & Radiant Cables
21.	Lighting Cables	M/s Radiant Cables

Ser.	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 M/s Siechem Technology 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)	M/s 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 M/s Krasny
35.	Heat Barrier Coating for Vikrant	NMRL
36.	Acid-Resistance Rubber Coating	NMRL
Additional Shipborne Systems		
37.	GSHRB	M/S ECIL
38.	C & C SW BD	M/S L & T LTD
39.	Emergency DA SWBD	M/S Marine Electricals
40.	20 KVA Convertor	M/S ELMOT LTD
41.	ACOS	M/S Marine Electrical
42.	SIRS	M/S ECIL
43.	ICCP System	M/S Cathodic Control Ltd
44.	Transformer	M/S Static Transformer
45.	Lighting System	M/S ISAAC Engg M/S Manish Industries M/S Arvin Industries M/S Ray Enterprises
46.	Emergency Supply System	M/S AIM Engg M/S ISAAC Engg
47.	30 KVA Helo Convertor	M/S Kirloskar Ltd
48.	Helo Starting Rectifier	M/S Static Transformer

Ser.	Project	Description
49.	CCS MK-III	M/S BEL
50.	VCS-28	
51.	SDN-28	
52.	LINK-II MOD-III	
53.	LUP-329	
54.	100 W MF Transmitter	
55.	EW SANKET	
56.	V/UHF COMNIT/ DF System ELK-7036-WB DF	
57.	MB/SRE	M/s Phi Audio Com
58.	Intercom System	
59.	SATCOM	ISRO
60.	SATCOM, PCS	M/s DEAL/ DRDO/ BEL
61.	Network Security Encryptors	M/s ECIL/BEL
62.	EW Ellora/ Ellora Mk II	M/s DLRL/ BEL
63.	EW Varuna	M/s DLRL/ BEL
64.	CMS-28	M/s BEL
65.	ATM Switch for CMS	
66.	DDU for RLG	M/s Data Patterns Ltd
67.	Kavach Mod –II	M/s Machine Tool
68.	50 KVA Converter	M/s PCL Ltd
69.	Radar Revathi	M/s BEL
70.	UWT	M/s Keltron
71.	Echo Sounder V-2	
72.	AK 630	M/s GSF, M/s Cossipore M/s BEL
73.	SOP for AK 630	M/s BEL
74.	ITTL	M/s L&T
75.	FCS LYNX U1	M/s BEL
76.	IAC MOD 'C'	
77.	SONAR HUMSA NG	
78.	IRL	M/s L&T
79.	Anchor Capstans	M/s Geeta

Ser.	Project	Description
80.	Foldable Hangar Door	M/s L&T
81.	Railed Helo Traversing System	
82.	Shore Supply Cables (including light weight SS cables)	M/s Radiant Cables M/s Siechem Technologies Pvt. Ltd M/s Quadrant Cables M/s Apar Cables M/s Thermo Cables M/s Polycab Ltd.
83.	SFC	M/s Precision Power Products M/s Elcome Integrated System M/s Static Transformers
84.	Boat Davit	M/s HH Group, M/s Fibroplast, M/s SHM Shipcare, M/s Hemant Engg
85.	AC Condenser Cooling Water Pumps	M/s KBL Pumps M/s SPX M/s DESMI
86.	Auxiliary Cooling Water Pumps	
87.	Chilled Water Pumps	
88.	Fresh Water Pumps	
89.	Economiser Elements for Boilers of Vikramaditya	M/s Virtue Engineering M/s BHEL
90.	Valves Fitted in Freshwater, Feed Water, Sea Water and Other Auxiliary System	M/s GDPA, M/s L&T M/s Lender, M/s Meason
91.	Feed Condensate Booster Turbo Driven Pump	M/s TOCOL
92.	Proportioning Pumps for Boiler Dosing	
93.	Motor Driven Fuel Pumps	M/s DESMI M/s Alektor M/s Allenetor
94.	Reducing Stations	M/s Hale Hamilton Pvt Ltd M/s Elgi

Ser.	Project	Description
95.	Globe Valves	M/s GDPA, M/s Meason M/s Lender, M/s L&T
96.	Diesel Monitoring Equipment	M/s Symptronic
97.	Coolant Expansion Tanks	M/s Ship Builder
98.	Electric Bilge Drying Pumps	M/s SPX, M/s MERU M/s DESMI
99.	Refrigerating Plants	M/s Accel, M/s KPCL, M/s JCIPL
100.	HP Air Compressors – Oil Filter (Submarine)	M/s Burckhardt DRDO/ CVRD M/s Elgi
101.	IBA (Integrated Broadcast Application)	M/s Data Byte
102.	HP Air Compressors – Air Filter (Submarine Application)	M/s NUKON Industries DRDO/ CVRD M/s BEKU/ NUCON
103.	Hydraulic Filters Filter Element (Submarine Application)	DRDO/ CVRD
104.	Air + Water Filters Cartridge (Submarine Application)	
105.	Reeled Compressed Air Foam System	M/s Adisan Systems LLP
106.	Indopene Foam Compound	
107.	Development of Integrated SATCOM Multifunction Antenna (ISMS) for SSK Submarines	M/s Navstar
108.	Axial Flux Motors	M/s Tressa Energy
109.	Inertial Energy Storage Systems	M/s ELMOT
110.	SSM Loader	M/s Mahindra Defence Systems Ltd
111.	Fuel/ Lub Oil Centrifuge	M/s Alfa Laval
Indigenisation Process in Progress		
112.	HDVLF Rx	M/s DEAL, M/s BEL
113.	HEMP, 1000 Amps Filter	DRDO, M/s Zeonics

Ser.	Project	Description
114.	Indigenous Secure Router	M/s Nivetty Systems
115.	MDA-DSS (Maritime Domain Awareness – Decision Support Software	M/s CRL, M/s BEL
116.	Fin Stabiliser	M/s L&T
117.	ONEGA Control System	
118.	Development of Portable & Universal Pump Efficiency Monitoring System	M/s CSIR, CSIO
119.	TDFL Pump for VKD	M/s Tocol Machine Tools Pvt. Ltd
120.	Main Circulating Pump for VKD	
121.	Thermal Imaging Camera (TIC)	M/s BEL
122.	85KW DC Motor with starter for HP Air Compressor for Submarines	M/s Elmot Alternator Pvt. Ltd

Appendix 'M'
(Refers to Para 23 Chap 01)

LIST OF *IN* ITEMS UPLOADED ON SRIJAN DEFENCE PORTAL

Ser	Product Description	Item Srijan Portal ID
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

Ser	Product Description	Item Srijan Portal ID
25	Autonomous Surface Vehicle	PRO60908
26	AI Based SCM and Logistics	PRO61045
27	Desalination/Bilge-Oily Water Separation	PRO61046
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. 5.5kw 380v3ph 50hz915 rpm star Winding	PRO70385
50	Hangar Ventilation Motor. 18.5kw	PRO70386
51	Pre Lube Oil Pump Motor. 3.3kw 380v3ph50hz1685rpm Star	PRO70387
52	Ventilation Motor, 2.2kw 380v3ph50hz2895rpm Star	PRO70388

Ser	Product Description	Item Srijan Portal ID
53	Ventilation Motor, 3kw 380v3ph50hz2880rpm Star	PRO70389
54	Ventilation Motor, 7.5kw 380v3ph50hz2925rpm Star	PRO70390
55	Ventilation Motor, 11kw 380v3ph50hz2880rpm Star	PRO70391
56	Bilge Pump Motor 8kw	PRO70392
57	Pressure Reducing Station forApz-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	40KVA 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	3.99M Inflatable Rubber Rib Collar	PRO70431

Ser	Product Description	Item Srijan Portal ID
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
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 Swarns	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

Ser	Product Description	Item Srijan Portal ID
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	1500KW TURBO GENERATOR	PRO71095
117	Sprayer P(Ts)-2.0	PRO71096
118	Sprayer P(Ts)-1.2	PRO71097
119	Interface Unit for AWOS MNS	PRO71111
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

Ser	Product Description	Item Srijan Portal ID
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
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

Ser	Product Description	Item Srijan Portal ID
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
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

Ser	Product Description	Item Srijan Portal ID
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
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	Ehaust 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, 12nos	PRO78520
230	Portable Smoke Generator-NBCD, 30 nos	PRO78521
231	DG Fuel Cooler, 04 nos	PRO78544
232	Indicating Valve, 06 nos	PRO78545

Ser	Product Description	Item Srijan Portal ID
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
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

Ser	Product Description	Item Srijan Portal ID
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
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

Ser	Product Description	Item Srijan Portal ID
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
307	Multi Frequency generator Unit, UCHES Unit and S band Pulse Modulator	PRO79074
308	Course Receiver Unit, X band traget 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

Ser	Product Description	Item Srijan Portal ID
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 60KVA	PRO90708
334	PLCs of Ships Cargo Handling System	PRO90709
335	Spring (Camshaft Drive)	PRO90710
336	Ring Spring	PRO90711
337	Gasket Copper	PRO90712
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

Ser	Product Description	Item Srijan Portal ID
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
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	$5M^3$ /H Oily Water Separator (OWS) System	PRO96209
383	127 mm Guided Projectile	PRO96212
384	Ship Based Rukmani SATCOM Terminal	PRO96213
385	Glide SSM	PRO96221
386	Light Weight High Speed Marine Engine for Naval Boats	PRO96224

Ser	Product Description	Item Srijan Portal ID
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
398	Shore based Guided Rockets (SB-GR) System’	PRO100814
399	12 MW Electric Propulsion for ships	PRO100815
400	4MW 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

Ser	Product Description	Item Srijan Portal ID
408	Ground Handling Equipment (GHE) for Air Loading of IN 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 ***IN*** 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
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

Ser	Product Description	Item Srijan Portal ID
428	Naval Aerial Robotic System	PRO125734
429	Economiser Coils (Elements) for VKD	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
449	Ni-Cd Battery 3.6 V, .9A	PRO125852
450	Flow Indicator	PRO125853
451	Shaft Cooling S/W Flow Detector	PRO125854
452	Flow Indicator	PRO125855
453	Turbo Condensate Pump Motor 7.5KW, 380V,3ph,50Hz,2895rpm Star winding	PRO125856
454	Boiler Chemical Cleaning Pump Motor 4KW, 380V,3ph,50Hz,2880 rpm Star winding	PRO125866

Ser	Product Description	Item Srijan Portal ID
455	Stripping Pump Motor 4KW, 380V,3ph,50Hz,2895 rpm Star winding	PRO125867
456	Feed Water Transfer Pump Motor 4KW, 380V,3ph,50Hz,2880 rpm Star winding	PRO125868
457	Boat Davit Motor 37KW, 380V,3ph,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
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

Ser	Product Description	Item Srijan Portal ID
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: 150kW, 178kW and 182kW 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 40m^3/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
504	Appliance for Lifting Cylinder Liner	PRO127741

Ser	Product Description	Item Srijan Portal ID
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

Ser	Product Description	Item Srijan Portal ID
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
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

Ser	Product Description	Item Srijan Portal ID
548	Inserter 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 Inserter	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
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

Ser	Product Description	Item Srijan Portal ID
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
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

Ser	Product Description	Item Srijan Portal ID
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
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

Ser	Product Description	Item Srijan Portal ID
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
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

Ser	Product Description	Item Srijan Portal ID
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-(l)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.ox21.8	PRO157534
677	Bonded Seal 17.0x24.0, Pt No SAX/TC/1 3 1 /75l 17 .Ox24.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
680	Bonded Seal 31.0x38.0, Pt No. SAVTC/1 31/75131.0x38.0	PRO157556
681	Bonded Seal 34.0x43.0, Pt. No.SAX/TC/1 31 /75134.0x43.0201A	PRO174352
682	Bonded Seal 39.0x48.0, Pt. No. SAXIT Cl I 31 17 5139.0x48.0	PRO174354
683	Bonded Seal 49.0x59.0, Pt. No. SAXrI d 1 31 17 51 49.0x59.0	PRO174356
684	Bonded Seal 50.0x64.0, Pt. No. SAXIT Cl 1 31 17 5150.0x64.0	PRO174357

Ser	Product Description	Item Srijan Portal ID
685	Bonded Seal 67.0x79.0, Pt. No.SAXTC/1 31/75/67.0x79.0	PRO174358
686	Bonded Seal 175.0x86.0, Pt. No. SAXrf C n 31 n 5175.0x86.0	PRO174359
687	Spring loaded Oil seal 35x58x10, Pt. No. SR6001 D-lCA-35-58-1 0-1 1 36	PRO174360
688	Spring loaded Oil seal 35x60x12, Pt. No. SR6001 D-lCA-35-60-12-1 136	PRO174361
689	SHIM Anti Flap 70105-28006-101	PRO174363
690	Spring loaded Oil seal 50x70x10, Pt. No. SR6001 D-lCA-s0-70-10-1 1 36	PRO174367
691	Spring loaded Oil seal 55x80x12, Pt. No. SR6001 D-lCA-55-80-'1 2-1 1 36	PRO174369
692	Spring loaded Oil seal 120x150x12, Pt. No. SR6001 D-|CA-120-1 50-12-1 136	PRO174377
693	Spring loaded Oil seal 280x320x18, Pt. No. SR6001 D-lCA-280-320-1 8-1 136	PRO174380
694	Gland Cup Seal (Special) C-25x40x6, Pt. No. SR6001 D -C-25-4O-6-3O1 2	PRO174381
695	Gland Cup Seal (Special) C-30x45x6, Pt. No. SR6001 D-C(CH)-1 03-1 01 -328	PRO174382
696	Gland Cup Seal (Special) C-30x50x8, Pt. No. SR600 1 D-C-30-50-8-301 2	PRO174383
697	Gland seal (Special) 25x4Ox7 .5, Pl. No. SR600'1 D-S-25x40x7 .5-301 2	PRO174384
698	Bonded Seal 25x40x4.4, Pt. No.SR6OO 1 D-S-25x4ox4.4-3012	PRO174385
799	SHIM,70102-28025-102	PRO174389
700	Washer, NAS1149E0663P	PRO174395
701	Washer, NAS1149E0616P	PRO174396

Ser	Product Description	Item Srijan Portal ID
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

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Appendix 'N'
(Refers to Para 4 Chap 10)

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